

BS 7121-1:2016



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Code of practice for safe use of cranes – Part 1: General

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Summary of pages

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Foreword

Publishing information

This British Standard is published by BSI Standards Limited, under licence from The British Standards Institution, and came into effect on 31 January 2016. It was prepared by Subcommittee MHE/3/11, *Crane safety and testing*, under the authority of Technical Committee MHE/3, *Cranes and derricks*. A list of organizations represented on these committees can be obtained on request to their secretary.

Supersession

This British Standard supersedes BS 7121-1:2006, which is withdrawn.

Relationship with other publications

BS 7121-1 provides general recommendations for crane types. BS 7121-2 covers in-service inspection, maintenance, thorough examination and testing for the safe use of all types of crane. Other parts of BS 7121 deal with the specific crane types as follows:

- Part 3: Mobile cranes;
- Part 4: Lorry loaders;
- Part 5: Tower cranes;
- Part 11: Offshore cranes;
- Part 12: Recovery vehicles and equipment;
- Part 13: Hydraulic gantry lifting systems;
- Part 14: Side boom pipelayers.

BS 7121 has been accepted as representing the consensus of practical experience for the safety of cranes.

Information about this document

This is a full revision of the standard. It is intended to be used in conjunction with other parts of BS 7121 to ensure, so far as is reasonably practicable, that lifting operations are carried out safely.

Use of this document

As a code of practice, this British Standard takes the form of guidance and recommendations. It should not be quoted as if it were a specification and particular care should be taken to ensure that claims of compliance are not misleading.

Any user claiming compliance with this British Standard is expected to be able to justify any course of action that deviates from its recommendations.

It has been assumed in the preparation of this British Standard that the execution of its provisions will be entrusted to appropriately qualified and experienced people, for whose use it has been produced.

Presentational conventions

The provisions of this standard are presented in roman (i.e. upright) type. Its recommendations are expressed in sentences in which the principal auxiliary verb is "should".

Commentary, explanation and general informative material is presented in smaller italic type, and does not constitute a normative element.

Contractual and legal considerations

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard cannot confer immunity from legal obligations.

In particular, attention is drawn to the following statutory regulations:

- The Health and Safety at Work etc. Act 1974 [1];
- The Lifting Operations and Lifting Equipment Regulations (LOLER) 1998 [2];
- The Provision and Use of Work Equipment Regulations (PUWER) 1998 [3];
- The Supply of Machinery (Safety) Regulations 2008, as amended [4];
- The Merchant Shipping and Fishing Vessels (Health and Safety at Work) Regulations 1997 [5];
- The Merchant Shipping and Fishing Vessels (Lifting Operations and Lifting Equipment) Regulations (MCA LOLER) 2006 [6];
- The Merchant Shipping and Fishing Vessels (Provision and Use of Work Equipment) Regulations (MCA PUWER) 2006 [7];
- The Road Vehicles (Construction and Use) Regulations 1986, as amended [8];
- The Manual Handling Operations Regulations 1992, as amended [9].

NOTE 1 Details of the Lifting Operations and Lifting Equipment Regulations 1998 [2] and the Provision and Use of Work Equipment Regulations 1998 [3], together with an HSE Approved Code of Practice and HSE Guidance, are given in HSE publications Safe use of lifting equipment [N2] and Safe use of work equipment [10].

NOTE 2 Details of the Merchant Shipping and Fishing Vessels Regulations [5], [6] and [7] are given in Maritime and Coastguard Agency Marine Guidance Notes MGN 20 (M+F), The Merchant Shipping and Fishing Vessels (Health and Safety at Work) Regulations 1997 [11], MGN 331 (M+F) The Merchant Shipping and Fishing Vessels (Provision and Use of Work Equipment) Regulations 2006 [12] and MGN 332 (M+F) The Merchant Shipping and Fishing Vessels (Lifting Operations and Lifting Equipment) Regulations 2006 [13].

1 Scope

This part of BS 7121 gives recommendations for the safe use of cranes permanently or temporarily installed in a work environment. Subjects covered include safe systems of work, selection, erection and dismantling, maintenance, inspection, thorough examination, operation, and the planning and management of lifting operations.

This standard is not applicable to the use of cranes:

- a) for bungee jumping or similar entertainment activities; or
- b) as part of a fully automated storage or production system.

NOTE Annex A and Annex B give recommendations for the training of appointed persons, crane supervisors, crane operators and slinger-signallers. Annex C outlines the features of contract lifts and crane hires. Information on the effect of wind and down-rating of the in-service lifting capacity is given in Annex D. Additional recommendations for the operation of cranes on or adjacent to sites of exceptional hazards are given in Annex E. Additional information on radio communication for lifting operations is given in Annex F.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

Standards publications

BS 5975:2008+A1:2011, *Code of practice for temporary works procedures and the permissible stress design of falsework*

BS 7121 (all parts), *Code of practice for safe use of cranes*

BS 7121-2, *Code of practice for the safe use of cranes – Part 2: Inspection, maintenance and thorough examination*

BS 7121-2-1:2012, *Code of practice for the safe use of cranes – Part 2-1: Inspection, maintenance and thorough examination – General*

BS 7121-3:2000, *Code of practice for safe use of cranes – Part 3: Mobile cranes*¹⁾

BS 7121-4, *Code of practice for safe use of cranes – Part 4: Lorry loaders*

BS 7671, *Requirements for electrical installations – IET Wiring Regulations*

BS EN 14439, *Cranes – Safety – Tower cranes*

BS EN 14502-1, *Cranes – Equipment for the lifting of persons – Part 1: Suspended baskets*

Other publications

[N1] HEALTH AND SAFETY EXECUTIVE (HSE). *Guidance Note GS6, Avoiding danger from overhead power lines*. Sudbury: HSE Books, 2013.

[N2] HEALTH AND SAFETY EXECUTIVE (HSE). *Safe use of lifting equipment. Lifting Operations and Lifting Equipment Regulations 1998*. Approved Code of Practice and guidance. L113 (Second edition). Sudbury: HSE Books, 2014.

[N3] HEALTH AND SAFETY EXECUTIVE (HSE). *Guidance Note HSG 141, Electrical installations on construction sites*. Sudbury: HSE Books, 1995.

¹⁾ Revision in preparation.

[N4]HEALTH AND SAFETY EXECUTIVE (HSE). Guidance Note HSG 118, *Electrical safety in arc welding*. Sudbury: HSE Books, 1994.

3 Terms and definitions

For the purposes of this British Standard, the following terms and definitions apply.

3.1 appointed person

person nominated (typically by the employing organization) to plan, and to have overall control of, the lifting operations

3.2 carrier

device that supports persons during lifting and lowering

NOTE Also known as a "manrider" or "man riding basket".

3.3 competent person

person who has such practical and theoretical knowledge and experience of the crane and the equipment used in the lifting operation as is necessary to carry out the function

3.4 configuration

combination of structural members, counterweights, support or outrigger position, hook block reeving and similar items assembled, positioned and erected according to manufacturers' instructions and ready for operation

3.5 control gear

switching devices in combination with associated control, measuring, protective and regulating equipment

3.6 crane coordinator

person responsible for planning and directing the sequence of operations of cranes to prevent collision with other cranes or loads and other equipment or structures (e.g. concrete placing booms, telehandlers, piling rigs)

3.7 crane operator

person who is operating the crane for the purpose of positioning loads or erection of the crane

NOTE Sometimes referred to as "crane driver".

3.8 crane supervisor

person who controls the lifting operation and is responsible for ensuring that it is carried out in accordance with the appointed person's safe system of work

3.9 employing organization

person or organization who requires a lifting operation to be carried out and is responsible for safe use of the crane

NOTE In the case of a crane hire the degree of the employing organization's responsibility for the safe use of the crane depends on whether the crane is being supplied under a crane hire contract or as part of a contract lift (see Annex C).

3.10 indicator

device which provides warnings and/or data to facilitate the competent control of the crane within its design parameters

3.11 lift

movement of loads or persons that involves a change of height

3.12 Lift categories**3.12.1 basic lift**

lifting operation where the load characteristics are considered straightforward and there are no significant hazards within the working area or on the access route for the crane to the working area

3.12.2 complex lift

lifting operation where significant hazards have been identified with the load or with the working area or access route of the crane, and the crane is used to lift complex loads or persons, or where two or more cranes are used to lift the load, or where the lifting operation is carried out at a location with exceptional hazards

NOTE An example of a location with exceptional hazards is a chemical plant.

3.12.3 intermediate lift

lifting operation where significant hazards have been identified with the load or with the working area or access route of the crane

NOTE Formally known as a "standard lift".

3.13 lift plan

information provided to the person supervising the lifting operation to enable them to complete the operation safely

NOTE This normally consists of at least the risk assessment, method statement and any relevant drawings.

3.14 lifting accessory

work equipment for attaching loads to machinery for lifting

NOTE Also known as "accessory for lifting".

3.15 lifting equipment

work equipment (crane) for lifting or lowering loads, including attachments used for anchoring, fixing or supporting the load

3.16 load

force on the crane arising from the weight lifted and any other forces, such as suction

NOTE If a crane is used to lift a load from water, the load could also include forces due to water flow or suction and the effect of loss of buoyancy.

