INTERNATIONAL STANDARD

ISO 12480-1

First edition
1997-03-01

Cranes — Safe use —

Part 1: General

Appareils de levage à charge suspendue — Sécurité d'emploi —

Partie 1: Généralités

Reference number
ISO 12480-1:1997(E)

Contents

International Organization for Standardization
Case postale 56 • CH-1211 Genève 20 • Switzerland
Internet: central@iso.ch
X.400: c=ch; a=400net; p=iso; o=isocs; s=central

Printed in Switzerland

Foreword

ISO (the International Organization for Standardization) is a world-wide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO Technical Committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. Internationals organizations, governmental and non governmental, in liaison with ISO, also take part in the work. ISO collaborates with the International Electronical Commission (IEC) on all matters of electrotechnical standardization.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 12480-1 was prepared by Technical Committee ISO/TC 96, *Cranes.*

ISO 12480 consists of the following parts, under the general title *Cranes - Safe use:*

Part 1	*General*
Part 2	*Mobile cranes*
Part 3	*Tower cranes*
Part 4	*Jib cranes*
Part 5	*Overhead travelling cranes and portal bridge cranes*

Annex C forms an integral part of this part of ISO 12478. Annexes A, B and D are for information only.

This page intentionally left blank

Cranes — Safe use —

Part 1: General

1 SCOPE

This part of ISO 12480 establishes required practices for the safe use of cranes, including safe systems of work, management, planning, selection, erection and dismantling, operation and maintenance of cranes and the selection of drivers, slingers and signallers.

It does not cover manually operated (non-powered) cranes, cranes in which at least one of its motions is manually operated and cranes mounted on water-borne vessels, except in those circumstances where a land-based crane is temporarily affixed to a vessel.

2. NORMATIVE REFERENCES

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 12480. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this part of ISO 12480 are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 4306-1: 1990	*Cranes - Vocabulary - Part 1: General*
ISO 4306-2: 1994	*Cranes - Vocabulary - Part 2: Mobile cranes*
ISO 4306-3: 1991	*Cranes - Vocabulary - Part 3: Tower cranes*
ISO 4309: 1990	*Cranes - Wire ropes - Code of practice for examination and discard*
ISO 4310: 1981	*Cranes - Test code procedures*
ISO 7363: 1986	*Cranes and lifting appliances - Technical characteristics and acceptance documents*
ISO 9926-1: 1990	*Cranes - Training of drivers*
ISO 9927-1: 1994	*Cranes - Inspections - Part 1: General*
ISO 9928-1: 1990	*Cranes - Crane driving manual - Part 1: General*
ISO 9942-1:1994	*Cranes - Information labels - Part 1: General*
ISO 12478-1: —[1]	*Cranes - Maintenance manual - Part 1: General*
ISO 12482-1: 1995	*Cranes - Condition monitoring - Part 1: General*
ISO 10973: 1995	*Cranes - Spare parts manual*

3 DEFINITIONS

For the purposes of this part of ISO 12480, the definitions given in ISO 4306-1, ISO 4306-2 and ISO 4306-3 and the following definitions, apply.

3.1 competent person: Person who has the necessary practical and theoretical knowledge and the necessary experience of the crane and equipment used in the lifting operation to carry out the function satisfactorily.

3.2 crane driver (operator): Person who is operating the crane for the purpose of positioning loads or operating for erection of the crane.

NOTE — For mobile cranes, the term "operator" is often used instead, and the term "driver" is then used to refer to that person who operates only those controls which moves the crane from place to place.

[1] To be published.

3.3 employing organization; employer: Person or organization requiring the lifting operation to take place.

NOTE — The employing organization is not necessarily the user.

3.4 rated capacity: Maximum permitted load that can be lifted by the crane under conditions specified by the manufacturer.

3.5 Service conditions

3.5.1 in-service: Condition in which the crane is handling loads up to the rated capacity in permissible wind speeds and in other conditions as specified by standards and/or the manufacturer.

3.5.2 out-of-service: Condition in which the crane is out of use, without load on the load-lifting attachment and in conditions as specified by standards and/or the manufacturer.

3.6 centre of gravity: Point at which the total mass of a body may be regarded as being concentrated, or about which the parts of a body exactly balance each other.

3.7 use: Any operation with or on the crane, e.g. transportation, erection, dismantling, maintenance, movements of the load.

3.8 user organization; user: Competent person or organization which has direct control over the lifting operation.

3.9 appointed person: One competent person who has overall control of the crane operation and acts on behalf of the management of the organization requiring the load to be moved (the employing organization).

4 MANAGEMENT OF THE CRANE OPERATION

4.1 Safe system of work

A safe system of work shall be established and this shall be followed for every crane operation whether it be an individual lift or a group of repetitive operations. The same principles shall be applied when crane operations are carried out at a site or when the crane is a permanent fixture, e.g. in a factory or at a dock.

The safe system or work shall include the following:

(a) planning of the operation;

All crane operations shall be planned to ensure that they are carried out safely and that all foreseeable risks have been taken into account. Planning shall be carried out by personnel who have the appropriate expertise and have been appointed for this purpose. In cases of repetitive or routine operations, this planning may only be necessary in the first instance, with periodic reviews to ensure that no factors have changed;

(b) selection, provision and use of suitable crane(s) and equipment;

(c) maintenance, checks, inspections etc. of crane(s) and equipment;

(d) the provision of properly trained and competent personnel who have been made aware of their relevant responsibilities and those of the other persons involved in the crane operation;

(e) adequate supervision by properly trained and competent personnel having the necessary authority;

(f) ensuring that all necessary certificates and other documents are available;

(g) prohibiting unauthorised movement or use of the crane at all times;

(h) the safety of persons not involved in the crane operation;

(i) cooordination with other applicable parties for appropriate approval compliance or cooperation in avoiding hazards or guarding against hazards;

(j) establishing a system of communication which is understood by the persons involved in the actual lifting operation (for an example see Annex D).

NOTE — It is essential for the safety of the operation to ensure that all personnel can communicate clearly in the same language.

The crane operation shall be taken to include any necessary preparation of a site, erection, dismantling and maintenance of the crane(s).

The safe system of work shall be effectively communicated to all parties concerned.

4.2 Control of the crane operation

To ensure the implementation of the safe system of work, one person shall be appointed to have overall control of the crane operation to act on behalf of the management of the organization requiring the load to be moved (the "Employing Organization"). The appointed person shall have adequate training and experience to enable these duties to be carried out competently.

4.3 Contractual considerations

4.3.1 Contract crane operations

The Employing Organization may enter into a contract with a "User Organization" who will undertake the work on their behalf.

The contract shall state the following:

(a) that all work shall be carried out in accordance with this part of ISO 12480;

(b) that the User shall appoint a person, in accordance with 4.2, to the satisfaction of the Employing Organization;

(c) that all information or services provided by the Employing Organization to facilitate compliance with this part of ISO 12480 shall be notified to the User in writing.

All other requirements given in this part of ISO 12480 shall be followed by the User. The User shall be given full authority to fulfil his obligations relating to this part of ISO 12480 including, where appropriate, authority to control and instruct the Employing Organization's personnel.

Before entering into a contract, Employing Organizations have a duty to satisfy themselves that the User has the necessary competence to carry out the work in accordance with this part of ISO 12480.

4.3.2 Owner´s duties when hiring out cranes

When a crane is hired out together with a driver to the organization requiring the load to be moved (the "User Organization"), the crane owner has a duty to provide a competent driver and a crane that is properly maintained, checked, inspected etc.

4.3.3 User's duties when using hired cranes

The User Organization retains the responsibility for appointing the competent person in accordance with 4.2, for those matters for which the appointed person is expressly made responsible and for following the requirements given in this part of ISO 12480. Notwithstanding any advice the crane owner may have offered concerning the selection of a particular crane or any other relevant matter, the responsibility for ensuring that the crane is of a suitable type, size and capacity for the task being undertaken and for planning the operation remains with the User Organization.

