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Specification

High pedestal or portal jib cranes

UDC 621.873.7

Co-operating organizations

The Mechanical Engineering Industry Standards Committee, under whose supervision this British Standard was prepared, consists of representatives from the following Government departments and scientific and industrial organizations:—

Admiralty*
Air Ministry
Associated Offices' Technical Committee*
Association of Consulting Engineers (Incorporated)
British Chemical Plant Manufacturers' Association
British Compressed Air Society
British Electrical and Allied Manufacturers' Association*
British Electricity Authority and Area Boards
British Engineers' Association
British Internal Combustion Engine Manufacturers' Association
British Iron and Steel Federation*
British Railways, The British Transport Commission*
Crown Agents for the Colonies*
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Institution of Mechanical Engineers*
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Locomotive Manufacturers' Association
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Ministry of Transport*
Ministry of Works
National Physical Laboratory
Radio Industry Council
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The Government departments and scientific and industrial organizations marked with an asterisk in the above list, together with the following, were directly represented on the Committee entrusted with the preparation of this British Standard:—

Aluminium Development Association
Association of Crane Makers
British Constructional Steelwork Association
Cable Makers' Association
Chamber of Shipping of the United Kingdom
D.S.I.R.—Building Research Station
Dock and Harbour Authorities Association
Docks and Inland Waterways, British Transport Commission
Engineering and Allied Employers' National Federation
Excavator Manufacturers' Association
Federation of Civil Engineering Contractors
Institute of Welding
Institution of Engineering Inspection
Institution of Structural Engineers
National Federation of Building Trades Employers

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Foreword

This standard makes reference to a number of British Standards which are listed in Appendix C.

This British Standard forms one of a number of standards relating to jib cranes, others being for low carriage jib cranes and mobile cranes.

It indicates the minimum requirements for electrically driven jib cranes, either fixed or movable, other than those covered by BS 327-1 and BS 327-3, BS 357 or BS 1757. It therefore covers the types frequently referred to as "wharf" or "dockside" cranes.

As with other British Standards for cranes, the object of the specification is to ensure reliability and safety, without placing restrictions on the general design of cranes or the methods employed in their construction.

Appendix E contains a list of Factories Acts legislation affecting cranes in Great Britain.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 22, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

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1 Scope

This specification applies to electrically driven jib cranes of the following types, mounted on a high pedestal or portal carriage:—

Type A. Level luffing.

Type B. Derricking.

Type C. Fixed radius.

It does not apply to the cranes dealt with in BS 327-1[1] or BS 327-3[2] or BS 357[3] or BS 1757[4].

Figure 1 to Figure 3 illustrate some of the types of crane to which the standard applies.

2 Information to be supplied with enquiry or order

All information regarding the conditions under which the crane is to be used, together with the particulars required to complete Appendix A, should be supplied with the enquiry or order.

3 Information to be supplied by manufacturer

The manufacturer shall supply to the purchaser the information regarding the construction of the crane required to complete Appendix B.

4 Materials

As far as is practicable, the materials used in the construction of the crane shall comply with the British Standards given in Appendix C.

No timber shall be used in any stress bearing part of the crane structure.

5 Service conditions

The crane shall be deemed to be under service conditions when it is operating without load or with a load up to and including the safe working load, and shall include, in the case of outdoor cranes, the load imposed by the wind pressure as specified in BS 2573-1.

6 Radius — load indication

The crane shall bear a legible and permanent inscription naming the safe working load (S.W.L.) or loads, the radii appropriate thereto, and the BS class of crane 2, 3 or 4 (see Clause **7**).

For cranes of variable radius, separate clear indication of the permissible loads at the various radii shall be given by means of an indicator, which shall be in full view of the operator.

When change-speed gear is used for the hoisting motion a corresponding safe working load for each speed shall be indicated.

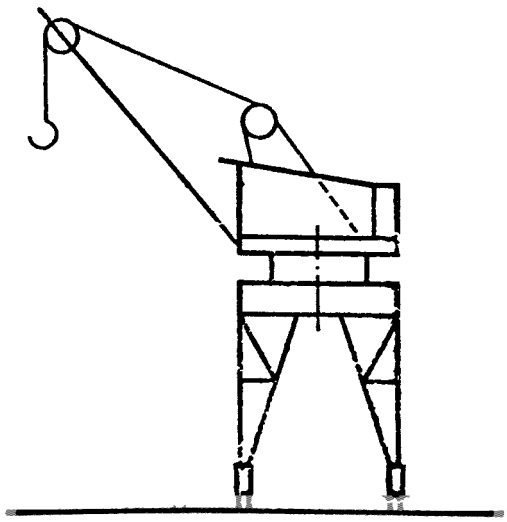

Figure 1 — Types of high pedestal or portal jib cranes

[1] BS 327-1, "*Power-driven derrick cranes*".

[2] BS 327-3, "*Power-driven rail mounted derrick and tower derrick cranes*" (in course of preparation).

[3] BS 357, "*Travelling jib cranes (contractor's type)*".

[4] BS 1757, "*Power-driven mobile cranes*".

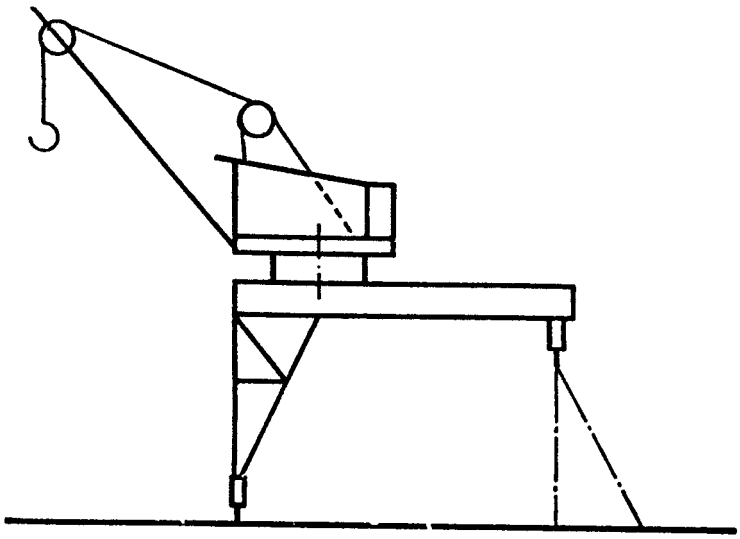

Figure 2 — Types of high pedestal or portal jib cranes

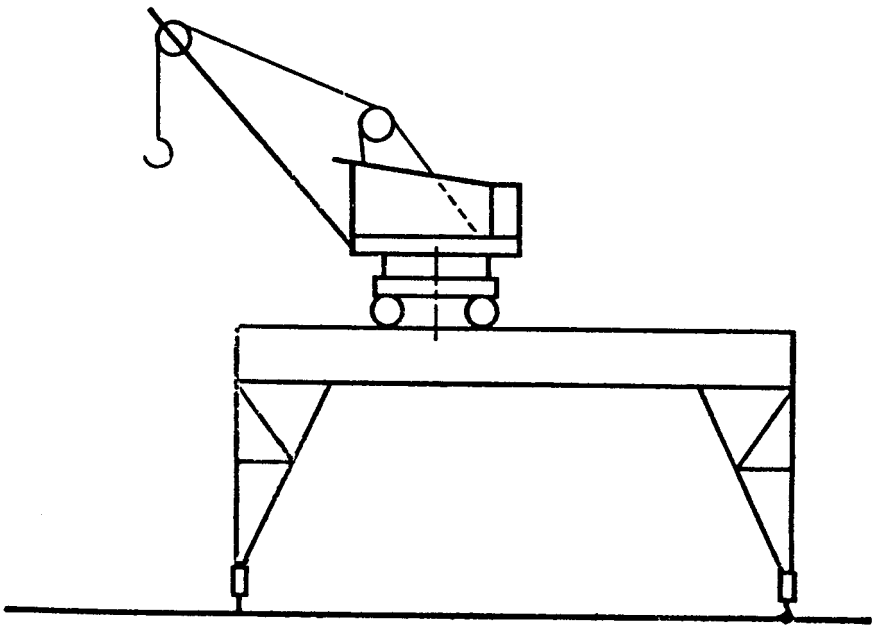

Figure 3 — Types of high pedestal or portal jib cranes

7 Classification and duty

This British Standard covers the design and construction of Classes 2, 3 and 4 cranes and the duty related to each of these classes is given below. For the purpose of computing permissible stresses, BS 2573 divides cranes into these same classes.