3.17 method statement

document produced by the appointed person to describe how the lifting operation is to be carried out

3.18 motion limiting device

device which restricts a crane motion or initiates the stopping of a motion

3.19 multi-crane lift down-rating system

additional mode programmed into the crane's rated capacity indicator/limiter (RCI/RCL) (see 3.24) which down-rates the maximum lift capacity in all duties when the mode is selected (typically by 33%) and ensures that an external visual indicator indicates to those in the vicinity of the crane that the mode has been selected

3.20 performance limiting device

device which automatically prevents a design performance limit from being exceeded

3.21 pre-use checks

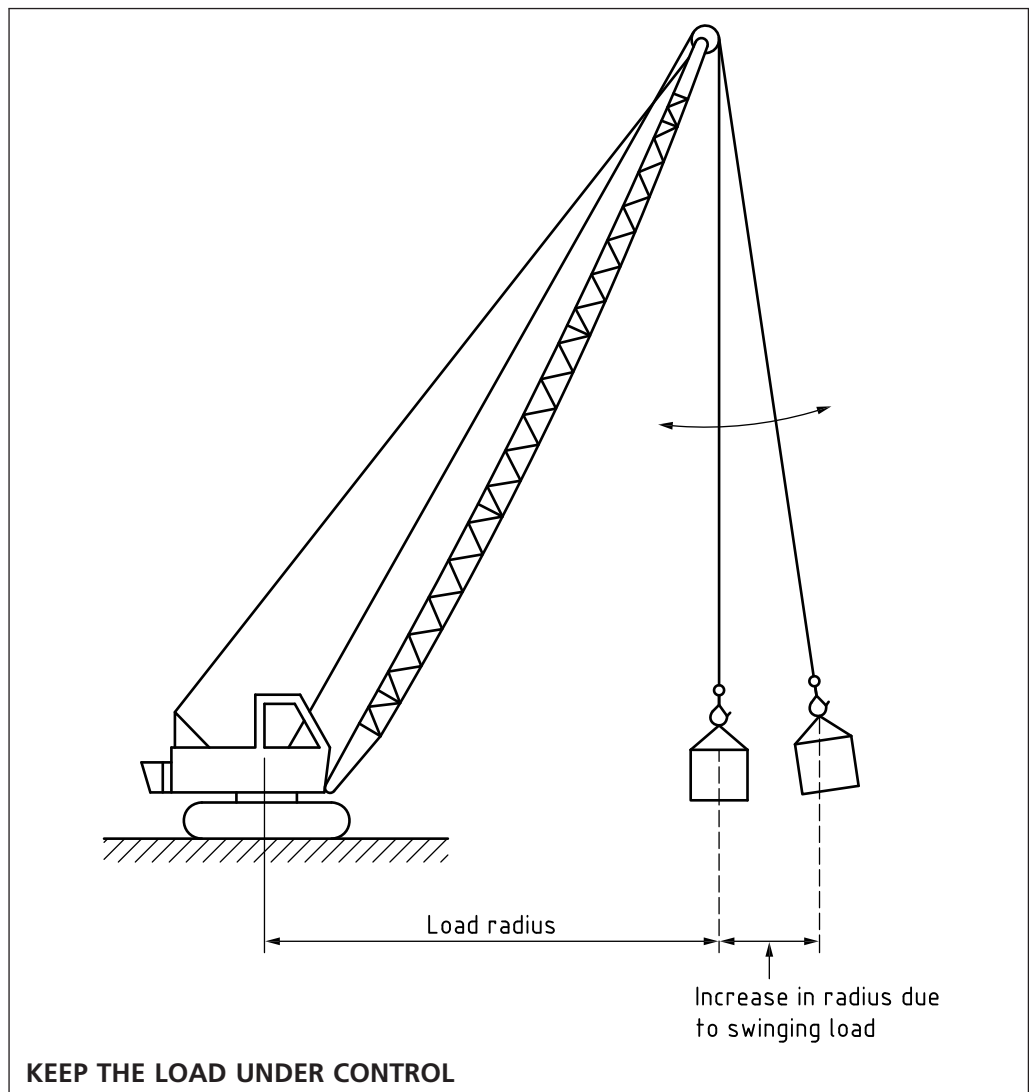
visual and functional checks carried out before the start of each shift or period of operation to ensure that the crane has not suffered any damage or failure and is safe to use

3.22 radius

horizontal distance between the axis of rotation of the crane and the vertical centreline passing through the centre of gravity of the load (see Figure 1)

NOTE For non-slewing cranes, the horizontal distance from the centreline of a load-lifting attachment to the centreline of the nearest axle, bogie or track, measured at ground level, may be assumed to be the radius for the purpose of this definition.

Figure 1 **Adverse effect of a swinging load on load radius**

**3.23 rated capacity**

load that the crane is designed to lift for a given operating condition (e.g. configuration, position of the load)

NOTE The rated capacity was formerly known as "safe working load" (SWL).

3.24 rated capacity indicator/limiter**RCI/L**

device(s) that warns of the approach to overload and prevents the crane from being overloaded

NOTE See BS EN 12077-2. This was previously known as an "automatic safe load indicator" (ASLI) and "overload protection". For information on ASLIs see BS 7262.

3.25 Service conditions**3.25.1 in-service**

condition where the crane is handling loads

3.25.2 out-of-service

condition where the crane is either not required for use or is out of use, without a load on the hook

NOTE Out-of-service conditions can include a higher wind speed than that permitted for the in-service conditions.

3.26 signaller

person responsible for directing the crane operator to ensure safe movement of the crane and load

3.27 site operator

person or organization in overall control of the site

NOTE This may be the owner of the site or a person or organization operating the site on their behalf.

3.28 slinger-signaller

person responsible for:

- a) attaching and detaching the load to and from the crane;
- b) correct identification and use of lifting accessories in accordance with the specifications of the appointed person;
- c) initiating the movement of the load; and
- d) directing the crane operator to ensure safe movement of the crane and load

3.29 tag line

light rope attached to an object being lifted by a crane, used to guide the object while it is lifted or lowered

3.30 Testing**3.30.1 functional testing**

operation of each motion of the crane without a load applied in order to determine whether the crane performs in accordance with the manufacturer's specification

3.30.2 non-destructive testing (NDT)

testing carried out on the structure of the crane to establish the presence, location and extent of any defects that could affect the integrity of that structure, employing techniques that do not damage or alter the material under test

NOTE NDT is also known as "non-destructive examination" (NDE).

- 3.30.3 overload testing <dynamic>**
operation of each motion of the crane with a load that exceeds the rated load applied in order to determine whether the equipment is structurally sound and fit for the use for which it was designed
- 3.30.4 overload testing <static>**
application of a load exceeding the rated load to the crane to determine whether the equipment is structurally sound and fit for the use for which it was designed
- 3.30.5 performance testing**
operation of each motion of the crane with the rated load applied in order to determine whether the equipment performs to the manufacturer's specification, including checking of the rated capacity indicator/limiter (RCI/RCL)
- NOTE* Not to be confused with calibration testing performed at $1.1 \times$ rated capacity, e.g. for lorry loaders (see BS 7121-2).
- 3.31 thorough examination**
examination by a competent person in such depth and detail as the competent person considers necessary to enable them to determine whether the equipment being examined is safe to continue in use
- NOTE* The thorough examination is not part of the maintenance regime for the equipment but provides owners with information which could be used to determine the effectiveness of the maintenance regime. The competent person might require supplementary tests as part of thorough examination. See BS 7121-2.
- 3.32 use <of work equipment>**
activity of any kind involving work equipment
- NOTE* Includes starting, stopping, programming, setting, transporting, repairing, modifying, servicing and cleaning.
- 3.33 user**
person or organization with control of both the lifting operation and the crane operator, and a responsibility to ensure that cranes and other equipment are properly maintained and are thoroughly examined by a competent person
- 3.34 weight**
vertical force exerted by a mass as a result of gravity
- 3.35 working load limit (WLL)**
maximum mass or force which a crane/lifting accessory is authorized to support in operation when the load is applied in-line, unless noted otherwise, with respect to its centreline
- NOTE 1* The term is generally only applied to lifting accessories.
- NOTE 2* The WLL of a lifting accessory is equivalent to its maximum safe working load (SWL); its actual SWL might be less due to configuration or operating conditions.

4 Management of installation and lifting operations

4.1 Safe system of work

4.1.1 A safe system of work should be established and followed for every crane installation operation or lifting operation, whether it is an individual lift or a group of repetitive operations.

4.1.2 The safe system of work should include:

- a) planning of the lifting operation, including preparation of the lift plan (see Clause 5);
- b) selection, provision and use of a suitable crane(s) and work equipment;
NOTE The appointed person has a duty to ensure that the crane selected has adequate capacity for the intended use. The crane user has a duty to ensure that a crane is used only for its intended purpose.
- c) any necessary preparation of a site for the lifting operation, including any entry or exit travel routes for the crane(s);
- d) any erection, dismantling or setting up of the crane(s), e.g. manual boom extensions, stabilizers, outriggers and counterweight;
- e) inspection, maintenance, thorough examination and, where necessary, testing of the crane(s) and equipment and ensuring reports are available;
- f) the provision of properly trained and competent personnel who have been made aware of their responsibilities under the Health and Safety at Work etc. Act 1974 [1];
- g) adequate supervision by properly trained and competent personnel having the necessary authority;
- h) preventing unauthorized movement or use at all times;
- i) coordination of crane movements to avoid collisions between cranes and other items of plant or structures;
- j) the safety of persons not involved in the installation or lifting operation; and
- k) the need for the operator, unless in imminent danger, to remain in control of the crane throughout the lifting operation.

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

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

4.2 Control of the lifting operation

4.2.1 General

4.2.1.1 In order to implement the safe system of work effectively, one person should be appointed to have overall control of the lifting operation to act on behalf of the management of the employing organization. The appointment of this person does not remove any legal responsibility from the management but enables them to use the appointed person's expertise. The person appointed may have other duties and need not be an employee of the employing organization. The appointed person should have adequate training and experience to enable them to carry out their duties (see 4.3.1) competently.

4.2.1.2 On large construction sites where multiple lifting operations are carried out by various subcontractors, the principal contractor should appoint the appointed person for the site. Each of the subcontractors on site may employ individuals who have undergone appointed person training, but they should remain subservient to the principal contractor's appointed person. The principal contractor's appointed person should ensure that the crane coordinator is advised of all lifting operations, to allow them to perform their duties.

4.2.2 Selection of appointed person

4.2.2.1 When selecting and assessing an appointed person, the employing organization should take into account the variety and complexity of the operation, as well as all the problems that could arise from proximity hazards and environmental causes. The appointed person should be notified formally in writing of their appointment.

NOTE To assist in the selection of an appointed person, some examples of lifting operations that require different levels of expertise, training and experience, and that impose different duties on the appointed person, are given in 4.3.

4.2.2.2 An appointed person should be trained in accordance with Annex A.

4.2.2.3 The employing organization should review the performance of the appointed person at planned intervals.

NOTE The duties of an appointed person for crane operations can vary according to the complexity of the operation. The duties for a basic lift are considerably fewer and less demanding than for a complex lift. An appointed person employed for a basic lift might not be competent to carry out a more complicated operation, and another appointment could be required for this. 4.3.2 can be used to make an appropriate appointment and produce a suitable lift plan for each lifting operation.