5 SELECTION, RESPONSIBILITIES AND MINIMUM REQUIREMENTS OF PERSONNEL

5.1 General

Safe operating of cranes depends on the selection of competent personnel.

Records of training and experience of persons such as the crane driver will assist the selection of competent personnel. Those responsible for the selection shall ensure that the personnel involved in the operation are efficiently organized in order to ensure good teamwork in the working situation. No person shall be a member of the team if their efficiency is impaired by alcohol, drugs or other influences. All personnel in the team shall be aware of their duties (see 5.2 to 5.7). Where personnel are under training they shall be adequately supervised.

NOTE — In some circumstances it may be appropriate for one person to undertake more than one of the duties described in 5.2 to 5.7.

5.2 Duties of the person appointed to control the crane operation (the appointed person)

The appointed person´s duties shall include the following:

(a) assessment of the crane operation to provide such planning, selection of crane(s), lifting gear and equipment, instruction and supervision as is necessary for the task to be undertaken safely. This shall include consultation with other responsible bodies if necessary and ensuring that where different organizations are involved they collaborate as necessary;

(b) ensuring that adequate checks, inspections etc. and maintenance of the equipment have been carried out;

(c) ensuring that there is an effective procedure for reporting defects and incidents and taking any necessary corrective action;

(d) responsibility for the organization and control of the crane operation. Ensuring that competent personnel are assigned as driver and other lift crew personnel;

The appointed person shall be given the necessary authority for the performance of all these duties and, in particular, authority to stop the operation whenever that person considers that danger is likely to arise if the operation were to continue.

Duties, but not responsibilities, may be delegated to another person where considered appropriate.

As the crane driver is required to be at the controls of the crane when it is handling loads, it would not be appropriate to appoint the driver to be in control of the crane operation.

See also 6.3, 8.2, 8.3.3, 9.2, 10.3 and Annex A, regarding duties of the appointed person.

5.3 Crane driver

5.3.1 Duties

The crane driver shall be responsible for the correct operation of the crane in accordance with the manufacturer's instruction and within the safe system of work (see 4.1). The crane driver shall at any one time respond only to the signals from one slinger/signaller who shall be clearly identified (see 6.2). Exception when a stop signal is received.

5.3.2 Minimum requirements

The crane driver shall be:

(a) competent;

(b) not less than 18 years of age unless under the direct supervision of a person competent for the purpose of training;

(c) fit, with particular regard to eyesight, hearing and reflexes;

(d) physically able to operate the crane safely;

(e) able to judge distances, heights and clearances;

(f) adequately trained for the type of crane being operated and have sufficient knowledge of the crane and its operational control and safety devices;

(g) fully competent in slinging and signalling;

(h) familiar with any fire appliances on the crane and trained in their use;

(i) familiar with any means provided for escape in case of emergency;

(j) authorized to operate the crane.

NOTE — Evidence that the driver is medically fit to drive a crane should be obtained at not more than five-year intervals.

5.3.3 Training of crane drivers

ISO 9926-1 specifies the minimum training to be given to trainee drivers of cranes, to develop basic operational skills and to impart the requisite knowledge for the proper use of those skills.

5.4 Slinger

5.4.1 Duties

The slinger shall be responsible for attaching and detaching the load to and from the crane load-lifting attachment and for the use of the correct lifting gear and equipment in accordance with the planning of the operation for proper positioning of loads.

The slinger is responsible for initiating the planned movement of the crane and load (see 5.4.2.j). If there is more than one slinger, only one of them shall have this responsibility at any one time, depending on their positions relative to the crane.

To ensure continuity of signalling where this slinger is not visible to the crane driver, a signaller is necessary to relay the signals to the crane driver. Alternatively, other audio or visual methods may be used. (See Annex D)

If, during the crane operation, responsibility for directing the crane and load is to be transferred to

another nominated person, the slinger shall clearly indicate to the crane driver that this responsibility is being transferred and to whom. Furthermore, the driver and the new nominated person shall clearly indicate that they accept the transfer of responsibility.

5.4.2 Minimum requirements

The slinger shall be:

(a) competent;

(b) not less than 18 years of age unless under the direct supervision of a person competent for the purpose of training

(c) fit, with particular regard to eyesight, hearing, reflexes and agility;

(d) physically able to handle lifting gear and equipment

(e) able to assess masses, balance loads and judge distances, heights and clearances;

(f) trained in the techniques of slinging;

(g) capable of selecting lifting gear and equipment in suitable condition for the load to be lifted;

(h) trained in the techniques of signalling and understand the signal code;

(i) capable of giving precise and clear verbal instructions where audio equipment (e.g. radio) is used and capable of operating the equipment;

(j) capable of initiating and directing the safe movement of the crane and load;

(k) authorized to carry out slinging duties.

5.5 Signaller

5.5.1 Duties

The signaller shall be responsible for relaying the signal from the slinger to the crane driver. The signaller may be given the responsibility for directing movements of the crane and load instead of the slinger, provided that only one person has the responsibility at any one time.

If, during the crane operation, responsibility for directing the crane and load is to be transferred to another nominated person, the signaller shall clearly indicate to the crane driver that this responsibility is being transferred and to whom. Furthermore, the driver and the new nominated person shall clearly indicate that they accept the transfer of responsibility.

5.5.2 Minimum requirements

The signaller shall be:

(a) competent;

(b) not less than 18 years of age unless under the direct supervision of a person competent for the purpose of training;

(c) fit, with particular regard to eyesight, hearing, reflexes and agility;

(d) able to judge distances, heights and clearances;

(e) trained in the techniques of signalling and understand the signal code

(f) capable of giving precise and clear verbal instructions where audio equipment (e.g. radio) is employed and capable of operating the equipment;

(g) capable of directing the safe movement of the crane and load;

(h) authorized to carry out signalling duties.

5.6 Crane erector

5.6.1 Duties

The crane erector is responsible for the erection of the crane in accordance with the manufacturer's instructions (see clause 9). Where two or more crane erectors are required, one shall be appointed as 'erector in charge' to control this operation at any one time.

5.6.2 Minimum requirements

The crane erector shall be:

(a) competent;

(b) not less than 18 years of age unless under the direct supervision of a person competent for the purpose of training;

(c) fit, with particular regard to eyesight, hearing, reflexes and agility;

(d) physically able to handle safely the loads involved in crane erection;

(e) able to work confidently and safely at heights;

(f) able to establish masses, balance loads and judge distances, heights and clearances;

(g) trained in the techniques of slinging and signalling;

(h) capable of selecting lifting gear and equipment that is suitable for the load to be lifted;

(i) adequately trained in the erection, dismantling and working of the type of crane being erected;

(j) adequately trained in the setting and testing of the safety devices fitted to the crane being erected.

5.7 Maintenance personnel

5.7.1 Duties

The maintenance personnel shall be responsible for maintaining the crane and for its safe and satisfactory operation. They shall carry out all necessary maintenance in accordance with the manufacturer's maintenance manual and within the safe system of work (see 4.1).

5.7.2 Minimum requirements

The maintenance personnel shall be:

(a) competent;

(b) fully conversant with the machinery they are required to maintain and its hazards;

(c) properly instructed and trained. This shall include attending appropriate courses where special equipment is used;

(d) familiar with the procedures and precautions recommended in clause 10.

6 SAFETY

6.1 General

The person or organization having overall control of the place of work and the employers of personnel involved in the crane operation have responsibility for safety. In order that this responsibility may be effectively discharged, the appointed person (see 5.2) shall be given the necessary authority to ensure that adequate systems to achieve safety are in operation. Safety matters relating to crane operations will include the use, maintenance, repair and renewal of safety equipment and the instruction of, and allocation of responsibilities to, the various personnel in relation to the equipment.