Class	Maximum number of hours in use per year (for design purposes)	Description of duty
2	2 000	Medium duty for general use
3	3 000	Heavy duty — intermittent grabbing and magnet work
4	Greater than 3 000	Extra heavy duty — continuous grabbing and magnet work

NOTE The previous Classes 1, 2 and 3 have been superseded by the Classifications 2, 3 and 4 respectively which have been adopted to align with BS 2573.

8 Permissible stresses

The structure of the crane shall comply with BS 2573-1:1960.

The factor of safety for all other parts of the crane shall be not less than 5, with the exception of gearing and wire ropes, for which see Clauses **26** and **32**.

9 Slewing

The acceleration and retardation of the slewing motion at the jib head when the crane is working at the radius at which the maximum stress is induced shall be assumed to be not less than the following:—

Class 2. $\frac{V}{240}$

Class 3. $\frac{V}{200}$

Class 4. $\frac{V}{160}$

where V is the rated slewing speed in feet per minute at the jib head and at the radius under consideration.

The value for the acceleration and retardation shall not, in any case, be taken as less than 2 ft/sec/sec.

The slewing speed at the jib head should not normally exceed 750 ft/min.

10 Wind

Text Deleted

11 Stability

Class 2 and Class 3 cranes shall not tip with less than 1.75 times, and Class 4 cranes with less than twice the safe working load at its maximum radius with not less than 5 lb/sq.ft. wind pressure.

The crane shall not tip either under storm conditions (see BS 2573) or with the jib removed.

These conditions shall be fulfilled without depending on the use of anchoring devices.

Where possible the vertical projection of the centre of gravity of the revolving superstructure shall be kept inside the horizontal rollerpath for all service conditions.

12 Crane structure

Text Deleted

13 Structural sections

Wherever practicable the rolled steel sections used in the work shall be in accordance with the appropriate British Standards.

14 Minimum sections

Plates, flat bars or angles used in the load-bearing members of the structure shall be not less than $\frac{5}{16}$ in. thick.

15 Jibs

The jib feet and the members by which they are connected to the revolving bedplate shall be of steel. Spigoted bearings of steel with bushes or of cast iron may be inserted into the jib feet to diminish the intensity of bearing pressure.

Diaphragm braces shall be provided for stiffening the jib when the jib is of lattice construction.

With jibs derricked by ropes buffer stops shall be provided, wherever practicable, just inward of the minimum radius.

16 Struts, including jibs

The slenderness ratio, $\frac{l}{k}$, for any strut shall be obtained by dividing the effective length,[5] l, of the strut in inches by the appropriate radius of gyration, k, in inches. For pin-jointed struts of tapered or parabolic form the value of k shall be the least radius of gyration within the middle third of the length.

[5] This is also known as the "equivalent length".

The slenderness ratio $\frac{l}{k}$ of strut members entirely of lattice construction shall not exceed 100. Where a strut consists of joists, channels or plated sections connected by latticing, the ratio $\frac{l}{k}$ shall not exceed 100 in the latticed direction and shall not exceed 160 in the direction not latticed.

The latticing and plating of a strut member shall be proportioned to resist, in the direction of each principal axis, the maximum applied transverse shear at any cross section plus 2½ per cent of the maximum axial load under service conditions. Where there are two parallel planes of bracing, the shear may be divided between them.

Struts including jibs shall be designed to comply with BS 2573.

17 Plate girders

The stresses in plate girders shall be calculated by moment of inertia and section modulus methods in accordance with BS 2573. The minimum thickness of webs, the maximum spacing for stiffeners and proportioning of stiffeners shall also be in accordance with BS 2573.

The flanges of plate girders shall be connected to the web plates by sufficient rivets or adequate welding to transmit the maximum horizontal shear at each point throughout the length of the girder together with the shear due to vertical loads transmitted to the girder from wheels or rollers, which loads shall be assumed to be distributed over a horizontal distance of $3d$, where d = depth of rail in inches. If flange plates are used, they shall be connected by sufficient rivets or adequate welding to transmit the maximum horizontal shear.

Flange angles shall form as large part of the flange area of riveted girders as practicable and the number of flange plates shall be a minimum.

If double-web plate girders are used, that part of the top flange plate between the webs shall not be assumed to give adequate support to the rail, and, if necessary, shall be supported at intervals to transmit the load from the rail to the girder webs.

18 Braced or lattice girders

The flanges (chords) of lattice girders shall withstand, in addition to the direct tensile or compressive stresses in the flanges, the local bending stresses due to the maximum wheel or roller loads and their own weight between the panel points.

Local bending moments to be assumed in the calculation of stresses shall be not less than $WL/6$ at the panel centre and $WL/12$ at the panel points where W is the total vertical load on the member arising from live load and the weight of the member, and L is the distance between panel points. The rail shall not be deemed to contribute to the strength of the members.

Where single angle bars connected by one leg are used as tension members the effective sectional area shall be taken as the net sectional area of the connected leg added to one-half of the sectional area of the free leg. If both legs are cleated at the end connections the net sectional area of the angle shall be taken.

The latticing of compression members shall be proportioned to resist a transverse shear at any point in the length of the member not less than 2½ per cent of the axial load in the member.

The thickness of flat lattice bars shall be not less than one-fortieth of the shortest distance between the centres of connections, in the case of single latticing, and one-sixtieth in the case of double latticing connected at the intersection.

All members shall, as far as possible, be placed symmetrically about the line of resultant load and all rivets grouped symmetrically about the same line. The neutral axes of intersecting main members shall, as far as possible, meet in a common point.

Not fewer than two rivets at each joint shall be used for the connection of riveted bracing members.

If the top chord of a braced or lattice girder has double webs, that part of the top flange plate between the webs shall not be assumed to give adequate support to the rail and, if necessary, the flange plate shall be supported at intervals to transmit the load from the rail to the girder webs.

If practicable, structural members shall be so designed that every part is accessible for periodical inspection, brushing and painting. Suitable drain holes shall be provided where water is likely to collect.

All tubular members shall be so sealed as to prevent the ingress of moisture to the inside of the members. Where a tubular member is drilled to take bolts or studs provision shall be made to prevent ingress of moisture. For example, a transverse sleeve can be inserted where a bolt passes through a tube, or grommets can be used under the bolt head and nut.

19 Working stresses in structure (excluding struts)

Text Deleted

20 Joints

a) *Strength of joints.* The calculated strength of riveted joints or joints made by friction grip bolts in structural members shall be not less than the calculated net strength of the member.

The calculated strength of other bolted joints in structural members shall be not less than the net strength of the member plus 25 per cent.

The calculated stress in rivets, bolts and welds shall not exceed the permissible stresses given in BS 2573.

Welded joints shall be designed in accordance with BS 2573.

b) *Rivet and bolt holes* (except those for friction grip bolts). All rivet and bolt holes shall be drilled accurately and all arrises and burrs shall be removed before assembly.

The diameter of holes for rivets shall not exceed the nominal rivet shank diameter by more than $^{1}/_{16}$ inch.

The diameter of holes for precision bolts shall not exceed the nominal bolt shank diameter by more than $^{1}/_{64}$ inch.

Where turned bolts are used in the structure the plain barrel part of the bolt shall be sufficiently long to ensure adequate bearing area for the load.

Where bolts are used in shear they shall be fitted into reamed holes. Black mild steel bolts shall not be used for joints in stress bearing members.

c) *Friction grip bolts.* Friction grip bolts shall comply with BS 3139 and shall be fitted in accordance with the recommendations of BS 3294, "*The use of friction grip bolts in structural steelwork*".

d) *Rivet spacing.* The distance between the centres of rivets for stress-bearing parts shall be not less than 2½ times the diameter of the rivet, and shall not exceed sixteen times the thickness of the thinnest outside plate or angle. Where two lines of staggered riveting are used in the same angle or flange, the maximum distance between the rivets on each line may be taken as 1.5 times those given above.

The distance between centres of rivets and the sheared or hand flame cut edge of a plate shall be not less than 1.75 times the diameter of the rivet, and between the centre of the rivet and a rolled, machined, or machine flame cut edge shall be not less than 1.5 times the diameter of the rivet.

e) *Welding.* All welding shall comply with BS 1856, "*General requirements for the metal-arc welding of mild steel*" or BS 938, "*General requirements for the metal-arc welding of weldable structural steel tubes*".