4.3 Duties of the person appointed to control the lifting operation

4.3.1 General

4.3.1.1 The appointed person's duties should include:

- a) planning the lifting operation (including approval of all risk assessments, lift categorizations and method statements), selection of the crane(s) and lifting accessories, instruction and supervision, and consultation with other responsible bodies to ensure effective collaboration as is necessary for the work to be undertaken safely;
- b) ensuring that the outcomes of the planning process are recorded in a lift plan;
- c) ensuring that adequate pre-operational checks, intermediate inspections, maintenance and thorough examination of the equipment have been carried out;

NOTE 1 For further information see BS 7121-2.

- d) ensuring that there is an effective procedure for reporting defects and incidents and for taking any necessary corrective action;
- e) taking responsibility for the organization and control of the lifting operation;
- f) ensuring that the crane supervisor and other members of the lifting team are fully briefed on the contents, scope and limits of the method statement (see 5.3); and

NOTE 2 This is generally acknowledged by the recipients by signing the briefing document.

- g) being familiar with the relevant parts of the project health and safety plan where the lifting operation is being carried out on a site where the Construction (Design and Management) Regulations 2015 [14] apply, and following, where appropriate, the recommendations of Annex C.

NOTE 3 Further guidance on roles and responsibilities under the Construction (Design and Management) Regulations 2015 [14] is given in the HSE's Managing

health and safety in construction: Construction (Design and Management) Regulations 2015. Guidance on Regulations [15] and A short guide for clients on the Construction (Design and Management) Regulations 2015 [16].

4.3.1.2 The appointed person should be given the necessary authority for the performance of all these duties, including the authority to:

- a) stop the operation whenever they consider that danger is likely to arise if the operation were to continue;
- b) consult others with specialist knowledge and experience; and
- c) delegate duties and tasks, but not responsibilities, for any part of the safe system of work to suitably qualified individuals.

4.3.1.3 Where the appointed person requires the assistance of specialists such as crane suppliers, geotechnical engineers, structural engineers and the designer of the load, care should be taken to ensure that these specialists have the necessary competence for the specific task for which assistance is sought.

4.3.2 Lift category and control measures

4.3.2.1 General

COMMENTARY ON 4.3.2.1

The complexity of a lifting operation depends on the hazards associated with the load path, the load itself and the equipment lifting it, and the environment in which the lifting operation is being carried out. Table 1 lists examples of some load and environment hazards which can be encountered during lifting operations.

Table 1 Example load and environmental hazards associated with lifting operations

Load hazards	Environmental hazards
Position of centre of gravity, including unknown position	Rain
High-temperature load	Ice
Fluid load or unsecured elements within the load	Snow
Lifting of people	Wind
Location of lifting points	Sea state
Complex slinging arrangements	Railways
Uncertainty of weight of load	Roads
Use of more than one crane	Petrochemical plants
Integrity of load	Nuclear plants
Dynamics of the load, e.g. floating load	Corrosive atmospheres
High surface area and/or drag coefficient	Adjacent cranes or other plant
Aerial load transfer	Power lines: overhead and underground
Orientation of the load	Public places
Load stability	Partially-observed load path
Fragility	Uneven ground (pick and carry)
Sharp edges	Ground suction
Load restraint	Partially-secured load (demolition)
	Lightning
	People (consequence of failure)
	Poor ground conditions

4.3.2.1.1 To enable a lift to be planned, supervised and carried out effectively, the appointed person should carry out the activities recommended in **4.3.2.2**, **4.3.2.3** and **4.3.2.4**, depending on whether an assessment of the hazards associated with the load, lifting equipment and the environment in which the crane is to be operated indicates that the lift is:

- a) basic, i.e. the weight of the load(s) can be simply established and there are no significant hazards within the working area or on the access route for the crane to the working area;
- b) intermediate, i.e. there are significant hazards, either within the working area of the crane or on the access route for the crane to the working area; or
- c) complex, i.e. the crane is used to lift complex loads or persons, where two or more cranes are used to lift the load, or where the lifting operation is carried out at a location with exceptional hazards.

NOTE 1 As demonstrated in Figure 2, increases in either or both environmental complexity or load complexity (the "complexity index"; see Table 2) lead to the lift being allocated a higher category.

NOTE 2 Consideration of environmental hazards at the location of the operation includes the access and egress required for the crane and the suitability of the ground to take the loads imposed by the crane during preparation for the lift and during the lift itself.

NOTE 3 Load complexity includes characteristics such as weight, centre of gravity and presence of suitable lifting points. This can be established by a reliable source of information, measuring and weighing the load, or calculation (with allowance for possible inaccuracies).

4.3.2.1.2 Having identified the hazards associated with a particular lift, a hierarchy of control measures should be applied to eliminate or control those hazards and reduce the risks.

Figure 2 Relationship between complexity index and lift category

Environmental complexity (E)	3	Complex	Complex	Complex
	2	Intermediate	Intermediate	Complex
	1	Basic	Intermediate	Complex
		1	2	3
Load complexity (L)				
Key				
1 Low				
2 Medium				
3 High				
<i>NOTE</i> Table 2 shows how lifting the same load in differing environments and lifting different loads in the same environment can lead to different lift categories.				

Table 2 Illustration of the categorization of lifts based on environmental and load complexities

Complexity, variables and constants	Lift category		
	Basic	Intermediate	Complex
Increasing environmental complexity	The crane operator has clear sight of the load path and the load is lifted from and to the ground.	The load is to be placed over an obstruction such that the crane operator does not have clear sight of the landing area from the control position.	The load is to be placed on a structure at height, without line of sight and with overhead power lines in close proximity.
Constant low load complexity	A load of known weight with designated top lifting points and central centre of gravity. The load does not contain fluids, is not fragile and is inherently stable when landed.	A load of known weight with designated top lifting points and central centre of gravity. The load does not contain fluids, is not fragile and is inherently stable when landed.	A load of known weight with designated top lifting points and central centre of gravity. The load does not contain fluids, is not fragile and is inherently stable when landed.
	Complexity index E1:L1	Complexity index E2:L1	Complexity index E3:L1
Increasing load complexity	A load of known weight with designated top lifting points and central centre of gravity. The load does not contain fluids, is not fragile and is inherently stable when landed.	A load of estimated weight with an estimated centre of gravity and without designated lifting points. The load does not contain fluids, is not fragile and is inherently stable when landed.	A load of estimated weight and centre of gravity and without designated lifting points. The load contains fluids, is fragile and is not stable when landed.
Constant low environmental complexity	The crane operator has clear sight of the load path and the load is lifted from and to the ground.	The crane operator has clear sight of the load path and the load is lifted from and to the ground.	The crane operator has clear sight of the load path and the load is lifted from and to the ground.
	Complexity index E1:L1	Complexity index E1:L2	Complexity index E1:L3

4.3.2.2 Basic lift

4.3.2.2.1 For a basic lift, the duties of the appointed person should include:

- a) an assessment of the proposed location of the lifting operation as part of the planning process to check that there are no significant hazards in the operating area, including any areas required for access or setting up of the crane;

NOTE 1 The appointed person may make an assessment on the basis of information with which they have been provided, visit the site personally or delegate a competent person to undertake the visit on their behalf.

- b) selecting the crane, based on:
 - 1) the load characteristics, including weight of the load and any lifting accessories;
 - 2) the maximum height of lift;
 - 3) the maximum radius required and/or the reach and range of movement required; and
 - 4) the rated capacity of the crane, as specified by the manufacturer/installer in the information for use supplied with the crane, or the manufacturer's sales leaflets, which should not be relied on for the rated capacity for a specific crane; or

- 5) the down-rated capacity of the crane as stated on the current report of thorough examination if this has been changed by the competent person at the time of thorough examination;
- c) establishing the maximum permissible wind speed in which the lifting operation can be safely undertaken, taking account of the maximum permissible wind speed specified by the manufacturer for the crane and movement of the load in the wind, including any reduction in permissible wind speed or restrictions in rated capacity required for the wind area of the load, and ensuring that the crane is not operated in wind speeds in excess of that established;

NOTE 2 See Annex D for the effect of wind speed.

- d) ensuring that the crane has a current report of thorough examination stating that it is safe to use, with evidence that pre-use checks have been carried out, and confirming that the equipment is considered safe;
- e) ensuring that the crane has been adequately maintained and that records of the maintenance are available;
- f) selecting appropriate lifting accessories, including their method of attachment to the load, configuration, centre of gravity and any protection used to prevent damage;
- g) ensuring that lifting accessories are thoroughly examined at least within the previous six months, and inspected and checked before use, and that the report of thorough examination is available to confirm that the lifting accessories are safe to use;
- h) ensuring that a system for reporting and rectifying defects is in place;
- i) determining any requirement for personnel in addition to the crane operator, such as a slinger-signaller, signaller or dedicated crane supervisor;
- j) designating a suitable person to check that the lifting accessories and any lifting points on the load are free from any obvious defects before attaching the load to the crane;
- k) defining the extent of any exclusion zone required and how it is to be controlled;
- l) ensuring that the outcomes of the planning process, including the hazards identified (see Table 1) and the lift categorization (see Figure 2 and Table 2), are recorded in the lift plan which is signed by the appointed person;

NOTE 3 For guidance on the combination of roles during a basic lift, see 6.2.8.

NOTE 4 In many instances, a generic lift plan is suitable for basic lifts, provided that no additional hazards are identified on site.

NOTE 5 A risk assessment and method statement are parts of the lift plan.

- m) briefing all persons involved in the lifting operation about the safe system of work described in the method statement, and obtaining signed acknowledgement from those briefed that they have understood;
- n) instructing all persons involved in the lifting operation to seek advice from the appointed person if any change is required to the lifting operation, or if any doubts about safety arise;
- o) if one or more hand lines/tag lines are required to give more control of the load, designating persons to handle the lines;
- p) checking that no changes are required in the safe system of work if numerous loads are to be lifted over a long period; and

- q) ensuring that a crane supervisor is designated to direct personnel and to identify any hazards not identified in the lift plan, and that the operation is carried out in accordance with the method statement.

4.3.2.2.2 The appointed person and crane supervisor should be aware of the limits of their knowledge and experience about lifting operations, and, when conditions exceed these limits, further advice should be sought.

4.3.2.3 Intermediate lift

For an intermediate lift, the duties of the appointed person should include the following, in addition to those in **4.3.2.2**:

- a) identifying all significant hazards in the operating area, including any areas required for access or setting up of the crane, which may involve an assessment of the proposed location of the lifting operation as part of the planning process, which itself may involve a visit to the site;

NOTE The appointed person may visit the site personally or delegate a competent person to undertake the visit on their behalf.