6.2 Identification of person directing crane movements

The person directing crane movements (slinger or signaller) shall be easily identifiable to the crane driver, e.g. by wearing high-visibility clothing or by using radio call signs.

NOTE — When choosing high-visibility clothing, the background, type of illumination and other relevant factors shall be considered.

6.3 Personal safety equipment

The appointed person shall ensure:

(a) that personal safety equipment appropriate for the conditions of the location is available, such as helmets, safety spectacles, safety harness, safety boots and hearing protection;

(b) that equipment is inspected before and after use and maintained in good working order or replaced where appropriate;

(c) that a record of inspection and repairs is maintained where appropriate.

Certain safety equipment (e.g. helmets and safety harnesses) may deteriorate with age and shall therefore be considered for renewal periodically. Safety equipment damaged by impact shall be replaced immediately.

6.4 Use of personal safety equipment

All personnel working on, visiting or in the vicinity of the crane shall be made aware of the requirements relating to their personal safety and to the use of the personal safety equipment provided.

Personnel shall be instructed in the correct use of the appropriate personal safety equipment provided and shall be required to use it.

6.5 Access and emergency escape

6.5.1 General

Safe access and means of emergency escape shall be maintained in good condition for the driving position(s) of the crane and for check, inspection, examination, maintenance, repair, erection and dismantling of the crane.

6.5.2 Boarding and leaving the crane

No person(s) shall be permitted to board or leave the crane or enter its physically designated area without first obtaining the driver's permission. The driver shall be aware of the precautions that are necessary while the person(s) is boarding or leaving and shall take them.

If the boarding or leaving point is out of sight of the driver, it shall be checked that means are provided to ensure that the driver is aware of the other person(s) whereabouts, and that a notice advising of the boarding procedure is posted at the boarding point.

6.5.3 Instruction of personnel

Personnel shall be instructed to use (and shall use) only the proper access and means of emergency escape.

6.6 Fire extinguishers

Regarding mounting of any fire extinguisher, see the product-specific standards.

6.7 Documentation

6.7.1 Rated capacity charts

For rated capacity charts applicable to the various specified operating configurations of the crane, see ISO 9942 and the product-specific standards.

6.7.2 Instruction manuals

Regarding manuals to be supplied by the manufacturer, see ISO 9928-1, ISO 10973 and ISO 12478-1.

6.7.3 Test and examination certificates and reports

All required reports or certificates of inspections, examinations and tests shall be kept readily available.

7 SELECTION OF CRANES

Cranes are available in a number of forms and the characteristics of the various types of cranes should be considered in relation to the job requirements. Having decided upon the type of crane and knowing the overall requirements involved, a crane that will safely meet all the requirements of a planned lift shall be selected.

Points to be considered in making the selection include the following:

(a) masses, dimensions and characteristics of loads;

(b)operational speeds, radii, heights of lifts and areas of movement;

(c) number, frequency and types of lifting operations;

(d) length of time for which the crane will be required or anticipated life expectancy for a permanently installed crane;

(e) site, ground and environmental conditions or restrictions arising from the use of existing buildings;

(f) space available for crane access, erection, travelling, operation and dismantling;

(g) any special operational requirements or limitations imposed.

8 SITING OF CRANES

8.1 General

Siting of the crane should take account of all the factors that may affect its safe operation, particularly the following:

(a) the crane standing and support conditions;

(b) the presence and proximity of other hazards;

(c) the effect of wind during in-service and out- of- service conditions;

(d) the adequacy of access to allow the placing or erection of the crane in its working position and for dismantling and removal of the crane following completion of lifting operations.

8.2 Crane standing or support conditions

The appointed person shall ensure that the loads imposed by the crane can be sustained by the ground or any means of support, and that these are assessed by a competent person.

The loads imposed by the crane whilst in service, out of service and during erection and dismantling, should be obtained from the crane manufacturer or other authority on crane design and construction. The loadings shall include the combined effects of the following:

(a) dead weight of the crane (including any counterweight, ballasting or foundation where appropriate);

(b) dead weight of the load(s) and any lifting attachment(s);

(c) dynamic forces caused by movements of the crane;

(d) wind loadings, resulting from wind speeds up to the maximum permitted, taking into account the degree of exposure of the site.

It is likely that in-service conditions will produce the greater imposed loading, but out-of-service and erection/dismantling conditions shall be taken into consideration.

The appointed person shall ensure that the ground or means of support is such that the crane can operate within the levels and other parameters specified by the manufacturer.

8.3 Proximity hazards

8.3.1 General

Consideration shall be given to the presence of proximity hazards such as nearby structures, other cranes, vehicles or ships being loaded or unloaded, stacked goods, public access areas including highways, railways and rivers. Where any part of of the crane or its load can not be kept clear of such hazards, the appropriate authority shall be consulted.

The danger to or from underground services, such as gas mains or electric cables, shall not be overlooked. Precautions shall be taken to ensure that the crane foundation is clear of any underground services or, where this is not possible, that the services are adequately protected to safeguard against damage being caused.

8.3.2 Overhead electric lines and cables

When operating a crane in close proximity to aerial conductors, the following precautions shall be observed by the appointed person, operator and other persons working with the crane.

(a) When operating in an unfamiliar area, check for the presence of aerial conductors.

(b) Consider all such conductors to be live unless it is positively known that they have been de-energized.

(c) Each crane type has different operating/equipment characteristics that dictate varying requirements for safe operating distances from electrical overhead conductors. Where contact can be made with live power lines, advice from the local power authority shall be sought prior to commencement of any work.

The load and crane should not approach the power lines any closer than shown in figure 1.

(d) Cranes shall not be used to remove material from under a power line if any part of the crane, lifting attachments or jib is capable of contacting the power line, unless approved by the power authority engineer. See figure 1.

8.3.3 Crane control in the vicinity of aerodromes/airfields

The appointed person shall observe local rules where the crane is to be used near an aerodrome/airfield.

9 ERECTION AND DISMANTLING

9.1 Planning

Erection and dismantling of the crane shall be thoroughly planned and properly supervised, in the same way as the crane operation (see clause 4).

A correctly planned erection and dismantling procedure shall ensure:

(a) that erection of the crane does not commence until an instruction manual, clearly understood by erection staff, is available for their use;

(b) that the erection/dismantling manual is appropriate to the particular crane and bears the crane manufacturer's serial and type numbers and the owner's identification;

(c) that the entire erection and dismantling operation is in accordance with the manual and is controlled by the erector in charge (see 5.6);

(d) that all personnel involved have a sound knowledge of their part in the operation;

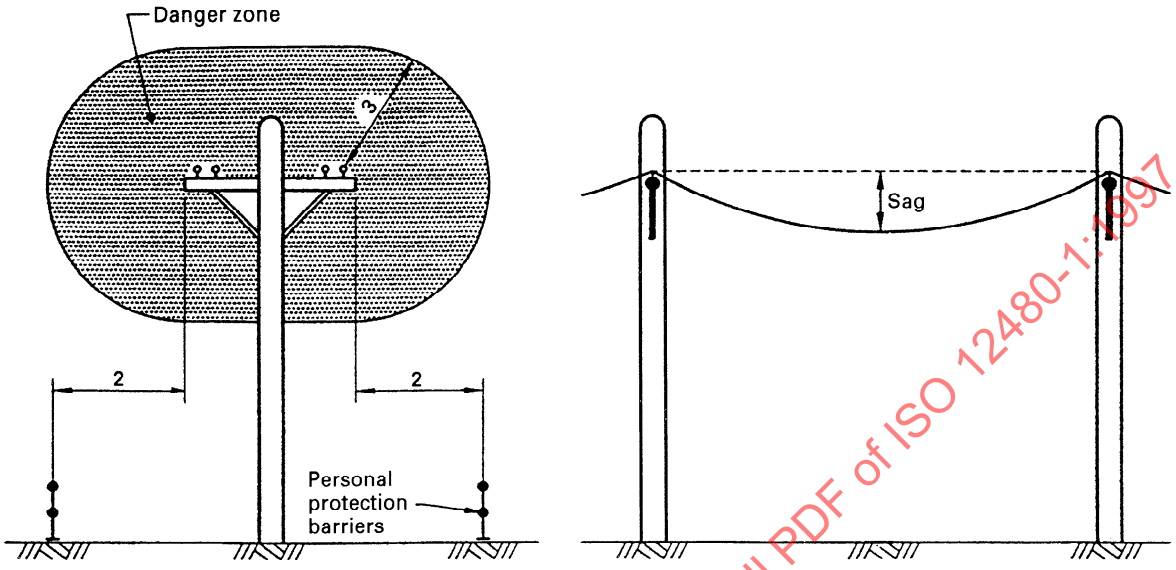
(e) that only correct parts and components are used when replacement is necessary;