21 Rivet spacing

Text Deleted

22 Rivets and bolts

Text Deleted

23 Fusion welding

Text Deleted

24 Bolts, other than those used in crane structure, and set screws

Bolts and set screws in rotating parts shall be locked; but this provision shall not apply to set screws used for locking purposes. The tensile stress on the net section of a bolt or set screw shall not exceed 3 tons/sq. in. for steel. The use of bolts and set screws in tension shall be avoided wherever possible.

25 Supports for the slewing part for the crane

The rotating part of the crane shall be supported by a bearing system which shall be designed to withstand the load and moment from the rotating part under both service and test conditions.

It shall be possible to remove the supporting system or its components without dismantling the superstructure.

The slewing mechanism shall be so designed that it is not damaged due to heavy braking or reversal of the motion.

NOTE This may be achieved either by designing the drive mechanism to resist the torque imposed by the above conditions or by the insertion of a torque limiting device (e.g. a slipping clutch) which will protect the mechanism from excessive shock loading.

26 Wire ropes (see Clause 8)

Ropes, unless otherwise specified or agreed by the purchaser shall be in accordance with BS 302, "*Round strand steel wire ropes for cranes*", but the 6 × 61 construction shall not be used for ropes of less than 1¼ in. diameter. The breaking strength of the lifting rope or ropes shall be not less than six times their safe working load for Class 2 and Class 3 cranes and 7.5 times the safe working load for Class 4 cranes. For grabbing cranes the safe working load shall be the weight of the grab together with the maximum weight of the contents that the grab is designed to lift. The factor of safety for derricking or luffing ropes shall be not less than 8. When a load is supported upon more than one part of rope, the tensions in the parts shall be equalized.

Eye splices, sockets, thimbles and rope anchorages shall be capable of withstanding not less than 90 per cent of the breaking strength of the rope or ropes to which they are attached. A thimble or loop splice shall have at least five tucks, three tucks with the whole strand of the rope, and two tucks with one-half of the wires cut out of each strand. The tucks shall be under and over against the lay of the rope. The splice shall be tightly drawn and neatly made. These requirements shall not operate to prevent the use of another form of splice that can be shown to be as efficient.

NOTE 1 This paragraph embodies the requirements of Clause **20** d) of the Docks Regulations 1934, made under the Factory and Workshops Act, 1901.

NOTE 2 When ordering a replacement rope it is important that a rope of the same quality of material, description of wire, construction, diameter and guaranteed breaking load as the original (for particulars see item 13 "Ropes" of Appendix B) is ordered, unless it has been agreed by the manufacturer of the crane or other competent person that a different rope should be fitted.

Where Bordeaux connections are fitted, the method of splicing described in the Appendix to BS 461, "*Bordeaux connections for wire rope and chain for general engineering purposes*" is recommended. Arrangements entailing reverse bends shall be avoided as far as possible. Except where non-spinning ropes are used, ball-bearing swivels shall be provided in lifting ropes with the object of preventing the accumulation of twist.

27 Rope drums

a) The diameter of drums and pulleys, measured at the bottom of the groove shall not be less than those given in Table 1.

Table 1 — Diameter of rope drums add pulleys

Class of crane r r r	Diameter of drum or pulley at the bottom of the grove (d = diameter of rope)		
	Drums	**Working pulleys**	**Compensating pulleys**
2	19d	21d	12d
3 and 4	22d	24d	15d

When selecting the appropriate drum or pulley to rope ratio, consideration should be given to Appendix A of BS 302:1968, "*Steel wire ropes for cranes, excavators and general engineering purposes*", which discusses the advantages to be gained in terms of rope fatigue life when larger ratios are used.

b) Rope drums shall be machine grooved, and the bottom of the grooves should have a circular arc over an angle of not less than 120°. The radius of the groove should be not less than 5 % nor more than 7½ % larger than the nominal radius of the rope.

The grooves on the drum shall be pitched so that there is clearance between neighbouring turns of rope on the drum, and also clearance between the part of the rope leading on to, or leaving the drum, and the adjacent coil.

The clearance between neighbouring turns of rope should not be less than:

1.6 mm $^1/_{16}$ in) for ropes up to and including 13 mm (½ in) diameter.

2.4 mm ($^3/_{32}$ in) for ropes over 13 mm (½ in) up to and including 28 mm (1⅛ in) diameter.

3.2 mm (⅛ in) for ropes over 28 mm (1⅛ in) diameter up to and including 38 mm (1½ in.) diameter.

For larger sizes of rope the clearance will need to be specially considered for each application.

c) The drum shall be sufficiently wide to accommodate in one layer the length of rope requisite for the specified lift, and in addition not fewer than three dead turns at each anchored end and one spare groove at the other end.

Rope anchorages shall be readily accessible.

d) The angle between the rope and a plane perpendicular to the axis of the drum shall not exceed 1 in 16 (3° 35′) for lifting ropes and 1 in 12 (4° 47′) for derricking ropes.

e) The drum shall be flanged at both ends, and when the rope is fully wound on the drum, the flanges shall project a distance not less than two rope diameters beyond the rope.

This shall not imply that an additional flange is to be provided when a spur or brake wheel is spigoted to the drum, and so forms one of the flanges.

28 Rope pulleys [see Clause 44 c)]

a) The diameter of rope pulleys at the bottom of the groove shall not be less than those specified in Clause **27** a).

b) Rope pulleys shall be machine grooved to a depth not less than 1½ times the diameter of the rope.

The contour at the bottom of the groove shall be circular over an arc of not less than 120°. The radius of this part of the groove shall be larger than the radius of the rope by the amount laid down in Clause **27** b).

Grooving shall be finished smoothly and be free from surface defects liable to damage the rope.

c) Pulleys shall be guarded to retain the ropes in the grooves.

d) The angle between the rope and a plane perpendicular to the axis of the pulley shall not exceed 1 in 16 (3° 35′) for lifting ropes and 1 in 12 (4° 57′) for derricking ropes.

e) Guide pulleys or rollers of light construction, preferably with ball or roller bearings, shall be fitted on the jib and other parts of the structure, where required, to prevent chafing of the ropes.

29 Lifting hooks

a) For loads up to 50 tons, ordinary type hooks shall comply, as regards strength and safety, with BS 482, "*Wrought iron and mild steel hooks for cranes, chains, slings, blocks and general engineering purposes (excluding building operations) and Liverpool or C*" type of hooks shall comply, as regards strength and safety, with BS 591, "*Wrought iron and mild steel hooks of the "C"*" or Liverpool type. For loads of 40 tons and" upwards ramshorn or triangular (or closed) hooks are to be preferred.

All hooks shall be tested as follows:—

For loads up to 50 tons	twice SWL
For loads from 50–100 tons	SWL + 50 tons
For loads over 100 tons	1½ times SWL

where SWL is the safe working load in tons.

The stress in the shank at the least section, under safe working load, shall not exceed:

For hooks up to 50 tons	3 tons/sq. in.
For hooks over 50 tons and not exceeding 75 tons	$\left(\frac{\text{SWL}}{25} + 1\right)$ tons/sq. in.
For hooks over 75 tons	4 tons/sq. in.

b) Hooks shall rotate upon ball or roller bearings and, where required, shall be provided with an efficient catch to prevent displacement of the sling or load from the hook, or shall be of such a shape as to reduce as far as possible the risk of such displacement. For ramshorn hooks care should be taken that the saddles on the two sides are at the same level.

c) The safe working load shall be legibly stamped on a non-vital part of each hook and a test certificate shall be supplied.

30 Shackles

a) Shackles shall comply as regards strength and safety with BS 825, "*Mild steel shackles*" and shall be provided with screwed pins.

b) When used eccentrically, the shackle shall not be subjected to a load in excess of one-third of the normal proof load.

c) Each shackle shall be legibly stamped at a non-vital part with an identification number and the pin of the shackle shall bear the same number (see Clause **16** of BS 825).

31 Overhauling weight

For single-fall hoisting the hook shall preferably be connected to the free end of the rope by means of a short length of chain, and the overhauling weight and ball bearing swivel, when us d, shall be attached to the top of the chain. If the overhauling weight is attached directly to the rope, the weight shall be machine-bored and bell-mouthed at the top and bottom unless the rope is efficiently served or otherwise protected; provision shall be made for the examination of the part of the rope passing through the weight. For split overhauling weights it is preferable that four bolts be used for connecting the two halves; all bolt heads and nuts shall be sunk and the nuts locked.