- b) ensuring that a site and/or task-specific risk assessment and method statement are prepared, detailing control measures for the identified risks;
- c) liaising with any other person or authority, as required to overcome any hazard, by including any necessary corrective action or special measures in the safe system of work; and
- d) considering the effect of the lifting operation on surrounding property or persons, including the general public, arranging for appropriate action to minimize any adverse effects and giving appropriate notice to all persons concerned.

4.3.2.4 Complex lift

For a complex lift, the duties of the appointed person should include the following, in addition to those in **4.3.2.2** and **4.3.2.3**:

- a) visiting the location of the planned lifting operation as part of the planning process and identifying all exceptional hazards in the operating area, including any areas required for access or setting up of the crane;
- b) ensuring that the method statement includes access, ground conditions, setting up, etc., as well as the exact sequence of operations when lifting the load;
- c) preparing a detailed and dimensioned drawing of the site, the crane and the load, identifying the load path, pick-up and set-down areas, together with the position of any exceptional hazards in the area, and including plan and side elevations as necessary to identify the position and extent of any hazards and to enable the operator to position the crane accurately;
- d) ensuring that, where persons are being lifted, the recommendations of **20.1** are followed;
- e) ensuring that, where the lifting operation requires more than one crane to lift the load, the recommendations of Clause **14** are followed; and
- f) being present on the site during a complex lift.

5 Planning of the lifting operation

5.1 General

5.1.1 All lifting operations should be planned to ensure that they are carried out safely and that all foreseeable risks are taken into account. Planning should be carried out by the appointed person who has the appropriate knowledge for the lift being undertaken (see 4.3). The outcome of the planning process should be a written lift plan which includes risk assessments, method statements and supporting information, such as a schedule of lifts, drawings and photographs.

NOTE 1 For repetitive or routine basic lifting operations, this planning might only be necessary in the first instance, with periodic reviews to ensure that no factors have changed.

NOTE 2 For lifting operations carried out on construction projects, further information on the duties of personnel is given in 4.3.1.1g).

5.1.2 Planning of the lifting operation should take into account:

- a) the load, its characteristics and the method of lifting, particularly when loads are lifted out of water, e.g. flow, suction, loss of buoyancy, position of centre of gravity;
- b) any adhesion between the load and its support and any other forms of resistance to lifting;
- c) the stability of the load when being lifted and set down;
- d) maximum motion speeds, acceleration and deceleration;
- e) the selection of a suitable crane(s) appropriate to the operation, ensuring that adequate clearances are maintained between the load(s) and the crane structure (see 5.5);
- f) the selection of lifting accessories/attachments, the weight to be taken into account when assessing the load on the crane(s);
- g) the position of the crane(s) and of the load before, during and after the operation;
- h) the site of the lifting operation, including proximity hazards, space availability and suitability of the ground or foundations and other environmental conditions;
- i) the proximity of other cranes and/or other plant/structures;
- j) zones where the crane and/or parts of the crane and load-lifting attachments are prohibited from entering or oversailing;

NOTE 1 See Annex E for precautions to be taken when using cranes close to or at sites with exceptional hazard potential, such as railways, chemical plant and nuclear installations.

- k) any necessary set-up (configuration) of the crane(s), including erection and dismantling;
- l) the identification and selection of personnel for the lifting operation; and
- m) the environmental conditions that exist or might occur at the site of the operation or the effect of the load on the crane, e.g. lifting with a floating crane might involve a change of angle of heel or trim of the supporting vessel if lifting on water, which could necessitate stopping the operation when conditions are unsuitable.

NOTE 2 Lone working is to be avoided wherever possible. Where this is not possible, it is essential that suitable measures are put in place to minimize risk to the lone worker.

5.2 Risk assessment

5.2.1 The risk assessment carried out by the appointed person as part of the planning process should identify the hazards associated with the proposed lifting operation. This should take account of any hazards that are present at the proposed lifting site. The assessment should evaluate the risks involved and the nature and extent of any measures required to mitigate those risks. The appointed person should also take into consideration hazards identified by the overall site risk assessments.

NOTE Attention is drawn to the Management of Health and Safety at Work Regulations 1999, as amended [17], which require a risk assessment to be carried out.

5.2.2 The results of the risk assessment should be recorded in writing and used in the preparation of the method statement (see 5.3) for that site.

NOTE The employing organization needs to inform the appointed person of hazards identified by the overall site risk assessments.

5.3 Method statement

5.3.1 The risk assessment(s), together with the manufacturer's instructions, should be used by the appointed person (see 4.3) to develop a method statement detailing the safe system of work (see 4.1) for the transportation, movement, assembly, erection, use and dismantling of the crane at the site.

5.3.2 The appointed person should, when necessary, consult others with specialized knowledge and experience.

5.3.3 The method statement should include:

- a) the tasks to be performed, together with the configuration of the crane at the end of each day's work;
- b) details of the control measures to be followed to eliminate or minimize risk to members of the lifting team;
- c) details of the steps to be taken to eliminate danger to personnel not involved in the lifting operation, and, where necessary, prevent their entry into danger zones, e.g. organizing road closures and segregation zones;

NOTE 1 Exclusion zones require the agreement of the employing organization (site owner or principal contractor) responsible for the enforcement of these zones.

- d) the requirement for pre-use checks to be completed;
- e) a clear statement of the allocation of tasks to all parties involved in the lifting operation;
- f) a description of the item(s) to be lifted, including its weight, dimensions and centre of gravity;
- g) lifting points/method;
- h) type of lifting accessories to be used and configuration;
- i) pick-up and landing points referenced to the site plan;
- j) the height of the lift and the maximum radius where applicable;
- k) the model and configuration of crane to be used;
- l) outrigger/stabilizer support arrangements, including assessment of ground or supporting structure;
- m) overhead hazards;

- n) underground hazards;
- o) personnel involved, together with information as to which roles if any may be combined;
- p) the sequence in which lifting operations are to be undertaken;
- q) control measures to be implemented to eliminate or minimize risk;
- r) method of communication, e.g. hand signals or radios;
- s) environmental limitations, such as maximum permitted wind speed for the lifting operation and sea state for lifting off a floating crane or lifting from the sea;
- t) arrangements for any working at height, including rescue plans;
- u) access to attach and remove slings; and
- v) measures to be taken to ensure that the load remains stable after slings or other lifting accessories have been released.

NOTE 2 The lifting operation will be under the control of a crane supervisor who has the authority to stop the work if local conditions are unsatisfactory.

5.3.4 The method statement should specify clear roles for each member of the lifting team. Arrangements for effective communication among the team (and, if necessary, with adjacent crane operators in case of danger) should be available.

5.4 Team briefing/induction

5.4.1 The crane supervisor should ensure that each member of the lifting team is briefed on the specific features of the planned lifting operation at the start of the job. The lift plan should provide the basis of this briefing. The team should also be briefed on the general site precautions. If the composition of the team changes during the work, new members should be briefed on the lift plan and any other relevant issues.

5.4.2 A copy of the lift plan and associated supporting documents should be made available to all those involved in the lifting operation. Lifting team members should sign a record to acknowledge their attendance at and understanding of the briefing.

5.4.3 During the site induction, the crane supervisor or principal contractor's representative should seek the views of the team about any arrangements for health and safety that might be relevant to them.

5.4.4 Arrangements for effective communication among the team (and, if necessary, with adjacent crane operators in case of danger) should be available.

5.4.5 The briefing should be given using a language common to all lifting team members.

5.5 Selection of cranes

COMMENTARY ON 5.5

See the appropriate part of BS 7121 for details of the different types of crane and their operational characteristics.

5.5.1 Cranes are available in a number of forms, and the characteristics of the various cranes should be considered in relation to the job requirements.

5.5.2 Having decided upon the type of crane and knowing the overall job requirements, a crane capable of safely carrying out the planned lift should be selected.

5.5.3 The following, as a minimum, should be taken into account when selecting a crane:

- a) weights, dimensions and characteristics of loads;
- b) operational speeds, radii, heights of lifts and areas of movement;
- c) crane type and lifting capacity (see **13.1**);
- d) number, frequency and types of lifting operations, with care taken to match the load spectrum and duty cycles of the application to the classification of the crane and to ensure that repeated loads do not exceed 70% to 80% of the crane's rated capacity appropriate to the configuration in which it is being used, unless the crane has a classification permitting repeated lifting at maximum load on every occasion;

NOTE 1 Details of crane classification are given in ISO 4301.

- e) length of time for which the crane is required;
- f) remaining life expectancy;
- g) site, ground and environmental conditions, or restrictions arising from the use of existing buildings;
- h) space available for crane access, erection, travelling, operation, dismantling and egress;
- i) the control type and operating position most suitable for the lifting operation, selected so that the crane operator has the best possible view of the load path and is adequately protected from crushing hazards; and

NOTE 2 Cranes are available with a range of fixed operator control stations and/or remote control.

- j) any special operational requirements or limitations imposed, e.g. the down-rated capacity of the crane as stated on the current report of thorough examination if this was changed by the competent person at the time of thorough examination.

5.6 Siting of crane

5.6.1 General

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

- a) the crane standing or support conditions;
- b) the presence and proximity of other hazards;
- c) hazards associated with working on or adjacent to a highway or railway;
- d) the effect of wind during in-service and out-of-service conditions as recommended in Annex E; and
- e) the adequacy of access to allow the placing or erection of the crane in its working position and for dismantling and removing the crane following completion of lifting operations.

NOTE 1 Attention is drawn to the New Roads and Street Works Act 1991 [18].

NOTE 2 Further details regarding the siting of mobile and tower cranes are given in CIRIA publication C703 [19] which might also provide information on other types of cranes, and further details regarding the siting of loader cranes are given by ALLMI [20].

NOTE 3 Further information on the siting of cranes on or adjacent to sites of exceptional hazards is provided in Annex E.

5.6.2 Crane standing or support conditions

5.6.2.1 The appointed person should obtain an assessment by a competent person as to whether the loads imposed by a crane that is not permanently installed in a fixed position can be sustained by the ground or any means of support.

NOTE Guidance on the assessment of ground conditions is given in CIRIA publication C703 [19] and the SFC publication Ground Conditions for Construction Plant [21].

5.6.2.2 The loads imposed by the crane should be obtained from the crane manufacturer or other authority on crane design and construction. The loadings should include the combined effects of the following:

- a) the dead weight of the crane (including any counterweight, ballast or foundation and, where appropriate, boom extensions);
- b) the dead weight of the load(s) and any accessories for lifting;
- c) dynamic forces caused by movements of the crane and, for floating cranes, the sea state at the time of lifting; and
- d) wind loadings resulting from wind speeds up to the maximum permitted, taking into account the degree of exposure of the site (see BS EN 1991-1-4).