(f) that the manufacturer's recommendations for the method of moving a crane from the place of erection to its place of work are followed;

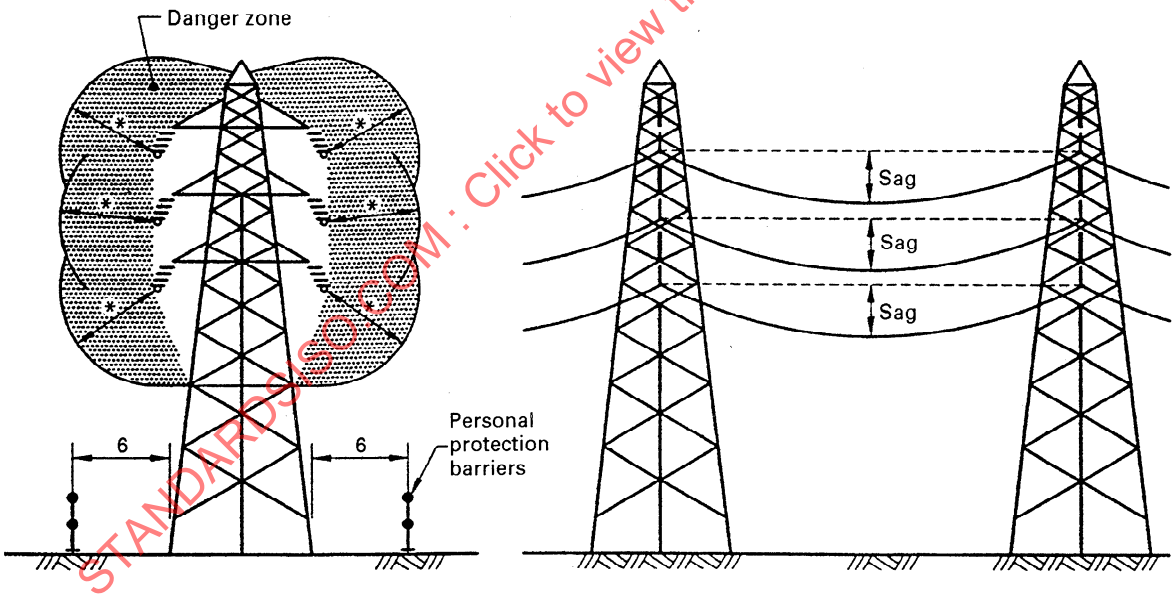
(g) that the crane is level to within the limits specified by the manufacturer.

Any departure from prescribed procedures or specifications shall be approved by the designer of the crane or an engineer.

Dimensions in metres



a) **Distribution lines on poles**



* Distance 6 m unless designated otherwise by electricity supply authority

b) **Transmission lines on towers**

Figure 1 — Clearances from live aerial conductors

9.2 Identification of components

All major components that form part of a crane and are dismantled for transportation, particularly those that are load-bearing or ensure the stability of the assembled crane, should carry a clear identification mark to ensure that they can be distinguished for inspection and condition monitoring purposes.

9.3 Electrical supply

Electric supply to a crane shall comply with the national authority requirements.

The following points - apart from design requirements - shall be noted if the crane is electrically operated from a power source external to the crane.

- The characteristics of the power supply and of the crane equipment shall be checked for compatibility before connection.

- Electrical fuses or circuit breakers shall be provided to interrupt the power supply in the event of an electrical overload for earth fault occurring.

- Care shall be taken to ensure that any trailing cable is not damaged during operational movement or when the crane is travelling. The travel distance shall be well within the length of the trailing cable.

- In addition to any isolator within the crane capable of cutting off the electrical supply to the crane motions, there should be an identified isolator remote from the crane which can be used to cut off the electrical supply to the crane itself.

10 PROCEDURES AND PRECAUTIONS

10.1 Crane operation

Whenever a crane is moved, whether or not it is lifting a load, it shall only be driven by a competent driver nominated by the appointed person.

The appointed person may nominate a trainee driver under the direct supervision of a competent driver.

Maintenance personnel who are required to move cranes during maintenance work and testing shall be competent and trained in crane driving to the extent necessary to enable them to carry out their duties safely.

10.2 Working on cranes

10.2.1 General

When personnel are required to work on cranes for inspection, maintenance or other reasons, the crane shall be taken out of service and a system shall be put in operation to ensure that they are not endangered by movement of the crane and that a secure working place is provided.

For small and simple cranes, where the driver has a clear view of all the moving parts, the system may be by means of verbal communication provided that it is clearly defined and readily understood by all personnel. For larger and more complex cranes, a permit-to-work system may be necessary.

10.2.2 Permit to work

An effective permit-to-work system will ensure that the crane is physically incapable of movement (by removal of fuses or some other means) before written authority is given to the person who is to undertake the work.

The recipient of the permit to work shall sign the document and take it into safe custody, understanding that he is responsible for the work and the personnel associated with that work. Upon completion of the work, the person who has been responsible for the work should sign the certificate certifying that all personnel have been withdrawn, that all gear, tools and loose materials have been removed, that all guards have been replaced and that all safety devices are operating properly.

Following the clearance of the form or certificate and the cancellation by the issuer, the safety precautions taken can then be removed and the crane returned to its normal mode of operation.

To achieve and maintain a safe system of work for the implementation of a permit system, several conditions need to be met and these should include the following:

(a) allocation of responsibilities for coordinating, monitoring, issuing, receiving, clearing and cancelling permits to work;

(b) clear identification of the crane and its associated plant and apparatus;

(c) effective means of isolation and making it safe from all sources of danger;

(d) secure means of retaining and keys, fuses or other devices essential for maintaining the isolation of plant and apparatus;

(e) demarcation of, and any special precautions taken to maintain, a safe working area.

10.2.3 Periodic checks

Periodic checks shall be carried out according to ISO 9927-1. The manufacturer will prescribe several types of periodic checks (for example see Annex A).

10.2.4 Regular inspections

Cranes shall be inspected according to ISO 9927-1.

10.2.5 Condition monitoring

When a crane approaches the design constraints, a special assessment shall be made according to ISO 12482-1.

10.3 Reporting of defects and incidents

The appointed person shall ensure that there is an effective procedure for reporting defects and incidents.

This procedure should include notification to the appointed person, recording of action taken to rectify any defects and clearance of crane for further service.

This procedure shall include the immediate notification of:

(a) any defects found during daily or periodic checks;

(b) defects found at any other time;

(c) incidents or accidents, however slight;

(d) overloads, however they occur;

(e) dangerous occurrences or reportable accidents.

10.4 Leaving the crane unattended

A crane driver shall always be present when a load is suspended from a crane.

In no case shall a crane be left unattended even for short periods, unless all loads have been removed from the lifting attachment and the lifting attachment has been left in a safe position, the power supplies to all motions have been switched off or the engine has been stopped, and appropriate motion brakes and locks have been applied to put the machine in a safe condition. The ignition key and any other keys shall be removed from the crane whenever the driver is absent from the machine.