32 Gearing

a) All gearing shall be of steel with the following exceptions:—

i) Wheels may have steel rims secured to cast iron or steel centres.

ii) Worms or worm wheels may be of bronze.

b) All gearing shall be machine cut with the exception of slewing racks and their engaging pinions which may have cast or machine-moulded teeth. Slewing racks may consist of steel channel, or other sections, with pins for teeth.

c) All gearing shall comply with the appropriate British Standard, as follows:—

BS 436, *Machine cut gears. A. Helical and straight spur*;

BS 545, *Bevel gears (machine cut);*

BS 721, *Machine cut gears. C. Worm gearing.*

and the load capacity of the gears shall be computed as described in those standards subject to such modifications recommended in Appendix D.

Although the standard pressure angle of 20° is preferred, it may be noted that for gears with 14½° pressure angle, the load capacity for the strength should be multiplied by 0.8, but the load capacity for wear will remain the same.

d) Keys in gear trains shall be so fitted and secured that they cannot work loose.

e) Where worm gearing is used as a first motion drive it shall, under test, have the same load and time rating as the driving motor, and the temperature-rise of the oil bath when measured by thermometer shall not exceed 100 °F. (56 °C) above the temperature of the atmosphere.

f) Wherever possible all gear wheels shall be a force fit on their shafts.

g) It is desirable that the number of teeth, pitch, pressure angle and material should be stamped on all gear wheels and pinions.

h) A slipping clutch, or its equivalent, should be provided in the slewing mechanism.

33 Gear boxes

Gear boxes shall be designed so that the gears which they enclose will be automatically lubricated and the boxes shall be virtually oil-tight. They shall be fitted with inspection covers, with facilities for oil filling and drainage and some means of indicating clearly the maximum and minimum oil levels. Gear boxes shall be designed so that the gears are readily removable. Change gear levers should be positively locked.

34 Shafts and axles

Shafts and axles shall have ample rigidity and adequate bearing surfaces for their purpose. They shall, where necessary, be finished smoothly, and where shouldered shall be provided with fillets of as large a radius as is practicable.

35 Keys and keyways

Keys and keyways shall be in accordance with BS 46-1, "*Keys and keyways*", and the bottom corners of keyways shall be rounded.

36 Bearings

Bearings for shafts running at 450 r.p.m. or more shall be of the ball, roller, or ring-lubricated type.

If they are of the ball or roller type they shall be mounted in dust-proof housings.

If of the ring-lubricated type they shall have oil reservoirs and drain plugs. Inspection covers shall be hinged or connected to their respective bearings by short lengths of chain.

All main bearings other than ball or roller bearings shall be lined with gunmetal, bronze or white metal and shall be accurately bedded.

The underside of the base of each bearing pedestal shall be machined and shall bear against a machined surface.

Plain bearings shall be of the adjustable cap type where practicable and shall be fitted with grease-gun nipples or lubricators or pipe connections.

Bearings subject to upward loads shall be designed to withstand this condition.

37 Travelling wheels

The travelling wheels shall be of steel or shall have steel tyres shrunk on and registered. They shall preferably be double or centre-flanged. It is recommended that driving wheels be provided on both tracks and that not less than half the total number of wheels be driven.

Provision shall be made at each corner of the under-carriage structure for the convenient insertion of lifting jacks to permit the removal of the travelling wheels.

38 Carriage buffers

When, from the position or duty of the crane, buffers are necessary on the carriage, they shall be of timber or of the spring type and shall, for preference, be fixed on the main sills and not on the bogies. The buffers shall be fitted on extensions of the sills where the tails of adjacent cranes would otherwise foul each other.

39 Crane anchoring

Provisions shall be made for the crane to be anchored when it is left unattended or under storm conditions. This may be by means of:

a) a rail clip or screwjack at each corner of the carriage, or

b) a chain anchor on each track, or a storm-brake which shall be independent of the normal travelling brake specified in Clause **45**.

40 Guarding

Effective guards shall be provided for gear wheels, chain drives and revolving shafts, couplings, collars and set screws, or similar moving parts, unless those parts are rendered safe by design or by position or are effectively guarded by parts of the crane structure.

NOTE 1 BS 1649, "*Guards for shaft couplings*," applies to guards provided for couplings between shafting on prime movers, transmission machinery, machines, parts of machines, or any two such appliances, and for associated shafting.

NOTE 2 In Appendix E reference is made to Section 17, Factories Act, 1937. Briefly this section makes it an offence for any person to sell any new machinery intended to be driven by mechanical power unless a) every set-screw, bolt or key on any revolving shaft, spindle, wheel or pinion is so sunk, encased or otherwise effectively guarded as to prevent danger; and b) all spur and other toothed or friction gearing which does not require frequent adjustment while in motion, is completely encased, unless it is so situated as to be as safe as it would be if completely encased.

This Appendix also indicates certain relevant sections of the Factories Acts, 1937 and 1948, and the related legislation which affect the construction and use of electrically driven cranes.

41 Lubrication

Provision shall be made for lubricating all bearings including ball and roller bearings. Plain bearings or their shafts shall have oil or grease grooves to distribute the lubricant over the bearing surfaces. All lubrication nipples shall be of a similar type and shall be readily accessible.

Ball and roller bearings shall be packed with grease during initial assembly.

Where accessibility to a bearing for oiling purposes would otherwise be difficult, provision shall be made for remote control lubrication or safe access to the lubricating point.

Suitable lubricating nipples are specified in BS 1486-1, "*Lubricating nipples and adaptors*" and BS 1486-2, "*Heavy duty lubricating nipples*".

42 Ladders and platforms

Safe means of access shall be provided to the driver's cabin, the machinery house and to every place where any person engaged on the examination, repair or lubrication of the cran has to work adequate handholds and footholds being provided where necessary (see Appendix E).

In particular:

a) Every platform shall be securely fenced with double guard rails and toe boards. Wherever practicable an unobstructed gangway not less than 2 feet wide shall be provided between any part of the crane liable to move and any guard rail, fencing or nearby fixture.

b) Sides of ladders shall extend to a reasonable distance beyond platforms or some other reliable handhold shall be provided.

c) Ladders shall be sloping wherever possible If the slope of a ladder exceeds 3 in 1 and its length exceeds 30 feet a resting place shall be provided approximately midway between the platform and the foot of the ladder.

43 Driver's cabin and machinery house

A control cabin not less than 6 ft. 6 in. height shall be provided to afford the driver adequate protection from the weather, a view of the load unrestricted by the crane structure and as clear a view as possible of the surroundings, including those forward, and to each side of his position. A seat shall be provided for the driver. A house shall be fitted over the main machinery, arranged to allow ready access for inspection and maintenance.

The cabin and machinery house may be combined in one structure, or be separate. Where they are combined the part occupied by the machinery shall, where practicable, be separated from the section occupied by the driver by a partition fitted with a door.

Windows and doors shall be provided. Windows shall be guarded where necessary.

Where ropes pass through the roof of the machinery house effective provision shall be made to check the entry of water.

44 Grabbing

The purchaser shall, whenever possible, indicate the type of grab required and the duty it will have to perform. It is advisable that the crane maker should be consulted on the best type adopt for a particular installation; the customary types of grab are described briefly in Appendix F.

The following provisions shall apply:—

a) *Ring discharge, single or double line.* When used on a level luffing crane the ring shall be suspended so that during luffing it moves in a path parallel to that of the grab. Where variation in height of discharge is desired, a height-adjusting winch, hand or power operated, shall be provided. The winch shall be fitted with a brake or self-sustaining gear capable of holding a weight not less than that of the grab and half its contents when discharging the grab. On a crane used for both grab and hook service, the winch shall be suitable for lifting the discharge ring above the maximum working height of the hook.

b) *Varying discharge, two, three or four lines.* Where the total power for hoisting the loaded grab exceeds 150 B.H.P. the holding drum shall preferably form part of an independent winch.

The holding motion shall have a brake capable of holding a weight not less than that of the grab and half its contents when the grab is being discharged. If a clutch is employed on a single motor winch this brake shall be fitted on the barrel or load side of the clutch.

To prevent rotation of the grab a steadying rope may be provided, one end being attached to the grab and the other to a sliding weight or spring drum carried on the crane structure.

c) Where Bordeaux connections are used for coupling the crane ropes to ropes or chains in the grab, the jib-head pulleys shall be at a height which avoids the need for the Bordeaux connections to pass over the pulleys. Failing this, the jib-head pulleys shall be of large diameter and have a wide groove for the Bordeaux connections. The radius of the wide groove shall be slightly larger than one-half of the diameter of the Bordeaux connection. The pulleys themselves shall have a diameter of not less than 30 per cent greater than that given in Clause **28**, "Rope pulleys" for the appropriate rope pulley.