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

5.6.2.4 The vertical and horizontal forces are unlikely to be uniformly distributed, so an allowance should be made for these and for any other unpredictable effects.

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

5.6.3 Proximity hazards

5.6.3.1 General

5.6.3.1.1 As part of the risk assessment, any proximity hazards in the area, such as the following, should be identified:

- a) overhead electric lines or cables (see also 5.6.3.2);
- b) nearby structures;
- c) underground services, voids and structures, such as gas mains or electric cables;
- d) other cranes and plant/structures;
- e) for a permanently installed crane, temporary structures or equipment within the path of the crane or personnel not involved in crane operations working within the proximity of the crane or crane tracks;
- f) other vehicles or ships being loaded or unloaded;
- g) stacked goods; and
- h) public access areas, including highways, railways and rivers.

5.6.3.1.2 Suitable measures should be devised to address each of the hazards identified.

- a) Where any part of the crane or its load cannot be kept clear of such hazards, the appropriate authority should be consulted.
- b) Precautions should be taken to ensure that the crane is clear of any underground services or, where this is not possible, that the services are adequately protected against damage.
- c) At any place where a crane or its load passes an obstacle, the following steps should be taken.
 - 1) Where practicable, the crane path should be clearly defined by marking to ensure that it is kept free from obstruction, and a clearance of not less than 600 mm should be arranged between any moving part of the crane and any obstacle. Where it is not reasonably practicable to achieve this clearance, effective precautions should be taken to prevent access to any crush areas.
 - 2) Where goods are regularly stacked near a crane, boundary lines for the stacking of goods should be permanently marked on the ground.
 - 3) On sites where there is a possibility of collision between the crane and other plant/structures [e.g. tower cranes, mobile cranes, overhead travelling cranes, dockside cranes, loader cranes, mobile elevating work platforms (MEWPs) or concrete booms], the crane coordinator (see 6.2.5) should plan the sequence of crane movements to prevent collisions. In such circumstances, the operators should obtain the agreement of the crane coordinator before carrying out any operation.
 - 4) During pauses in the lifting operation or on completion of the lifting operation, the crane and its components should be positioned to ensure that collisions cannot take place (see 14.2.6).

5.6.3.2 Overhead electric lines and cables

5.6.3.2.1 Many fatal accidents have occurred due to some part of a crane, such as a rope, sling or load, touching, or even coming near to, overhead electric lines or cables. Where the crane or load can come within 10 m of electric lines or cables and it is reasonably practical to turn the power off, steps should be taken by the appointed person to isolate the power.

5.6.3.2.2 Where this cannot be done, the appointed person should ensure that HSE Guidance Note GS6 [N1] and ACOP L113 *Safe use of lifting equipment* [N2] are followed. All distances should be measured at ground level from a position estimated by eye to be vertically below the outermost conductor at a tower or pole position and should include an allowance for the load.

WARNING. All overhead lines and other electrical apparatus should be treated as live unless declared "dead" and "safe" by the line operator. If in doubt, seek advice.

5.6.3.2.3 Devices are available that are designed to be fitted to a crane to give warning when the crane comes within a predetermined distance of overhead electric lines and cables. Such devices are not recommended and should not be considered a substitute for a safe system of work.

5.6.3.2.4 Where cranes are frequently used in the vicinity of overhead power lines, consideration should be given to fitting height limiters.

5.6.3.3 Crane control in the vicinity of aerodromes/airfields

If a crane is to be used within 6 km of an aerodrome/airfield and its height exceeds 10 m or that of surrounding structures or trees if higher, the appointed person should consult the aerodrome/airfield manager for prior permission to work.

NOTE 1 Restrictions could be placed on the overall height of the crane and there could be a requirement to fit warning (obstacle) lights to the top of the crane. Further details are given in CAA document CAP 1096 Guidance to crane operators on aviation lighting and notification [22].

NOTE 2 The Air Navigation Order 2000 [23] makes it an offence to act recklessly or negligently in a manner likely to endanger aircraft.

6 Selection and duties of personnel other than the appointed person

COMMENTARY ON CLAUSE 6

See 4.3 for the selection and duties of the appointed person.

6.1 Selection of personnel

COMMENTARY ON 6.1

Safe lifting operations (including installation) depend upon the selection of suitable personnel who are competent to carry out the required duties. Records of training and experience assist in the selection of suitable personnel as crane supervisors, crane operators and slinger-signallers.

6.1.1 Crane supervisors, crane operators and slinger-signallers should be trained in accordance with Annex A and Annex B.

6.1.2 Those responsible for the selection of personnel should ensure that the personnel involved in the operation are efficiently organized in order to ensure good teamwork during the lifting operation.

6.1.3 Work associated with lifting operations should not be carried out by personnel whose efficiency is impaired by alcohol, drugs or other influences. All personnel in the team should be made aware of both this fact and their other duties (see 7.1).

6.1.4 Where personnel are undergoing training, they should be supervised by appropriate personnel.

NOTE For basic lifts it might be appropriate for one person to undertake more than one of the duties identified in 7.2, depending on the hazards identified by the risk assessment.

6.2 Roles and duties of personnel

6.2.1 Crane operator

6.2.1.1 The crane operator should be responsible for the correct operation of the crane in accordance with the manufacturer's instructions and within the safe system of work (see 4.1), as detailed in the method statement (see 5.3).

6.2.1.2 The crane operator should at any one time respond only to the signals from one signaller (where separate signallers are provided), who should be clearly identified (see 6.2.3).

NOTE It is essential that the crane operator responds immediately to an emergency stop signal from any person.

6.2.2 Slinger-signaller

6.2.2.1 The slinger-signaller should be properly trained in all aspects of slinging loads and signalling, and be authorized by the appointed person.

6.2.2.2 The slinger-signaller should be responsible for:

- a) carrying out pre-use and post-use checks of lifting accessories;
- b) attaching and detaching the load to and from the crane load-lifting attachment; and
- c) using the correct lifting accessories and other equipment in accordance with the lift plan.

6.2.2.3 The slinger-signaller should also be responsible for initiating and directing the safe movement of the crane [see 7.5h)]. If there is more than one slinger-signaller, only one of them should have this responsibility at any one time, depending on their positions relative to the crane.

NOTE Where continuity of signalling is required and this slinger-signaller is not visible to the crane operator, another slinger-signaller or signaller might be necessary to relay signals to the crane operator. Alternatively, other audio or visual methods may be used.

6.2.2.4 Where audio or visual methods are used, the equipment or its means of use should be such that the operator is immediately aware of failure of the equipment, to enable them to stop crane movements.

NOTE Typical examples of audio or visual methods used are:

- a) a blank screen on a television monitor immediately indicates that the operator needs to stop all crane movements; and
- b) a slinger-signaller using a radio continuously instructs the operator to lower a load, e.g. by saying "Lower...lower...lower...", and failure of this continuous instruction from the slinger-signaller indicates that the operator needs to halt all crane movements.

6.2.2.5 If, during the lifting operation, responsibility for directing the crane and load is to be transferred to a signaller, the slinger-signaller should clearly explain this to the crane operator and indicate to whom responsibility is being transferred. The slinger-signaller should clearly indicate to the signaller that this transfer is taking place. Furthermore, the operator and the signaller should clearly indicate that they accept the transfer of responsibility. At the end of the operation, a slinger-signaller should disconnect the load and remove any lifting accessories.

6.2.3 Signaller

The signaller should be responsible for relaying the signal from the slinger-signaller to the crane operator. The signaller may be given the responsibility for directing movement of the crane and load instead of the slinger-signaller, provided that only one person has the responsibility.

6.2.4 Crane supervisor

6.2.4.1 All lifting operations should be supervised by a crane supervisor. The crane supervisor should direct and supervise the lifting operation, ensuring that it is carried out in accordance with the lift plan. The crane supervisor should be competent and suitably trained, and should have sufficient experience to carry out all relevant duties.

NOTE Competence requirements for self-supervision might differ from those for supervising others.

6.2.4.2 The crane supervisor should also have sufficient authority to stop the lifting operation if they consider it dangerous to proceed.

NOTE The appointed person may decide to undertake the duties of the crane supervisor or to delegate these to another person with appropriate expertise for the lifting operation.

6.2.5 Crane coordinator

Where more than one crane is to operate on a site, the crane coordinator should plan and direct the sequence of operations of cranes so that they do not collide with other cranes, loads and other equipment (e.g. concrete placing booms, telehandlers, piling rigs).

NOTE The crane coordinator role is often taken on by one of the crane supervisors.

6.2.6 Crane erector

The crane erector should be responsible for erecting the crane in accordance with the manufacturer's instructions (see **10.2**). Where two or more crane erectors are required, one should be nominated by the appointed person or employing organization as "erector in charge" to control the operation.

NOTE 1 The personnel erecting (rigging) mobile cranes are often known as "crane riggers".

NOTE 2 Further information on the selection, appointment and control of tower crane erectors is given in BS 7121-5.

6.2.7 Maintenance personnel

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

NOTE Further information on the selection, appointment and maintenance personnel is given in BS 7121-2-1:2012.

6.2.8 Combination of roles

6.2.8.1 In certain circumstances, it might be possible to combine some of the roles of members of the lifting team. However, the combination of roles should only take place following a review of the lifting operation by the appointed person.

6.2.8.2 All lifting operations should be planned by an appointed person.

6.2.8.3 The combination of roles should only be considered if the person undertaking the combined role has achieved the necessary competence for each role.

NOTE Competence requirements for self-supervision might differ from those for supervising others.

7 Minimum attributes of personnel

NOTE See 4.3 for the duties of the appointed person in lifting operations.

7.1 General

All personnel appointed for a lifting operation should be:

- a) competent to perform the tasks required of them;
- b) adequately trained and/or successfully assessed;
- c) aware of the responsibilities allocated by the appointed person to all members of the lifting team (see Clause 6);
- d) able to present a record of training and assessment; and
- e) medically fit to the extent required by their role (see *Medical Fitness to Operate Construction Plant* [24]).