For longer periods and for out-of-service conditions, isolation should be more permanent, i.e. switches locked off, fuel supplies cut off and any doors giving access to machinery or control cabs locked to prevent unauthorized access. Machinery should be left in the out-of-service condition.

For details of methods to safeguard particular types of cranes, reference should be made to the appropriate part of ISO 12480.

10.5 Maintenance

10.5.1 General

The crane and other equipment used in the lifting operation shall be maintained in a satisfactory condition.

Adequate information, such as manufacturer's instructions, shall be available. All maintenance shall be carried out by trained personnel with adequate knowledge of current procedures. The frequency and extent of such maintenance should take account of all factors that affect the crane in carrying out its work.

10.5.2 Planned maintenance

To ensure safe and satisfactory operation of the crane, a properly planned maintenance system shall be established and used.

Manufacturer's instruction books recommend that specific tasks shall be carried out at stated intervals, and these periods should not be exceeded. They also specify the lubrication points that require attention, the interval or frequency of greasing and oil changes, and the grades and quality of lubricants to be used. Furthermore the instruction books will also cover other essential maintenance such as replacement of filters, recommended tyre pressures, frequency for checking the security of fixing bolts and recommended torque settings and other adjustments, e.g. clutches, brakes.

Regular inspection shall be carried out at intervals recognizing the frequency of use of the crane and the environmental conditions.

An effective planned maintenance system should recognize the possible need to prohibit use of the crane until essential maintenance work is carried out.

10.5.3 Replacement components

Replacement components shall conform with the manufacturer's specification or an equivalent standard.

10.5.4 Repairs

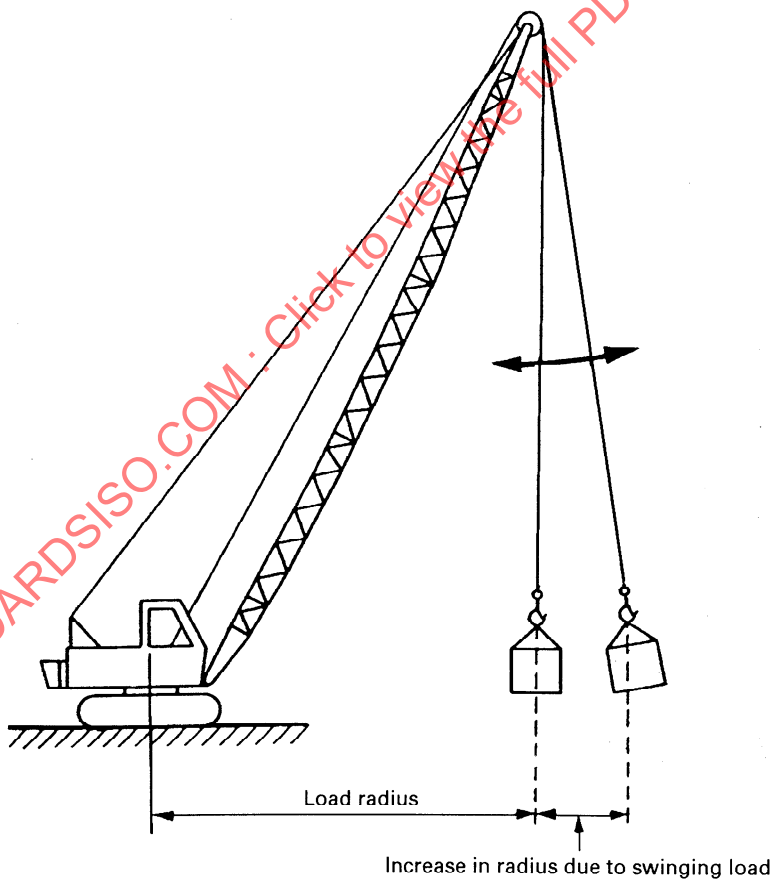
If it is necessary to carry out any significant repairs to any part of the crane structure, it is essential that the correct procedure laid down by the manufacturer is strictly followed. If the manufacturer's procedures are not available, then procedures shall be provided by an expert engineer.

11 OPERATING CONDITIONS

11.1 Rated capacity

The rated capacity of the crane shall not be exceeded other than for the express purpose of a test of the crane.

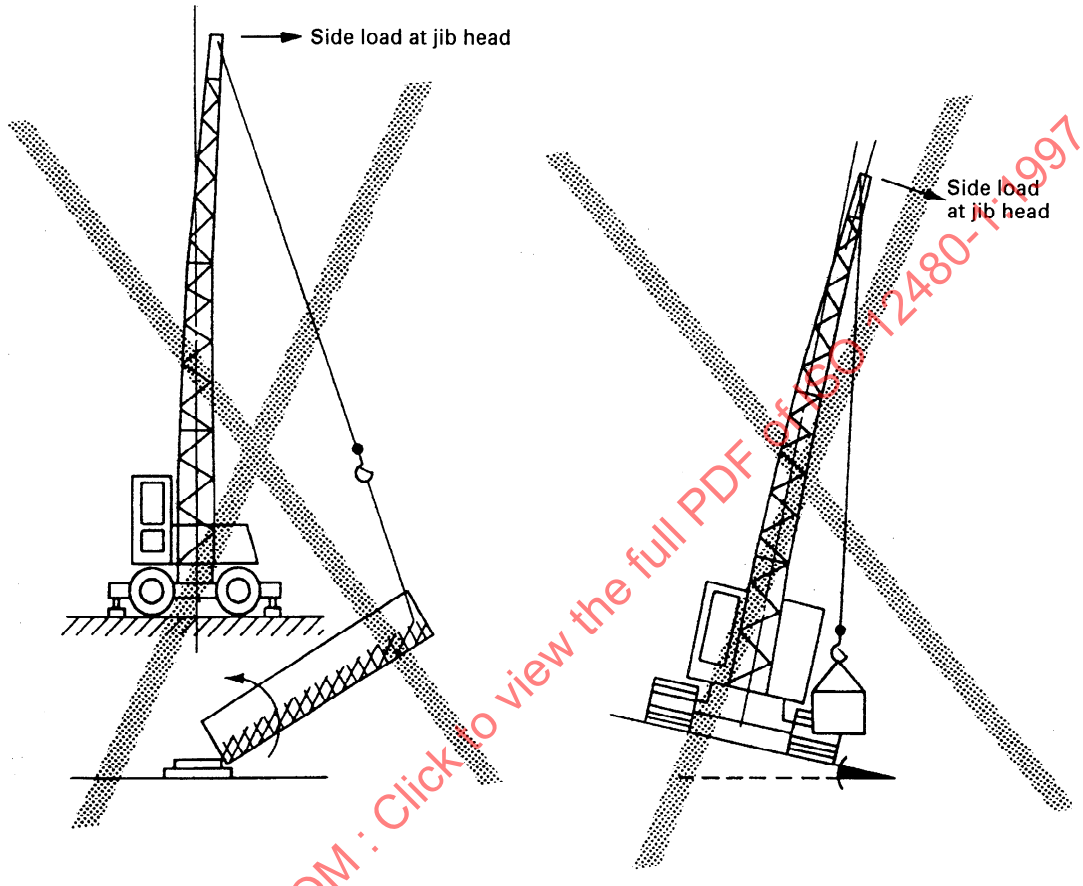
Care should be taken to prevent pendulum swinging of the load by careful control of the operating motions to match the swing of the load and to keep it under control at all times (see figure 2).



NOTE — Loads should always be lifted gently and crane motions should be operated smoothly to avoid swinging (a swinging load will increase the overturning moment of the crane). Steady lines should be used where necessary and where the load presents a wind-catching area. Travel should always take place with the load near to ground level so load swinging can be controlled.