45 Brakes (see also Clause 46)

The minimum requirements for braking shall be as follows:—

a) *Hoisting motion.* An electro-mechanical service brake shall be provided which will arrest and hold any load, up to and including the test load, at any position of the lift.

Provision shall be made to control safely the lowering of any load up to and including the test load.

When advisable, owing to the special duty of the crane or where specified by the purchaser, an independent brake shall be fitted, capable of holding the test load and of being applied promptly by the driver.

Where gravity lowering is used it is recommended that an automatic speed limiting brake be provided. Where a change-speed-gear is fitted and is of such a type that the barrel is disconnected from the service brake when the gear is changed, an emergency holding brake shall be included on the barrel side of the change gear.

b) *Level luffing or derricking motion.*

i) *Level luffing.* An electro-mechanical brake shall be provided on each crane. Where the jib tends to run inwards or outwards, due to unbalanced forces, an additional independent brake shall be provided.

ii) *Derricking.* An electro-mechanical brake shall be provided which, when the current is cut off or fails, will arrest the jib with any load up to and including the test-load, and at any radius between maximum and minimum. An independent brake shall be fitted for use in an emergency.

c) *Slewing motion.* A mechanical brake operated by hand or foot lever from the driver's cabin shall be provided. This shall be capable of being locked in the "On" position.

d) *Travelling motion.* Electro-mechanical braking shall be provided.

e) *All motions.* Electro-mechanical brakes shall act without shock.

Arrangements shall be made, when necessary, to prevent the brake magnet from being energized by the back e.m.f. of the motor when the supply has been interrupted.

NOTE This paragraph does not apply to any circuit arrangement in which the load is still under full control despite supply failure, as for example, the potentiometer system of control.

Springs for electro-mechanical brakes shall be of the compression type and shall comply with the requirements of BS 24-3, "*Springs and spring steel*", specification No. 7A, unless otherwise specified by the purchaser.

The springs shall not be stressed in excess of 80 per cent of the torsional elastic limit of the material.

Attention is drawn to BS 1726, "*Guide to the method of specifying helical compression springs*". Springs should be designed in accordance with the recommendation of that standard.

Brake weights shall be securely bolted to their levers and locked nuts shall be used.

Ratchet wheels and pawls shall be made of steel.

The rubbing surfaces of all brake drums shall be machined smooth and be free from defects. Under service conditions, the temperature of the rubbing surfaces of all brakes shall not exceed 212 °F. (100 °C.) with fabric lining or 400 °F. (204 °C.), with asbestos or metal linings.

Brakes shall be provided with a simple and easily accessible means of adjustment for the wear of the lining. Brake shoes shall be readily removable for relining.

Under service conditions brakes applied by hand shall not require a force greater than 35 lb. at the handle. Brakes applied by foot shall not require a force of more than 70 lb. on the pedal. Where hand or foot brakes are used in the normal duty cycle of the crane, the force to be applied shall be appreciably reduced.

It is recommended that the stroke of hand levers shall not exceed 24 in., and of pedals 10 in. Locking devices shall be provided on brake levers where necessary. Pedals shall have a non-slip surface.

46 Electric braking

In addition to the requirements of Clause **45**, and irrespective of the supply current, electric braking is permissible on all motions.

NOTE Care should be taken not to confuse the terms "electro-mechanical brake" and "electric braking". Although the former is often referred to as an "automatic electric brake" its action is mechanical, and the braking effect is nullified electrically by a solenoid or electromagnet.

47 Brake magnets

The terminals of brake magnets shall be protected from accidental contact and the windings shall be effectively protected from mechanical damage. Where necessary magnets shall be provided with an efficient cushioning device.

Two degrees of duty are recognized for both A.C. and D.C., viz.:

1) Continuous or heavy duty.
2) Normal duty.

Table 2 — Brake magnet ratings

Duty	D.C. magnets	A.C. magnets
Heavy duty	Suitable for being in circuit not more than 7½ minutes out of every 15 minutes or 240 operations per hour	Suitable for being in circuit continually where the brake coil operates infrequently or For 240 operations per hour where the time the brake coil is in circuit is not more than 5 minutes out of every 15 minutes.
Normal duty	Suitable for 240 operations per hour where the time that the brake coil is in circuit is not more than 5 minutes out of every 15 minutes.	Suitable for 120 operations per hour where the time that the brake coil is in circuit is not more than 5 minutes out of every 15 minutes.

Table 3 — Brake magnet operating currents

Winding	D.C.magnets	A.C.magnets
Series		
For series resistor control	Lift at 60 per cent full load current. Hold at 20 per cent full load current.	
Potentiometer control	Lift at 40 per cent full load current. Hold at 20 per cent full load current.	
Shunt [a]	Lift at 90 per cent normal voltage [a]	Lift at 90 per cent normal voltage.
[a]	Hold at 50 per cent normal voltage [a]	Hold at 50 per cent normal voltage.

NOTE Motor magnets or electro-hydraulic brake releasing gear may be used instead of brake magnets if desired.

[a] This is intended to apply with hot coils corresponding to the duty cycle at normal volts. The temperature rise of the brake magnet shall not exceed that allowed for the control equipment fitted (see BS 587, "*Motor starters and controllers and resistors employed therewith*").

Since with an alternating current brake magnet the current in the coil is greater for the open position than when closed, the ratings for A.C. are slightly different from D.C. as shown in Table 2.

The brake magnets shall operate, for both duties, at the currents and voltages given in Table 3.

48 Electric motors

Electric motors shall be of the protected, screen-protected, drip-proof, or totally-enclosed type, except where special protection is required. Unless otherwise agreed they shall comply with the requirements of BS 168, "*Industrial electric motors and generators*", and their construction and characteristics shall be suitable for crane service.

On Class 4 cranes the hoisting, and slewing motors shall be rated for the duty cycle with a minimum rating of one hour.

Unless otherwise specified, the pull-out torque for an A.C. motor shall be in accordance with BS 168.

49 Controllers and resistors

Controllers and resistors for direct-current motors and alternating-current slip-ring induction motors shall comply with the requirements of BS 587, "*Motor starters and controllers and resistors employed therewith*", except that, where series resistor control is used, i.e. where there are no special slow-motion connections, the current with the hoisting controller at the first step shall not, unless otherwise specified, exceed 75 per cent of that at full load. For other motions the current at the first step shall not exceed full load value.

The controllers and resistors shall be adequately protected to prevent accidental contact with live parts, and shall be rated so that the temperature does not exceed the limit specified in BS 587 during the operation of the crane under service conditions. For Class 4 cranes the hoisting, luffing and slewing resistors shall have a rating of not less than 7½ minutes.

Controllers and resistors shall be so arranged that they are easily accessible for adjustment, examination and replacement. Whenever controllers or resistors are located outside the cabin or machinery house they shall be protected from the weather.

A manually-operated main current controller when in the "Off" position shall disconnect all supply leads to the associated motors unless otherwise specified.

Where deemed advisable contactor type control gear may be used.

A diagram, in durable form, of the connections of each controller shall be fixed to the inside of each cover.

50 Controls

All control handles and pedals shall be placed in convenient positions to allow the driver ample room for operation and admit of unrestricted view of the load. Where practicable, controller handles should move in the direction of the resultant load movement.

The positions of controls shall be such that when the driver is intentionally operating any control handle he cannot readily operate any other control inadvertently.

The control levers shall be provided with stops or catches, to ensure safety and facility of operation. A controller drum fitted with a starwheel shall be regarded as complying with this requirement. Each control shall bear an indelible indication of the motion controlled and of the direction of movement.

51 Electrical protective gear

Enclosed protective gear shall be provided as follows:—

a) When the aggregate horse-power of the two largest motors is less than 40 h.p. or their aggregate current less than 60 amp. a manually-operated switch-fuse panel may be used and the minimum equipment on such panel shall be a main switch in association with high rupturing-capacity fuses, or the equivalent, for each motor. The number of poles in the main switch, and the number of fuses in the motor circuits shall be in accordance with the I.E.E. Regulations[6)], or as may be otherwise directed by the purchaser.