7.2 Crane supervisor

The crane supervisor should be:

- a) authorized to carry out the duties listed in 6.2.4;
- b) fully conversant with the duties of all personnel involved in the lifting operation;
- c) able to give clear, unambiguous instructions to all other members of the team; and
- d) able to assess danger to the lifting operation from changed circumstances on site, and to call a halt to the operation if the risk becomes unacceptable, so that the appointed person can be referred to for further instructions if necessary.

7.3 Crane coordinator

The crane coordinator should be:

- a) fit, with particular regard to eyesight, hearing, reflexes and agility; and
- b) capable of giving precise and clear verbal instructions where audio equipment (e.g. radio) is employed, and capable of operating such equipment in accordance with Clause 17.

7.4 Crane operator

7.4.1 The crane operator should be:

- a) fit, with particular regard to eyesight, hearing and reflexes;
- b) physically able to operate the crane safely;
- c) able to judge distances, heights and clearances;
- d) adequately trained for the type of crane being driven and have sufficient knowledge of the crane, its operating instructions and its safety devices;
- e) fully conversant with the duties of the slinger-signaller and signaller, and trained in the techniques of signalling and instructed in a common signal code, such as that shown in Figure 3, and any alternative methods of relaying the signals that are to be used;
- f) trained in the use of the fire extinguishing/firefighting equipment on the crane (where provided);

- g) trained in the use of any means provided for escape in case of emergency; and
- h) authorized to operate the crane.

7.4.2 Evidence that the operator is medically fit to operate a crane should be obtained on employment and subsequently at yearly intervals.

NOTE The type of evidence obtained, e.g. health questionnaire, medical examination, is dependent on the type of crane being operated and the risks to the operator and others involved in the operation.

7.5 Slinger-signaller

The slinger-signaller should be:

- a) fit, with particular regard to eyesight, hearing, reflexes and agility (see *Medical Fitness to Operate Construction Plant* [24]);
- b) physically able to handle lifting accessories and equipment;
- c) able to establish weights, balance loads and judge distances, heights and clearances;
- d) trained in the techniques of slinging;
- e) capable of selecting accessories that have been identified in the lift plan, assessing their condition and suitability prior to use and ensuring that they are within thorough examination period;
- f) trained in the techniques of signalling and instructed in a common signal code, such as that shown in Figure 3;
- g) capable of giving precise and clear verbal instructions where audio equipment (e.g. radio) is used and of operating the equipment in accordance with Clause 17;
- h) capable of initiating and directing the safe movement of the crane and load; and
- i) authorized to carry out slinging duties.

7.6 Signaller

7.6.1 The signaller should be:

- a) fit, with particular regard to eyesight, hearing, reflexes and agility;
- b) able to judge distances, heights and clearances;
- c) trained in the techniques of signalling and instructed in a common signal code, such as that shown in Figure 3;
- d) capable of giving precise and clear verbal instructions where audio equipment (e.g. radio) is employed and of operating the equipment in accordance with Clause 17;
- e) capable of directing the safe movement of the crane and load; and
- f) authorized to carry out signalling duties.

7.6.2 The signaller should stand in a secure position where they can see the load and can be clearly seen by the crane operator, and should face the operator if possible. Each signal should be distinct and clear.

Figure 3 Example crane signals

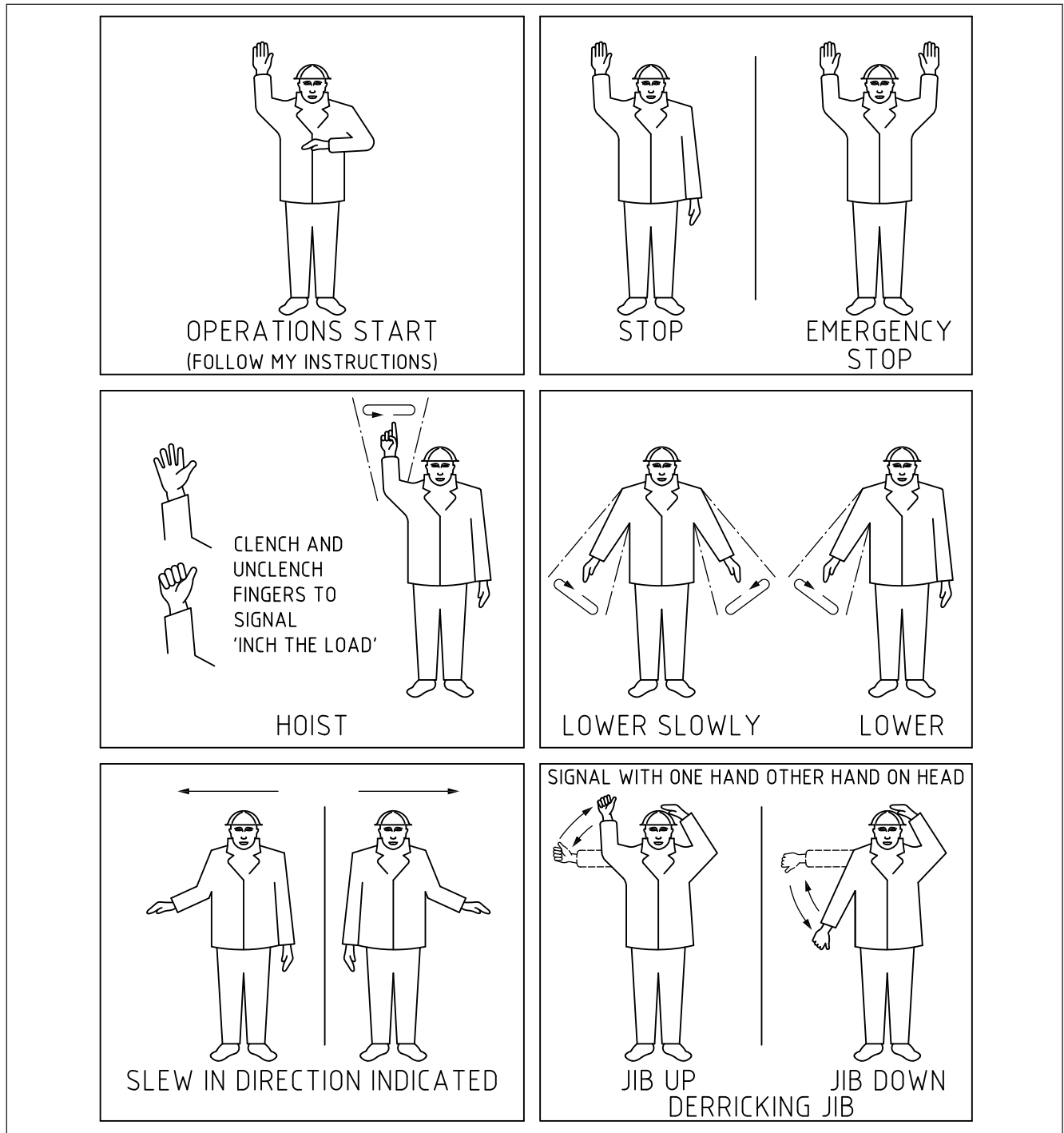
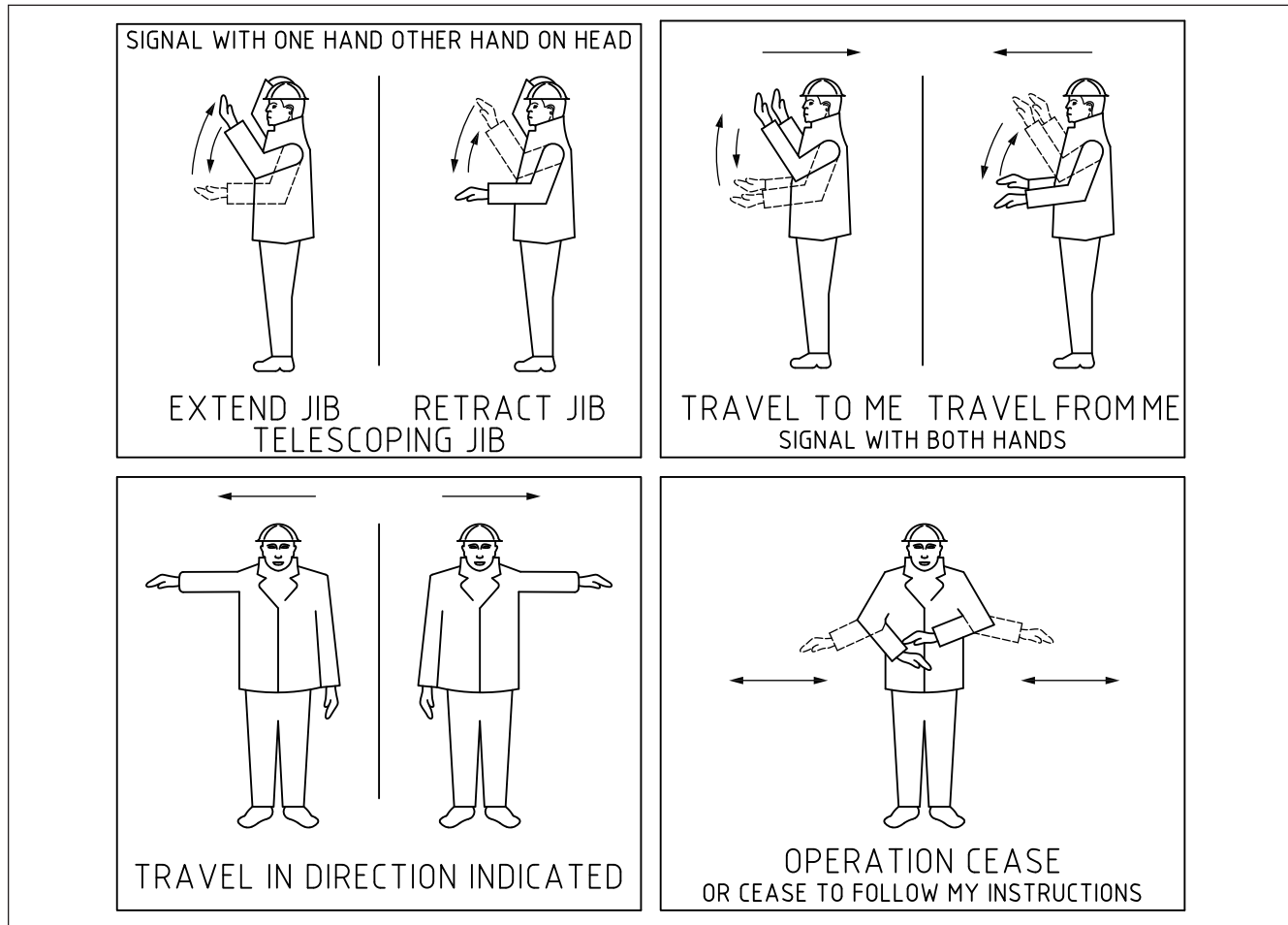


Figure 3 – Example crane signals



7.7 Crane erector

The crane erector should be:

- fit, with particular regard to eyesight, hearing, reflexes and agility;
- physically able to handle safely the loads involved in crane erection;
- able to work confidently and safely at heights;
- able to establish weights, balance loads and judge distances, heights and clearances;
- trained in the techniques of slinging;
- capable of selecting lifting gear and equipment that are suitable for the load to be lifted;
- adequately trained in the erection, dismantling and operation of the type of crane being erected, and in the safe use and setting up of any lifting appliance used in the course of these duties;
- capable of assessing that components and equipment are in a suitable condition for incorporation into the crane being assembled; and
- adequately trained in the setting and testing of the safety devices fitted to the crane being erected and those on any lifting appliance being used for the erection.