Figure 2 — Adverse effect of a swinging load on load radius (see 11.1)

The hoisting, slewing, traversing, luffing or travelling motions of a crane shall not be used to drag any load along the ground with the hoist rope out of the vertical position. Before lifting a load, the hoist line should be plumb (see figure 3). Failure to observe these points may adversely affect the stability of the crane or introduce loadings (stresses) into the crane for which it has not been designed and, even with an automatic safe-load indicator fitted, a structural failure may result without any warning being given.



a) Pulling a load sideways

b) Travelling across a slope

NOTE — Typical operational conditions imposing a side loading on the jib of a crane are shown. Jibs are not designed for high side loads in crane service. Loads should not be pulled or dragged sideways using either the slewing motion or hoist line. The hoist line should always be in the plane of the jib and hanging plumb. Side loading of the jib should be avoided.

Figure 3 — Side-loading on jib (see 11.1)

11.2 Operation and control

11.2.1 General

Before starting any lifting operation with a crane, the following shall be observed.

(a) The driver shall check for the presence of lockout and tagout devices installed on the equipment or controls before start of operation.

(b) The driver shall be familiar with the controls and their layout.

(c) The driver shall have a clear and unrestricted view of the load and operational area. If not, the driver should act under the directions of the slinger or an signaller who is positioned to have a clear and uninterrupted view. The driver and/or the signaller shall ensure that loads and the crane hoist ropes are well clear of obstructions.

(d) Where telephone, radio or closed circuit television communications are being used, the driver shall ensure that the calling signal is functioning satisfactorily and that verbal messages can be clearly heard.

(e) Where air or hydraulic systems are used, the driver shall ensure that the gauges are functioning and that the systems are at the correct operating pressures.

The hoist rope, or if applicable the hoist chain, shall be vertical throughout the hoisting operation. The load shall initially be lifted just clear of the supporting surface and be brought to rest while the slings, balance of the load, etc. are checked, before proceeding. Proper care shall be exercised by the driver at all times to avoid shock or side loadings on the jib or structure. Care should be taken to avoid the load-lifting attachment coming into contact with the structure.

Motion motors should not be reversed before the motor has come to rest, unless the control mechanism is specifically designed to allow this to be done.

The crane safety devices shall not be used as a routine means of stopping the motion(s).

Travelling cranes which move close to where personnel may be located should be equipped with an appropriate warning device.

Before any crane is moved along its track, a warning should be given to all personnel whose safety is likely to be endangered. A warning bell or klaxon may be fitted for this purpose.

11.2.2 Remote-controlled cranes

To prevent unauthorized use, the driver of a crane which is controlled by transmitted signals, e.g. radio, should:

(a) retain the transmitter in his physical possession, or

(b) remove the key from its keylock switch and, for short periods, retain the key in his possession, or

(c) for longer periods, or when the crane is not in use, deposit the transmitter in safe storage.

NOTE — Provision should be made for the security of the transmitter when the crane is not in use.

When the transmitter is fitted with a belt or harness, the driver shall be wearing the harness before switching on the transmitter so that accidental operation of the crane is prevented. The transmitter should only be switched on when operating the crane and should be switched off before removing the harness.

The controlled-range feature, where provided on a remote-controlled crane, shall be tested at regular intervals. The controlled-range feature shall also be checked at the beginning of each shift or whenever there is a change of driver, to ensure that it operates within the limits specified.

11.3 Handling of loads near persons

When loads have to be handled in the vicinty of persons, extreme care shall be exercised and adequate clearances allowed. Drivers and signallers shall pay particular attention to possible danger to persons working out of sight.

All persons shall stand clear of the load being lifted. When lifting from a stack, all persons shall stand away from the stack in case adjacent materials or objects are displaced.

Lifting of loads over highways, railways, rivers or other places to which the public have access shall be avoided. If this is not possible, permission should be obtained from the appropriate authority and the area should be kept clear of traffic and persons.

11.4 Multiple lifting

11.4.1 General

Lifting a load with two or more cranes or hoists on a single crane requires greater attention to planning and supervision than lifting with one crane, because the effects of the relative motion between the cranes may induce additional loadings on the cranes, the load and the lifting gear. Because of this and the difficulty in monitoring these additional loads, multiple lifting shall only be used when the physical dimensions, characteristics, mass or required movement of the load prevent the operation being carried out by a single crane.

Multiple lifting shall be planned with extreme care (see clause 4) and shall include an accurate assessment of the proportion of the load to be carried by each crane. It is essential that the planning shall ensure that the hoist ropes remain vertical. The cranes shall not be subjected to forces in excess of those that would occur were they handling their rated capacity as single lifts.

11.4.2 Main factors to be considered when planning multiple lifting

11.4.2.1 Mass of the load

The total mass and its distribution shall be either known or calculated. Where the information is taken from a drawing, due allowances shall be made for casting and rolling margins and manufacturing tolerances.

11.4.2.2 Centre of gravity

Owing to the variable effect of manufacturing tolerances and rolling margins, quantity of weld metal, etc., the centre of gravity may not be known accurately and the proportion of the load being carried by each crane may therefore be uncertain. When necessary, steps should be taken in advance to accurately locate the centre of gravity.

11.4.2.3 Mass of the lifting gear

The mass of the lifting gear should be part of the calculated load on the cranes. When handling heavy or awkwardly shaped loads, the deduction from the safe working load(s) of the cranes to allow for the mass of the lifting gear may well be significant. The mass of the lifting gear, and hook blocks where appropriate, and its distribution should therefore be accurately known.

11.4.2.4 Capacity of the lifting gear

The distribution within the lifting gear of the forces that will arise during the lifting operation should be established. The lifting gear used should, unless specially designed for the particular lifting operation, have a capacity margin well in excess of that needed for its proportioned load. Special lifting gear may be necessary to suit the maximum variation in distribution and direction of application of loads or forces that can occur during multiple lifting.

11.4.2.5 Synchronization of crane motions

If the variations in the direction and magnitude of the forces acting on the crane during the multiple lift are to be kept to a minimum, it is essential that the crane motions should be synchronous in their effect. Cranes of equal capacity and similar characteristics shall therefore be used whenever possible. In practice, there will always be some variation due to differences in response to the activation of the motion controller and the setting and efficiency of the braking system.

The rated capacity of a crane is calculated on the assumption that the load will be raised and lowered in a vertical plane. The crane structure will have been designed to withstand any lateral loads imposed by accelerations in the various crane motions, but it is unsafe to rely on this lateral strength to withstand horizontal components of out-of-plumb lifts. Since it is unlikely, particularly if the cranes have dissimilar characteristics, that the motions of the two cranes will be accurately synchronized, an assessment should be made of the effect of variation in plumb of the hoist ropes, which may arise from inequalities of speed, together with a determination of the means for keeping such inequalities to a minimum.

11.4.2.6 Instrumentation

Instruments are available to monitor the angle of the load and verticality and the force in each hoist rope constantly throughout the lifting operation. The use of such instruments can assist in the control of the loads on the cranes within the planned values.

11.4.3 Supervision

One competent person shall be in attendance and in overall control of the multiple crane operation. Only this person shall give instructions to personnel operating or driving machines, except in an emergency, when a commonly recognized stop signal may be given by any person observing a situation leading to danger.

If all the necessary points cannot be observed from one position, other personnel will be required at various positions to observe and report to the person in charge of the operation.

11.4.4 Capacity requirements during multiple lifting

If the appointed person is satisfied that all the relevant factors in 11.4.2.1 to 11.4.2.6 have been accurately identified and are being monitored by instruments, the cranes may be used up to their rated capacity.

When all the factors cannot be accurately evaluated, an appropriate downrating shall be applied to all the cranes involved. The downrating may have to be 25 % or more.

11.5 Special duties

11.5.1 General

In all cases involving special duties, the designer's or another competent engineer's guidance shall be obtained.

The mass of any special lifting attachment shall always be included as part of the load to be lifted. The attachment shall be tested, certified and plainly marked with the safe working load and mass of the attachment. Attachments shall only be used for the purpose for which they were designed.