[6)] These are the Regulations for the Electrical Equipment of Buildings published by the Institution of Electrical Engineers.

b) When the aggregate horsepower of the two largest motors is 40 h.p. or more, or their aggregate current 60 amp. or more, a protective panel of the contactor-type, or the equivalent, complying with BS 587, shall be provided. The minimum equipment on such panel shall be an airbreak contactor-type main circuit breaker, together with magnetic-type inverse time-element overload relays for each of the several motor circuits. The number of poles in the circuit breaker and number of overload relays fitted, shall be in accordance with the I.E.E. Regulations[7)] for the protection of motors on A.C. or D.C. supplies, or as may-be otherwise directed by the purchaser. A double-pole fuse for protecting the operating-coil circuit of the contactor shall be provided. A push-button emergency stop shall be so place that it can be used promptly by the driver for cutting off the main supply.

The main circuit breaker shall be electrically interlocked with the controllers in such a way as to prevent the current supply being reinstated unless all controllers are in the "Off" position.

A diagram, in durable form, of connections of the protective panel shall be fixed to the inside of the cover of the panel.

52 Main, emergency and isolating switches

An iron clad isolating switch with "Off" position lock shall be provided for each crane and be placed in an accessible position on the crane carriage. An indicator shall be fitted to show clearly whether the switch is "On" or "Off".

Means shall be provided in the control cabin, and readily accessible to the driver, for switching off promptly all power to the motors in case of emergency. This may be a main switch or the push-button [Clause **51** b)] associated with the crane protective panel, where contactor-type circuit breakers are used, or the main switch [Clause **51** a)], where switch-and-fuse protection is adopted.

When a main switch is combined with the crane protective panel it shall be mechanically interlocked with the door giving access to the panel and the incoming terminals shall be screened to prevent accidental contact when the door is open. When not so combined, a red label plate shall be attached to the cover of the protective panel, marked "Isolate before opening cover".

53 Limit switches

A positively acting mechanism, which cuts off the current and stops the hoisting motion when the hook has risen to an appropriate predetermined level at any radius, shall be provided to prevent overwinding.

A similar mechanism shall be provided to limit the derricking or level luffing motion in each direction. If required, a similar mechanism shall be provided to prevent over-lowering or over-travelling in either direction.

NOTE If desired by the purchaser, a slow-down limit switch may be provided.

54 Cables and wiring

Unless otherwise agreed between purchaser and manufacturer, cables shall comply with BS 7, "*Rubber-insulated cables and flexible cords*," and/or BS 608, "*Dimensions and testing of metal-sheathed or braided varnished cambric insulated annealed copper conductors*", and cables smaller than 7/0.029 (nominal area of conductor, 0.0045 sq. in.) shall not be used for the mains to any of the motors.

The loading in any cable under service conditions shall not exceed the rating specified in the I.E.E. Regulations for the Electrical Equipment of Buildings for the type of cable and the conditions of installation.

All cables shall be adequately protected against mechanical damage, and metal trunking may be used if desired.

Where cables and wires are drawn into a metal conduit, the conduit shall be of welded or solid-drawn heavy gauge metal tube and shall be screw-jointed. The conduit shall preferably be arranged to prevent ingress of air and moisture or alternatively shall be drained. Galvanized conduit shall be used when exposed to the wind or damp conditions.

For external wiring V.I.R. cables shall not be used unless enclosed throughout their entire length in conduit as above specified. Varnished cambric insulated, taped and braided cable shall not be used for external wiring.

Provision shall be made for the protection of all live conductors and terminals against accidental contact in accordance with statutory requirements.

[7)] These are the Regulations for the Electrical Equipment of Buildings published by the Institution of Electrical Engineers.

55 Collector rings (see Clause 60)

For conveying current between the non-revolving and the revolving part of the crane a collector column shall be provided, preferably inside the machinery house and at the top of the centre pin.

The column shall consist of collector, rings with contact fingers of ample capacity for the duty, and shall be completely protected against accidental contact. Rings and fingers shall be readily accessible for examination.

56 Main supply

For travelling cranes the main supply may be obtained from bare conductors and collectors, or by flexible cable from plug boxes or fixed supply points.

If the bare conductors are above ground, they shall be strongly and effectively guarded so that they, cannot be fouled by the load.

Where flexible cables in the way of traffic are liable to be run over, manually or automatically operated take-up gear shall be provided.

57 Wiring diagram

A wiring diagram of the crane shall be provided. On this diagram shall be given the particulars of each of the motors, the cable sizes and such other information as will facilitate inspection and maintenance of the crane.

58 Lighting

Sufficient and suitable lighting shall be provided in the driver's cabin and the machinery house and at access ladders.

The main lighting circuit may be connected to the "live" side of the isolating switch; but to protect such a circuit there shall be an Ironclad double-pole switch fuse in close proximity to the isolating switch.

Where cargo lighting is required by the purchaser and where the lamps are arranged in series, double-pole switching shall be provided for each lamp circuit.

In the event of a handlamp being provided it shall not be connected to a circuit exceeding 250 volts D.C. or 25 volts A.C.

With a D.C. supply the handlamp circuit shall be controlled by a double-pole switchfuse. If the voltage of the supply system exceeds 250 volts D.C. unearthed, or its voltage above earth exceeds 250 D.C., other means shall be adopted for supplying any handlamp circuit.

With an A.C. supply the 25-volt handlamp circuit shall be fed from the secondary winding of a double-wound transformer. Some part of this secondary winding shall be earthed to ensure that the voltage between any part of the handlamp circuit and earth does not exceed 25 volts. The primary winding of the transformer shall be controlled by a double-pole switchfuse; the secondary circuit shall also have fuse protection.

Handlamps shall be of Home Office safety pattern and the flexible cable shall be tough rubber sheathed.

59 Heaters

Electric heaters shall be provided when required by statute or by the purchaser, and shall be of the non-luminous type. The voltage of heaters shall not exceed 250 volts. When arranged in series on any higher voltage special protection shall be provided.

60 Earthing

The crane structure, motor frames and metal cases of all electrical equipment, including metal conduit or cable guards, shall be effectively earthed.

An earthing conductor and collector ring shall be provided.

The earthing shall be provided independently of the contact between the track wheels and the rails.

61 Insulation

An insulation test shall be made of each motor circuit and of the complete wiring of the crane.

NOTE No specific values of insulation resistance can be given.

62 Testing

Before being put into service, the crane shall have each motion tested under the following conditions:—

a) With each safe working load at its specified maximum radius.

b) With no load.

c) With overloads 25 per cent in excess of the conditions defined in a).

When a stability test is required by the purchaser the load on the hook or grab shall be of static character only, and build up gradually above the amount of the active test load. It shall be suspended a few inches above the ground. The overload in excess of the condition defined in a) should not exceed 66⅔ per cent of the safe working load for Class 2 and Class 3 cranes, or 90 per cent for Class 4 cranes. The jib shall be at right angles to the larger side of the rectangle formed by the wheel base and the span of the carriage, it is understood that during the stability test the load shall not be moved under power.

During the tests a) and b) the speeds enumerated in Appendix B shall be substantially as specified.

During test c) the specified speeds need not be attained, but the crane shall show itself capable of dealing with the overload without difficulty. All motions shall be tested in each direction.

A certified record of the test figures shall be supplied to the purchaser together with the appropriate certificate of test and examination. (Docks Regulations Form 1945.)

The tests shall be carried out on a track true to the specified levels and centres.

When conducting acceptance tests the manufacturer shall be entitled to employ his own crane driver.

The contract speeds to be achieved are contingent on the voltage and frequency of the electric supply to the crane being correctly maintained.

All brakes shall be tested with 25 per cent overload on the crane. In addition, it is recommended that each brake on the hoisting and derricking motion be tested under full load, from the associated maximum rated working speed to rest, not less than three times in quick succession.

Test loads and slings shall be provided by the purchaser.

63 Painting

Where two surfaces will be in permanent contact, each shall receive immediately before being assembled and after being thoroughly scraped and cleaned, one coat of hot linseed oil, red-lead paint or oil paint, the surfaces being brought together while the oil or paint is still wet.

At least one coat of paint shall be applied to all parts of the crane before leaving the manufacturer's works.

Painting shall be carried out when the surface of the metal is dry.

64 Identification

For purposes of identification the crane shall bear the manufacturer's name, serial number, the year of manufacture and the class of crane (see Clause **7**).

Appendix A Information desirable to be supplied with enquiry or order

(See Figure 4 Clearance diagram and Figure 5 Track rail)

1. Duty for which crane is required.

Is level luffing required?

Are conditions tropical?

If duty cycle is required, state working hours per day.

Is travelling required?

Is crane to be used with hook, with grab, or with both hook and grab?