7.8 Maintenance personnel

Personnel carrying out maintenance should have the competences set out in BS 7121-2-1:2012, Clause 5.

8 Safety

8.1 General

The person or organization with overall control of the location of the lifting operation and the employers of personnel involved in the lifting operation have the responsibility for safety during lifting operations. To ensure that this responsibility is discharged effectively, the appointed person (see 4.3) should be given the necessary authority to ensure that adequate systems to achieve safety are in operation.

NOTE Safety matters relating to lifting operations 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.

8.2 Modifications and materials

Modifications to the structure, controls systems or any other part of the crane and the use of materials should be in accordance with BS 7121-2-1:2012.

8.3 Identification of person directing crane movements

8.3.1 The person directing crane movements (slinger-signaller or signaller) should be easily identifiable to the crane operator, for example by wearing distinctive high-visibility clothing or by using radio call signs.

8.3.2 When choosing high-visibility clothing, backgrounds, type of illumination and other relevant factors should be taken into account.

8.4 Personal safety equipment

8.4.1 The appointed person should ensure that:

- a) personal protective equipment is available that is appropriate for the conditions of the location, such as helmets, safety spectacles, fall protection equipment, safety boots, ear defenders, high-visibility clothing and life jackets or other buoyancy aids;
- b) equipment is inspected before and after use, and maintained in good working order or replaced where appropriate; and

NOTE Further information on the selection, use and maintenance of personal fall protection systems and equipment is given in BS 8437.

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

8.4.2 Certain safety equipment, for example helmets, safety spectacles and fall protection equipment, can deteriorate with age and should therefore be considered for renewal periodically. Damaged safety equipment should be replaced immediately.

NOTE The Health and Safety at Work etc. Act 1974 [1] and the Personal Protective Equipment at Work Regulations 1992 [25] require that employees cooperate with their employer, and use and report defects in appropriate personal protective equipment provided for their safety.

8.5 Use of personal protective equipment (PPE)

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

8.5.2 Personnel should be instructed in the correct use of the appropriate PPE provided.

NOTE Attention is drawn to the Personal Protective Equipment at Work Regulations 1992 [25], which require that any PPE provided is used.

8.6 Access and egress (including emergency escape)

8.6.1 General

8.6.1.1 Requirements for safe access and means of emergency escape are specified in product standards such as BS EN 13557, BS EN 13586, BS EN 14502-1 and BS EN 14502-2, and in standards for particular crane types such as BS EN 13000. If additional means of access/emergency escape are required on the crane, these should be incorporated only with the agreement of the crane manufacturer or appropriate design authority. All access, including that for the driving position(s) of the crane and for inspection, maintenance, repair, erection and dismantling of the crane, should be maintained in good condition.

NOTE Attention is drawn to the Work at Height Regulations 2005 [26] regarding the provisions for safe access and rescue.

8.6.1.2 All access ways should be kept clear of obstructions and other hazards.

8.6.2 Boarding and leaving the crane

8.6.2.1 Persons may only board or leave a crane with the operator's permission. The operator should be made aware of the precautions that are necessary while a person(s) is boarding or leaving.

8.6.2.2 If the boarding or leaving point is out of sight of the operator, means should be provided to make the operator aware of the other person's(') whereabouts. A notice advising of the boarding procedure should be posted at the boarding point.

8.6.2.3 Personnel should be instructed to use only the proper access and means of emergency escape.

8.7 Fire extinguishers

The selection, location, use and maintenance of fire extinguishers should be made in conjunction with advice from the relevant fire authority following a suitable and sufficient risk assessment. Potential users of fire extinguishers should be adequately trained.

8.8 Limiting and indicating devices

8.8.1 General

The correct operation of all limiting and indicating devices should be verified regularly. These devices should be maintained in good working order in accordance with the manufacturers' instructions.

8.8.2 Level indicators and inclinometers

Where fitted, crane level indicators and inclinometers should be used in accordance with the instruction manual and maintained in good working order.

8.8.3 Wind-speed indicating and monitoring devices

8.8.3.1 An anemometer should be fitted where the need for this is identified by the risk assessment (see 5.2). Where fitted, anemometers or other wind-speed measuring devices should have their indicators located in clear view of the crane operator and, if appropriate, the person controlling the lift. The correct operation of these devices should be determined regularly and they should be maintained in good working order.

8.8.3.2 The sensor of the indicator should be positioned so that it can measure airflow uninterrupted by the crane or adjacent structures.

NOTE 1 Sensors are often positioned on the highest point of the crane.

NOTE 2 Where it is not possible to fit an anemometer to the crane, a hand-held anemometer may be used.

NOTE 3 Frequent calibration of wind-speed indicators is not generally required as they are an indicator to the crane operator to assist in a judgement about when to take a crane out of service because of increasing wind speed.

8.8.4 Zoning and anti-collision devices

8.8.4.1 Zoning and anti-collision devices should be fitted where the risk assessment completed as part of the planning process (see 5.2) identifies a risk of cranes and/or the fixed load attachments:

- a) entering or oversailing a prohibited zone; or
- b) colliding with fixed structures, other cranes and/or other mobile plant.

8.8.4.2 The functioning of these devices should be confirmed during the pre-use inspections.

8.8.5 Rated capacity indicator and limiter (RCI/L)

The functioning of the RCI/L should be confirmed during the pre-use inspections.

8.8.6 Transport position indicators

The functioning of any indicators used to monitor the correct position of the crane prior to transport should be confirmed during the pre-use inspections.

NOTE Examples of these indicators include boom stowed, slew ring locked, outriggers or stabilizers stowed, hook block stowed, and counterweight locked.

8.9 Machinery guarding

All machinery guarding should be properly fitted whenever the crane is in motion or use and maintained in good condition.

NOTE Attention is drawn to PD 5304, BS ISO 11660-2 and the appropriate crane specifications.

9 Crane documentation

9.1 Rated capacity charts

Readily understandable rated capacity charts applicable to the various specified operating conditions of the crane, with appropriate down-rating for special applications such as magnet or grabbing duties, should be prominently displayed to the crane operator.

NOTE Operation of the crane outside these parameters, even in an unloaded situation, could be dangerous.

9.2 Instruction manuals

Operating instructions in the appropriate language(s), containing adequate information on the erection, use, alteration and dismantling of the crane, should either be kept on site or with the crane if it moves from one site to another.

9.3 Reports of thorough examination/test certificates

9.3.1 All current reports of thorough examination and any current test certificates for cranes and accessories for lifting should either be kept on site or with the crane if it moves from one site to another.

9.3.2 Where records are kept electronically, it should be possible to print a paper copy.

9.4 Maintenance records

Maintenance records should be maintained in accordance with BS 7121-2-1:2012, 7.9.

10 Erection and dismantling

10.1 Planning

10.1.1 Erection and dismantling of the crane should be thoroughly planned and properly supervised in the same way as the lifting operation (see Clause 5). Any supporting structure on which the crane is to be erected should be checked by a competent person to ensure it is adequate for the loads to be imposed.

10.1.2 The planning should take account of the need to dismantle the crane after use.

NOTE Detailed guidance on the erection and dismantling of specific crane types is given in other parts of BS 7121.

10.1.3 A correctly-planned erection and dismantling procedure should ensure that:

- a) erection of the crane does not commence unless an instruction manual is available for reference by erection staff and they have indicated an understanding of its relevant contents;
- b) the erection/dismantling manual is appropriate to the particular crane and bears the crane manufacturer's serial and type numbers and any owner's specific crane identifier;
- c) the entire erection and dismantling operation is controlled by the erector in charge (see 6.2.6);
- d) all personnel involved have confirmed they have a sound knowledge of their part in the operation;
- e) any departure from prescribed procedure is approved by the designer of the crane or another competent engineer;
- f) only correct parts and components of the original equipment manufacturer's standard and quality are used when replacement is necessary;
- g) the manufacturer's recommendations for the method of moving a crane from the place of erection to its place of work are followed;
- h) the crane is level to within the limits specified by the manufacturer; and
- i) a safe means of access is provided.

NOTE Attention is drawn to the Work at Height Regulations 2005 [26].

10.2 Manufacturer's erection and dismantling instructions

10.2.1 The crane manufacturer's instructions should be closely followed. Any departure from the specified sequential procedure should be approved by the designer or another competent engineer, to ensure stability of the crane and that structural and mechanical parts are not subjected to excessive loading.

10.2.2 Manuals sometimes deal with dismantling procedures by the simple statement that they are the reverse of erection procedures. The appointed person should ensure that such a statement is correct and, if there is any doubt, obtain further information from the manufacturer.

10.3 Identification of components

10.3.1 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.

10.3.2 Components should be marked in the same manner as shown in the crane instruction manual.

NOTE LOLER 1998 [2] state that it is necessary to identify any part of a crane jib that can be removed so as to indicate the crane of which it is a part.

10.3.3 Care should be taken to avoid a mismatch of thread forms of fasteners (nuts and bolts), for example between imperial and metric.

NOTE Nuts and bolts manufactured from high-tensile steel or other special steels carry markings so that they can be distinguished from other nuts and bolts. High-tensile bolts are tightened to a specified preload so that torsional loads are transferred across the joint by friction, rather than by shear across the bolt shank, and there is sufficient preload on the joint to reduce the effects of cyclic loading (fatigue). The reuse of high-tensile bolts needs to be in accordance with the manufacturer's conditions.