11.5.2 Grabbing and magnet crane service

11.5.2.1 General

When using cranes for special duties such as grabbing or magnet crane service, allowance shall be made not only for the mass of the grab, magnet or other attachments, together with load, but also for additional loadings imposed on the crane resulting from fast slewing, grab suction effects,

impacts, etc. Consequently the mass of the grab and contents, or the masses of the magnet and load, will be less than the corresponding safe working load for normal crane duty. Reference should be made to the crane designer or another competent engineer for details of special duty ratings.

11.5.2.2 Grabbing service

In case of grabbing cranes, the load lifted is the mass of the grab and its contents; the mass of the latter depends on the density of the material handled. It is essential that any grab used should be of appropriate capacity for the material, having regard to the safe working load of the crane. A check should always be made in cases of doubt.

11.5.2.3 Magnet service

The magnet shall be marked with the safe working load as determined by tests using masses of the same characteristics as the load for which the device is intended to be used.

The power to the magnet shall not be switched on until the magnet has been lowered on to the load to be lifted. The magnet shall be carefully lowered on to the load and should not be allowed to strike a solid obstacle while in use. It should not be used on hot metal unless specifically designed for this duty.

When not in use, the power shall be switched off to avoid the magnet becoming too hot; the magnet shall not be deposited on the ground but shall be rested on a wooden platform.

11.5.3 Vacuum lifting devices

11.5.3.1 Vacuum lifting attachments shall be regularly inspected to ensure that adequate suction is maintained over the required period.

Every vacuum lifting device shall be fitted with a device that gives a visual indication to the crane driver of the state of the vacuum at any time, and an audible warning to the driver and any person working in the vicinity at ground level when the vacuum is 80 % or less of the designed working vacuum and/or in the event of failure of the vacuum-inducing pump.

11.5.3.2 Every vacuum lifting device shall have means that, in the event of failure of the vacuum-inducing pump, will maintain sufficient vacuum to continue to support the load suspended for a sufficient time (allowing a safety margin) for that load to be safely deposited from the maximum height of lift of the crane to ground level.

Every vacuum lifting device shall be fitted with a suitable vacuum gauge that is of sufficient size and situated in a position where the gauge reading may be easily read at the attachment and release positions of the load. The gauge should be distinctively marked in red to indicate the vacuum below which the appliance should not be used.

A vacuum lifting device shall only be used to lift loads that have a surface suitable for vacuum lifting pads.

11.5.3.3 The vacuum device shall beconstructed:

(a) so that each pad supports an equal part of the load, as far as is practicable;

(b) so that the contact surfaces of the load is suspended horizontally as far as is practicable;

(c) so that the surface of the load is clear of any loose material that would prevent any vacuum pad from making an effective contact with the surface.

11.5.3.4 Before being used for the first time or after any substantial repair, the vacuum device shall be tested by a competent person by application of a test load. The test load surface shall, as far as is practicable, be similar to the worst type of surface on which the device is intended to be used.

The vacuum device, particularly the hoses and vacuum pads, shall be inspected before use at the beginning of each shift or day, and the warning device should be tested at the beginning of each week.

11.5.4 Demolition and other special operations

Demolition and other special operations are not normally permitted with cranes. The use of cranes for such purposes may however exceptionally be permitted by national local authorities. The procedures given in Annex B shall then be followed.

11.6 Weather conditions

11.6.1 General

The operation of cranes in situations where they are likely to be affected by the weather should be given careful consideration. Certain weather conditions such as strong wind, heavy rain, ice or snow, can impose loads on a crane and adversely affect the safety of crane operations.

11.6.2 Wind

The crane shall not be operated in wind speeds that are in excess of those specified in the operating instructions for the crane. Gusting wind conditions may have an additional adverse effect on the safe handling of the load and the safety of a crane. Even in relatively light wind conditions, extra care shall be taken when handling loads presenting large wind-catching areas.

The limitations on wind speed for erecting, testing and dismantling the crane may be lower than the limitation for normal operation. In cases of doubt the designer's or another competent engineer's advice should be obtained. The testing of a crane shall not be carried out in an area that is known to be subject to freak weather conditions.

Advice issued by the crane manufacturer regarding the out-of-service conditions shall be strictly followed.

In the case of cranes in positions where they may be adversely affected by winds, the wind speed shall be readily determined.

11.6.3 Visibility

In poor visibility, suitable means of communication shall be provided to ensure the safe operation of the crane. In extreme conditions, crane operations shall be stopped until there is sufficient improvement in visibility to enable operations to be resumed safely.

11.6.4 Rain, snow or ice

During adverse weather conditions, the appointed person shall ensure that adequate precautions are taken to avoid danger when the crane or the load is affected by rain, snow or ice.

12 SLINGING AND HANDLING OF LOADS

12.1 Load estimation, mass and centre of gravity (C of G)

12.1.1 Mass of the load

The mass of the load should be obtained by one or more of the following methods.

(a) See if the mass is marked.

(b) Check the mass stated on any documentation.

(c) Look at drawings of the load to see if the mass is marked.

(d) Use a weigh bridge to assess the mass.

(e) Estimate the mass of the load by using tables of masses.

12.1.2 Centre of gravity

See the definition in 3.6.

12.1.3 Hooks and hook blocks

To prevent displacement of an unloaded lifting attachment, the hook should be provided with a safety catch or other efficient device. Alternatively the hook should be of such a shape as to minimize the risk of the sling or load becoming detached.

13 RAISING AND LOWERING OF PERSONS

13.1 Raising and lowering of persons by crane is normally not permitted. The use of cranes for such purposes may however exceptionally be permitted by national or local authorities. The procedures given in Annex C shall then be followed.

13.2 Use of cranes for recreational and entertainment purposes is prohibited.

14 TESTS, INSPECTIONS AND CONDITION MONITORING

Various tests and inspections are required to ensure that a crane is safe for use. See the following non-exhaustive list of International Standards for example:

ISO 4309
ISO 4310
ISO 7363
ISO 9927-1
ISO 12482-1

There may be other components on the crane that are subject to governmental requirements and national standards for inspection and test.

ANNEX A
(Informative)

PERIODIC CHECKS

A.1 General

The appointed person shall ensure that the checks given in A.2, A.3 and A.4 below have been carried out.

NOTE — The crane driver may be authorized to carry out periodic checks to the extent that he is considered to be competent.

A.2 Daily

At the beginning of each shift or working day that the crane is in use the following routine checks, as appropriate for the type of crane concerned, should be carried out:

(a) checks as required by the manufacturer's handbook;

(b) check that all ropes are correctly positioned on their sheaves, and drums have not been displaced;

(c) visually check that no electrical equipment is exposed to contamination by oil, grease, water or dirt;

(d) visually check, by inspecting relevant levels and/or components, that no loss of fluids such as lubricating oil and coolant is apparent;

(e) check the operation of all limiting devices or cutouts and the dead man's handle or lever, using caution in making checks in case of malfunction;

(f) check that the crane rated-capacity indicator is functional and that the required daily test of the device is carried out;

(g) check that the load-radius scale is appropriate to the jib configuration fitted if the equipment is separate from that in item (f);

(h) by varying the load-lifting attachment radius without load, check the correct movement of the equipment in items (f) and (g);

(i) check that the correct air pressure is maintained in any pneumatic control system, e.g. brakes;

(j) check that the lights, windscreen wiper(s) and washers operate efficiently;

(k) visually check the security of wheels and the condition of tyres on wheel-mounted cranes

(l) check correct function of all crane controls without load;

(m) check satisfactory operation of all audible warning devices;

(n) in the interests of safety and fire prevention, check that the crane is in a tidy condition and free from tins of oil, rags, tools or materials other than those for which storage provision is made, that means of access and egress are not obstructed and that the appropriate fire-fighting equipment is available;

(o) check that the storm anchorages (where fitted) are satisfactory and there are no obstructions in the path of travel of the crane;

(p) check effectiveness of brakes and clutches before start of operation;

(q) check that no tagout or layout devices are installed on the equipment or controls before the start of operation.