If required for grabbing state:

a) Nature of material.

b) Weight per cubic foot.

c) Sizes of pieces.

d) Output in tons per hour.

e) Type of grab, e.g. self dumping, ring discharge, or varying discharge (see Clause **44**).

f) Number of ropes.

g) If grab is to be supplied by crane builder or purchaser. In the latter case, state weight of grab and maximum gross weight of grab and contents.

2. Capacity of crane.

Main hoist: ..... tons of 2 240 lb. Maximum radius ..... ft. (A).
Maximum radius ..... ft. (B).

Auxiliary hoist: ..... tons of 2 240 lb. Maximum radius ..... ft. (A).
Maximum radius ..... ft. (B).

Are separate motors required for main and auxiliary hoists?

Is change-gear required on main hoist?

Intermediate loads and radii (if any).

3. Travelling track.

a) Centre to centre of track rails (C).

b) Weight and type of rails (heads proud or flush with ground).

c) Width of rail head (Q) and height of rail (P).

d) Maximum permissible wheel load.

e) Maximum gradient, if any.

f) Radius of sharpest curve, if any.

g) Portal clearance, if required [height (E) and width (F)].

h) If the track rails are not on same level, state difference in levels.

j) A drawing of the cross section of the quay, showing the crane tracks, clearances and obstructions.

k) Distance from bollard or fairlead to centre line of nearest rail (M).

l) Distance from nearest fouling point to centre line of nearest rail (N).

m) Distance from centre line of crane to nearest fouling point (D).

4. Range of lift (to hook or underside of open grab).

Main hoist: ..... ft.(G) above rail at maximum radius ..... ft. (A).
..... ft.(H) above rail at maximum radius ..... ft. (B).

Auxiliary hoist: ..... ft.(G) above rail at maximum radius ..... ft. (A).
..... ft.(H) above rail at maximum radius ..... ft. (B).

5. Maximum permissible tail radius (J).

Minimum clear height (K) to underside of jib or revolving structure at distance (L) from centre of crane.

6. Speeds.

Main hoist: slow gear ..... tons at ..... ft/min.
fast gear ..... tons at ..... ft/min.
Auxiliary hoist: ..... tons at ..... ft/min.
Derricking or luffing: full load ..... tons at ..... ft/min.
Slewing: full load ..... tons at ..... ft/min.
Travelling: full load ..... tons at ..... ft/min.

7. Power supply.

D.C. or A.C.

..... Volts, ... Phase, ... Cycles per second.

Types and position of conductors or plug boxes.

Are plug boxes to be supplied by purchaser?

If cable drum is required, state whether automatic or hand-operated.

Types and rating of motors.

8. Any special requirements, statutory or technical.

e.g. heaters or special limit switches.

Appendix B Information to be supplied by manufacturer

(See Figure 4 Clearance diagram and Figure 5 Track rail)

1. Type offered ..... Drawing No. .....

2. Capacity of crane.

Main hoist: ..... tons of 2 240 lb. maximum safe working load at
maximum radius ..... ft. (A).
minimum radius ..... ft. (B).
Main hoist: ..... tons change-gear load at
maximum radius ..... ft. (A).
minimum radius ..... ft. (B).
Auxiliary hoist: ..... tons of 2 240 lb. at
maximum radius ..... ft.
minimum radius ..... ft.

3. Type, full description and where applicable weight of grab with method of discharge and capacity in cubic feet.

4. a) Particulars of power supply required.

b) No. of motors ..... Type .....
Protected, screen protected, drip-proof or totally enclosed.

c) Horsepower and speed of motors at full load.

d) Rating of motors ..... degrees F. temp. rise after ..... hour.

e) Type of controllers and rating of resistors.

f) Further particulars of electrical equipment.

5. Travelling track.

a) Centre to centre of track rails (C).

b) Weight and type of rail recommended.

c) Maximum load per wheel ..... tons.

6. Range of lift (to hook or underside of open grab).

Main hoist: ..... ft. (G) above rail at ..... ft. maximum radius (A).
..... ft. (H) below rail at ..... ft. minimum radius (B).

Auxiliary hoist: ..... ft. (G) above rail at ..... ft. maximum radius (A).
..... ft. (H) below rail at ..... ft. minimum radius (B).

7. Tail radius, ... ft. (J).

8. Speeds.

Main hoist: slow gear	..... tons at ..... ft/min.
Main hoist: fast gear	..... tons at ..... ft/min.
Auxiliary hoist:	..... tons at ..... ft/min.
Derricking or luffing: full load	..... tons at ..... ft/min.
Slewing:	..... tons at ..... ft/min.
Travelling:	..... tons at ..... ft/min.

9. Gearing.

a) Type.

b) Material.

c) Kind of slewing rack.

10. Type of bearings.

11. Travelling wheels, type, material, diameter and width of tread.

12. Supports for rotating part of structure. State whether:

a) Live ring of rollers.

b) Rollers on fixed axles.

c) Centre pillar.

13. Ropes.	Main hoist	Auxiliary hoist	Derrick
a) Number of falls	.....	.....	.....
b) Quality of material	.....	.....	.....
c) Description of wire	.....	.....	.....
d) Construction	.....	.....	.....
e) Diameter	..... in.	..... in.	..... in.
f) Guaranteed breaking load	..... tons	..... tons	..... tons
g) Factor of safety	.....	.....	.....

14. Type of driver's cabin and machinery house.

15. Particulars of safety and indicating devices.

16. Description of brakes.

17. Tools and accessories supplied.

18. Ballast, if any, to be supplied by purchaser ..... tons.

..... material.

19. Approximate total weight of crane in working order ..... tons.

Appendix C List of British Standards for materials and equipment to be used in the manufacture of cranes

Crane detail	BS no.	and title
1. Materials.		
Castings, iron		
grey	1452	Grey iron castings.
malleable blackheart	310	Blackheart malleable iron castings.
malleable whiteheart	309	Whiteheart malleable iron castings.
Castings, steel	592	Carbon steel castings for ships and for marine engines and general engineering purposes (in BS 3100).
Steel, structural	15	Structural steel.
	968	High tensile (fusion welding quality) structural steel for bridges, etc., and general building construction.
Tubes, steel	1775	Steel tubes for mechanical, structural and general engineering purposes.
Rivet materials	15	Structural steel.
Springs, coil and spiral	24	Part 3, Springs and spring steel (specifications 7X and 7Y).
	1408	Hard drawn steel wire for springs.
	1429	Annealed steel wire for oil-hardened and tempered springs.
Shafts and axles, steel	970	Wrought steels.
2. Structural details, etc.		
Bolts and nuts	1083	Precision hexagon bolts, screws, nuts (B.S.W. and B.S.F. threads) and plain washers.
Rivets (dimensions)	275	Dimensions of rivets (½ in. to 1¾ in. diameter).
	641	Dimensions of small rivets (ferrous and non-ferrous, of nominal diameter below ½ in.) for general purposes.
Stresses	2573	Permissible stresses in cranes.
		Part 1. Structures.
Welding	1856	General requirements for the metal-arc welding of mild steel.
	693	Oxy-acetylene welding in mild steel.
	938	Metal arc welding as applied to tubular steel structural members.
3. Machinery and machinery details.		
Bearings, ball and roller	292	Dimensions of ball bearings and parallel-roller bearings.
oil retaining	1131	Bronze oil-retaining bearings.
Chains and chain wheels	228	Steel roller chains and chain wheels.
Engines	649	Reciprocating internal combustion engines for marine auxiliary and land service (excluding carburettor-type).
	765	Internal combustion engines, carburettor-type, excluding aero-engines.
Gearing		
spur	436	Machine cut gears. A. Helical and straight spur.
bevel	545	Bevel gears (machine cut).

Crane detail	BS no. and title	
worm	721	Machine cut gears. C. Worm gearing.
Keys and keyways	46	Part 1. Keys and keyways.
Taper pins, solid and split	46	Part 3. Solid and split taper pins.
Lubricating nipples and adaptor	1486	Part 1. Lubricating nipples and adaptors.
Screw threads	84	Screw threads of Whitworth form.
	1580	Unified screw threads.
Splines and serrations	2059	Splines and serrations.
4. Electrical machinery and equipment.		
Cables	7	Rubber-insulated cables and flexible cords.
Circuit breakers	862	Air-break circuit-breakers (including totally-enclosed flameproof types) for voltages not exceeding 660 volts.
Conduit	31	Steel conduits and fittings for electrical wiring.
Controllers and resistors	587	Motor starters and controllers and resistors employed therewith (excluding liquid starters and controllers and single-phase A.C. models).
Motors	168	Industrial electric motors and generators.
5. Lifting equipment.		
Bordeaux connections	461	Bordeaux connections for wire rope and chain for general engineering purposes.
Hooks	482	Wrought iron and mild steel hooks for cranes, chains, slings, blocks and general engineering purposes: excluding building operations.
Shackles	825	Mild steel shackles.
Wire ropes	302	Steel wire ropes for cranes, excavators and general engineering purposes.

Appendix D Load capacity of gears

All gears should be designed on the basis of the load capacity formulae given in the appropriate British Standards quoted in Clause **32**.

It is recommended that, for the necessary calculations, the gears should be considered as carrying the following loads:—

Motion	Class 2	Class 3	Class 4
a) For strength			
All motions	1.5 × full load	1.6 × full load	1.8 × full load
b) For wear			
Hoisting	0.3 × full load	0.4 × full load	0.6 × full load
Slewing	0.3 × full load	0.4 × full load	0.6 × full load
Luffing	0.5 × full load	0.7 × full load	0.8 × full load
Travelling	0.5 × full load	0.7 × full load	0.8 × full load

The full load value should be derived from the motor horse-power but allowance may be made for the friction losses in the various gear reductions.

Appendix E Factories acts legislation affecting cranes in Great Britain

1) Factories Act, 1937. Sections 12–17, 20, 23–24, 26, 60 and 117.

2) Factories Act, 1948. Section 6.

3) The Chains, Ropes and Lifting Tackle (Register) Order, 1938, dated 16th June, 1938. S.R. & O. 1938, No. 599.

4) The Cranes and other Lifting Machines (Register of Examinations) Order, 1938, dated 16th June, 1938. S.R. & O. 1938, No. 600.

5) Certificate of Exemption No. 1. Annealing. Factory Form 661 dated, 4th August, 1938.

6) Docks Regulations, 1925. S.R. & O. 1925, No. 231. Regulations 18, 19, 20 and 46.

7) Docks Regulations, 1934. S.R. & O., 1934, No. 279. Regulations 3, 18–22, 25–29, 33–34, 49, 51 and the Schedule of manner of test and examination before taking lifting machinery and gear into use.

8) Docks Regulations, 1934. Certificate of Exemption No. 1. Annealing. Factory Form 1950, dated 1st June, 1934.

9) Shipbuilding Regulations, 1931. S.R. & O., 1931, No. 133. Regulations 34–37, 39–41 and 53.

10) Building (Safety, Health and Welfare) Regulations, 1948. S.I., 1948, No. 1145. Regulations 2–3, 5, 29, 34–41, 43–60, 63–65, 85–86, 91 and the First and Third Schedules to these Regulations.

11) Regulations for use of locomotives and waggons on lines and sidings in or used in connection with premises under the Factory and Workshop Act, 1901. S.R. & O., 1906, No. 679. Regulations 1–5, 11–19, and 21.

12) Electricity Regulations, 1908, S.R. & O., 1908, No. 1312.

13) Electricity (Factories Act) Special Regulations, 1944. S.R. & O., 1944, No. 739.

Cranes for use in coal and metalliferous mines and in quarries are subject to:

Coal Mines Act, 1911, Section 55.

Coal Mines Act, 1911: Regulations and Orders relating to Safety and Health: Part III, Electricity.

The Quarries General Regulations (S.R.O. No. 632 of 1938): Part IV, Regulations 14, 15, 16, 17 and 18.

The Quarries General Regulations (Electricity) (S.R.O. No. 1233 of 1938).

The Metalliferous Mines General Regulations (S.R.O. No. 630 of 1938): Part IV, Regulations 24, 26, 27, 28 and 30 and Part V, Regulation 31 (Electricity).

It should not be assumed that this list is complete.

Appendix F Customary types of grabs

a) *Self dumping, single or double line.* This type is discharged by resting it on the ground or other surface. A single line grab can be used when attached direct to the crane hook.

b) *Ring, discharge, single or double line.* This type is discharged by connecting it with the discharge ring. The grab is usually discharged at a fixed height, but where variation is desired, a height-adjusting winch is provided, the winch being fitted with a brake, self-sustaining gear or ratchet to hold the grab and its contents when discharging. On a crane used for both grab and hook service, the winch is suitable for lifting the discharge ring above the maximum working height of the hook.

c) *Varying discharge, two, three or four lines.* This type of grab can be discharged at any height of the crane lift through relative movement of the ropes, separate drums being employed on the crane for holding and closing. The holding drum may be driven from the hoisting mechanism or form part of an independent winch, the latter arrangement being usually for larger loads.

Appendix G Design of struts

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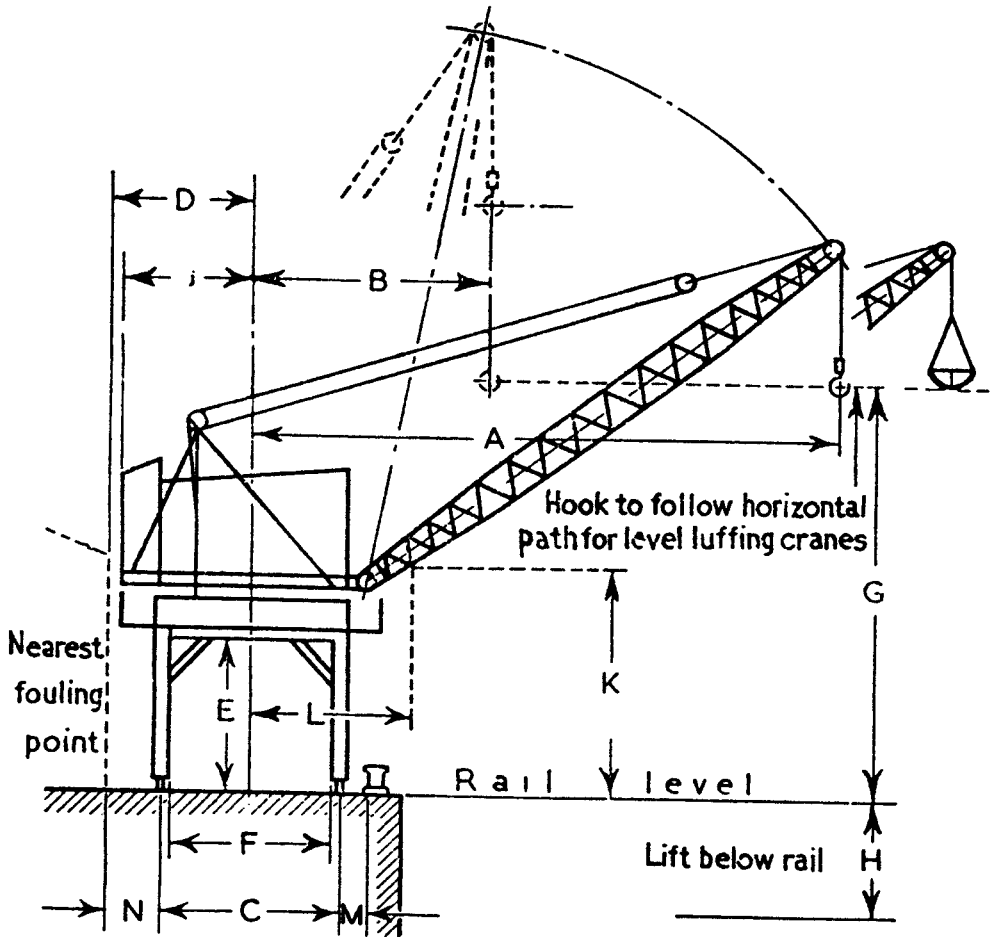

Figure 4 — Clearance diagram of high pedestal jib crane

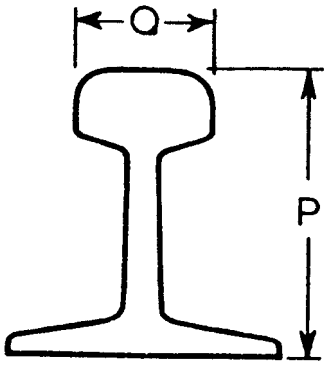

Figure 5 — Track rail

Figure 4 and Figure 5 are to be read in conjunction with Appendix A and Appendix B

Charts 1–5. *Text Deleted*

British Standards

The following are available on application:
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Gas and solid fuel and refractories (SL 2)
Glassware, excluding laboratory apparatus (SL 39)
Heating, ventilating and air conditioning (SL 42)
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