A.3 Weekly

Normally once a week - or within another safe interval as specified by the manufacturer or as more appropriate to the usage of the crane - when the crane is in use, in addition to the checks in A.2 the following checks as appropriate for the type of crane concerned shall be carried out.

(a) Checks as required by the manufacturer's handbook.

(b) Visually inspect all ropes for broken wires, flattening, bird caging or other signs of damage, excessive wear and surface corrosion.

(c) Check all rope terminations, swivels, pins and retaining devices. Also check all sheaves for damage, worn bushes or seizure.

(d) Inspect the structure for damage, e.g. missing and bent bracings on bridges and strut jibs, bulges, indentations and unusual rubbing marks on telescopic jibs, cracked welds, loose bolts and other fasteners, etc.

(e) Check hook(s) and other load-lifting attachments, safety catch(es) and swivel(s) for damage, free movement or wear. Check the hook shank thread and securing nut for undue movement which may indicate wear or corrosion.

(f) Check operation and adjustment of controllers.

(g) On hydraulic machines check for creep of hydraulic rams.

(h) Check effectiveness of brakes and clutches.

(i) On wheel-mounted mobile cranes, check tyres for pressure as well as damage and wear on walls and tread. Also check wheel nuts for tightness.

(j) On rail-mounted cranes check rails, end stops and also ties if fitted. Check existence and condition of guards to remove foreign material from rails.

(k) Check slew lock if fitted.

(l) Enter results of checks in the record of inspections. Where applicable, statutory forms should be used.

A.4 Crane not in regular use

In cases where a crane is not in regular use, it may be necessary to carry out a programme of checks before it is used. The extent and thoroughness of this programme will depend not only on the length of the period that the crane was out of use but also on the location of the crane during this period. A crane standing under cover or inside a workshop may require very little in addition to the checks recommended in A.2 and A.3, but a crane that has been out of use in the open and therefore exposed to the weather and atmospheric pollution, etc. may require an extensive appraisal to ensure its fitness for work.

The appraisal shall include at least the following:

(a) any checks which may be recommended by the manufacturer;

(b) examination of all crane ropes for signs of corrosion and damage and ensuring that there is

thorough lubrication;

(c) examination of all control linkage for evidence of seizure or partial seizure and ensuring that there is correct lubrication;

(d) testing of every crane motion for several minutes without load, each motion individually at first, then by combination of two or more motions simultaneously as appropriate. The test should then be repeated with a load on the crane;

(e) checking the correct functioning of all the crane safety devices;

(f) checking of hoses, seals or other components for evidence of deterioration.

The result of all the tests should be recorded with details of any corrective action taken to overcome any defects prior to the crane being returned to service.

ANNEX B
(Informative)

DEMOLITION AND OTHER SPECIAL OPERATIONS

B.1 General

In demolition ball operations a round or pear-shaped weight, known as a breaking ball, is suspended from the hoist rope of a crane and caused to move to strike a building, structure or other object so that the impact causes collapse or breakage.

During these balling operations, dynamic loadings are imposed on the jib structure and other parts of the crane by movement and impact of the ball. In practice the magnitude of dynamic loading values will vary widely according to the method of using the breaking ball, the skill of the driver and the impact resistance of the object being broken. Manufacturers' recommendations and working loads should therefore be regarded only as a guide.

NOTE — It should be noted that certain manufacturers do not recommend use of their machines for demolition ball operations.

The ball should never be swung by operation of the derricking mechanism.

The drivers of cranes engaged in balling operations should be skilled and experienced in the use of the equipment and techniques of demolition balling, familiar with the machine in use and aware of the potential dangers and their possible causes. Operational methods should be used that do not overstrain the jib or hazard the stability of the crane.

The use of swinging techniques should be restricted to machines designed for arduous or heavy-duty service. The mass of the ball should always be less than the capacity of the machine at the required radius, and a maximum of 50% of the rated capacity load is recommended.

A rope from the second drum of the crane should also be attached to the ball to prevent an inadvertent increase in radius which might result in an overload situation.

The ball should be connected to the hoist rope by means of a free-running swivel if no method of preventing the ball from turning is to be used.

Care should be taken to prevent the ball striking the crane and jib or objects other than that to be broken. As a protection against the jib springing over the cab on release of the ball, jib angles greater than 60° from the horizontal should not be used. Jib safety stops should always be fitted on the crane and adequate protection against flying debris provided for the driver.

In cases of free-standing cranes, the ball should only be used when the crane is standing stationary on firm and level ground. A crane should never stand within a building that it is demolishing. When demolishing masonry arches, suspended floor slabs, etc., care should be taken to avoid the ball becoming trapped, as a sudden collapse of the structure could overload the crane. If the ball does become trapped it should be lowered off before being freed, as a dragging or lifting action might cause the structure to collapse on top of the ball, so pulling the crane over.

In practice the operational techniques described in B.2 to B.4 are used in balling operations.

After those operations detailed in this annex B and before return to service on lifting-crane duties, the structure and mechanisms shall be subject to inspection and testing to ensure adequate conditions for those duties.

B.2 Vertical-drop balling

The breaking of objects by drop balling is achieved by raising the ball vertically above the object and then allowing it to drop into the object by force of gravity.

The ball may be attached to the hoist rope of a crane with a free fall capability. It should then be raised a short distance, be held by the hoist brake, then permitted to fall until the object is struck. Sudden application of the brake while the ball is still moving should be avoided to prevent structural damage to, or overturning of, the crane. The distance which the ball is allowed to drop should only be increased once the characteristics of the object being struck have been determined and heavier impacts are considered to be safe.

Where the point of impact is above ground level or above an underground void, there is a possibility of the ball missing the intended point of impact, passing through the object or bouncing off. In such circumstances the drop distance should be kept to a minimum and at the intended point of impact there should be sufficient length of rope left on the crane to allow the ball to brought to rest by the brake to avoid endangering the crane.

In operations such as demolition, it is often advisable to effect a number of heavy impacts to cause multiple cracking, to follow with a number of lighter impacts until part of the object is broken and then to repeat the exercise.

Where it is not possible or not desirable to use a crane with a free-fall capability, the ball may be dropped by application of a quick release mechanism. The ball should be carefully positioned above the object to be struck. The mechanism is normally released by a downward force on a light rope or handline. The ball is permitted a free fall to the point of impact, and therefore great care should be exercised to ensure that the ball is contained in the working area and that all personnel are outside that area and are suitably protected from flying debris.

Other means of free dropping include use of a magnet or grab.

B.3 Swinging the ball in line with the jib

An additional rope from a second drum on the crane attached to the ball is used to pull the ball in towards the machine. The pulling rope is then released allowing the ball to pendulum outwards, in the plane of the jib, to strike the object. The pulling rope is also used to control and limit the outward swing of the ball. Care should be taken to ensure that the stability of the crane is not hazarded by allowing the ball to swing outwards beyond the maximum safe working radius.

This method is limited to relatively low-level objects, as the ball cannot be swung effectively when positioned at much more than half the available height of lift. However it is the most advisable method as it produces the least strain on the crane.

B.4 Swinging the ball by slewing

By this technique the ball is suspended some 3 m or more below the jib head and the slew motion is engaged, causing the ball to swing in an arc and strike the object. The slew motion should be disengaged and the slew brake applied to stop the jib at a point in line with the point of impact. Again a second rope should be used to prevent the ball swinging out of the safe radius. Considerable torsional loadings can be applied to the jib and other elements of the crane by use of this technique, though these can be reduced to almost nil by good driver control. The actual strain will be governed by a number of factors including the following:

(a) length of jib and operating radius;

(b) distance of ball below the jib head;

(c) rate of acceleration of the slewing motion;