10.4 Electrical supply

10.4.1 Where a crane is electrically-operated from a source external to the crane:

- a) the crane should have an effective earth connection and, if mounted on rails, at least one rail track should be electrically bonded at each rail joint and the track should be effectively earthed – crane wheels should not be used for earthing the crane;
- b) the crane structure, motor frames and conducting cases of all electrical equipment, including metal conduit and cable guards, should be effectively and directly connected to earth;
- c) the characteristics of the power supply and of the crane equipment should be checked for compatibility before connection;
- d) cables providing power to the crane should be protected from mechanical damage by one or more of the following means:
 - 1) running in conduit, trunking or on trays;
 - 2) being clipped to a structure in a position where they are protected from mechanical damage; or
 - 3) being of armoured construction.

10.4.2 Where conducting material is used for protection, it should be bonded to earth at each end. The protection should never be used as an earth conductor.

10.4.3 Where practicable, the power supply to a travelling crane should either be through a cable winding drum or a properly installed, insulated and protected collector system.

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

10.4.5 In addition to any isolator within the crane that is capable of cutting off the electrical supply to the crane motions, there should be an identified isolator remote from the crane that can be used to cut off the electrical supply to the crane itself. All isolators should be capable of being locked in the off position and be identified with the individual crane power supplies they control.

10.4.6 The installation of electrical supplies should be in accordance with HSG 141 [N3] and BS 7671.

11 Procedures and precautions

11.1 Crane operation

11.1.1 Whenever a crane is moved, whether or not it is lifting a load, it should only be driven by a competent operator (see 7.4) approved by the appointed person.

NOTE However, the appointed person may approve a trainee operator provided they are under the direct supervision of a competent operator who has also been approved for that purpose by the appointed person.

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

NOTE Special arrangements might be necessary when carrying out maintenance or repairs on the crane (see Clause 12 and 19.7).

11.2 Working on cranes

11.2.1 General

When personnel are required to work on cranes for inspection, maintenance or other reasons, a system should be in operation to ensure that:

- a) they are not endangered by movement of the crane; and
- b) a safe working place and access are provided.

NOTE 1 Attention is drawn to the Work at Height Regulations 2005 [26] regarding the provision of a safe working place.

NOTE 2 For small and simple cranes where the operator 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 might be necessary.

11.2.2 Permit to work

COMMENTARY ON 11.2.2

An effective permit to work system ensures that the crane is physically incapable of movement (by removal of fuses or by some other means) before written authority is given to the person who is to undertake the work. The system requires a specifically-designed form or certificate to be issued only when the safety precautions necessary to achieve the safe system of work have been taken.

11.2.2.1 The recipient of the permit to work should sign the document and take it into safe custody, noting that they are responsible for the work and the personnel involved in that work. Upon completion of the work, the person responsible for the work should sign the clearance section of the form or 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.

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

11.2.2.2 To achieve and maintain a safe system of work for the implementation of a permit to work system the following conditions should be met:

- 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 the crane safe from all sources of danger;
- d) secure means of retaining any keys, fuses or other devices essential for maintaining the isolation of plant and apparatus; and
- e) demarcation of, and any special precautions taken to maintain, a safe working area.

11.2.3 Periodic checks

The appointed person should ensure that the appropriate pre-use checks and in-service inspections are carried out and that a system is in place to rectify any defects disclosed by the checks and inspections (see BS 7121-2-1:2012, Clause 6).

11.2.4 Crane not in regular use

Where a crane is not used for an extended period of time the user should ensure that the competent person specifies a special programme of pre-use checks, in-service inspections and thorough examination before it is used. The extent and thoroughness of this programme should be based 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 (see BS 7121-2-1:2012, Clause 9).

11.3 Reporting of defects and incidents

11.3.1 The appointed person should 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 the crane for further service.

11.3.2 This procedure should include the immediate notification of the following:

- a) any defects found during daily or weekly checks;
- b) defects found at any other time;
- c) incidents or accidents, however slight;
- d) shock loads, however they occur; and
- e) dangerous occurrences or reportable accidents.

NOTE Attention is drawn to RIDDOR 1995 [27] in relation to the reporting of defects and incidents.

11.3.3 The procedure should include provision for an examination by a competent person after any incident, whether or not a repair is necessary, to ensure that the crane is fit for further service.

NOTE See also BS 7121-2-1:2012, 8.8.

11.4 Leaving the crane unattended

11.4.1 A crane operator should be present when a load is suspended from a crane.

11.4.2 When a crane is to be left unattended for even a short period:

- a) all loads should be removed from the lifting attachment/accessory and the lifting attachment/accessory left in a safe position;
- b) the power supplies to all motions should be switched off or the engine should be stopped;
- c) appropriate motion brakes and locks should be applied to put the machine in a safe condition;
- d) the operator should remove the ignition key and any other keys from the crane; and
- e) if the crane is controlled by transmitted signals, e.g. radio, the operator should either retain the transmitter in their physical possession or remove the key from its key-lock switch and, for short periods, retain the key in their possession, or, for longer periods or when the crane is not in use, deposit the transmitter in safe storage.

11.4.3 For longer periods and for out-of-service conditions, switches should be 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 in accordance with the operating instructions.

NOTE For details of methods to safeguard particular types of cranes, see the appropriate part of BS 7121.

12 Maintenance

Maintenance should be carried out in accordance with BS 7121-2.

13 Operating conditions

13.1 Rated capacity: dynamic effects and non-vertical lifting

COMMENTARY ON 13.1

Rated capacities apply only to cranes used in accordance with the manufacturers' instructions. The rated capacity of a crane or any item used to attach a load to a crane may only be exceeded when testing the crane or item under the supervision of a competent person.

13.1.1 Loads should always be lifted gently and crane motions should be operated smoothly to avoid loads swinging (a swinging load increases the overturning moment 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 1). Tag 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 that load swinging can be controlled (see Figure 1).

13.1.2 The hoisting, slewing, traversing, luffing or travelling motions of a crane should not be used to drag any load along the ground with the hoist rope or hook out of the vertical position. Before lifting a load, the hoist line should be vertical (see Figure 4).

NOTE Failure to observe these points can adversely affect the stability of the crane or introduce loadings (stresses) into the crane for which it has not been designed. Even with a rated capacity indicator/limiter fitted, a structural failure can result without warning.

13.1.3 The competent person installing a crane on a floating vessel should take into account the possible heel angle of the vessel in determining the rated capacity of the crane in these conditions.

NOTE Wind can have a significant effect on suspended loads as shown in Annex D, leading to an increase in the load radius or side loadings on jibs.

Figure 4 Out of vertical lifting

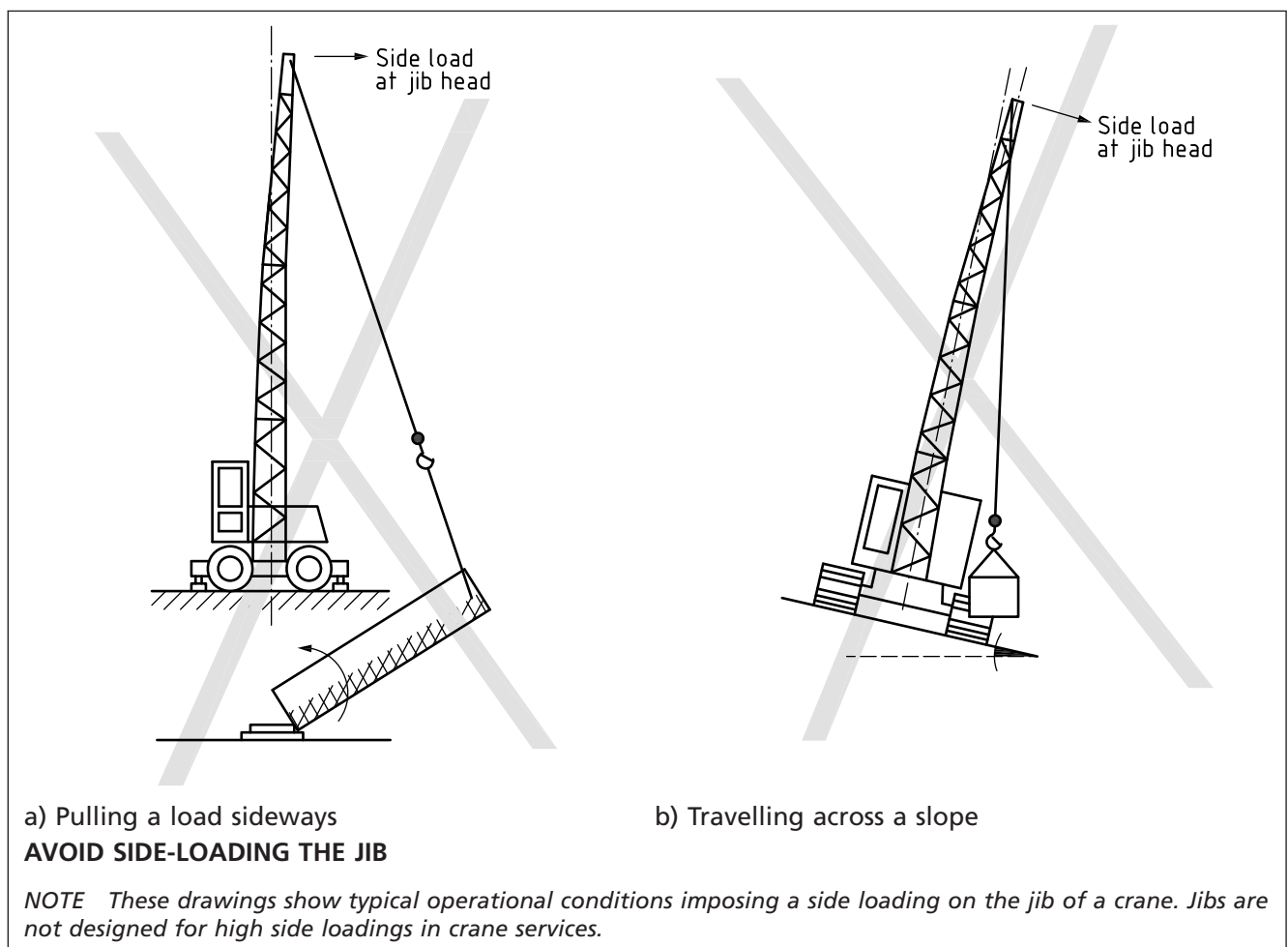
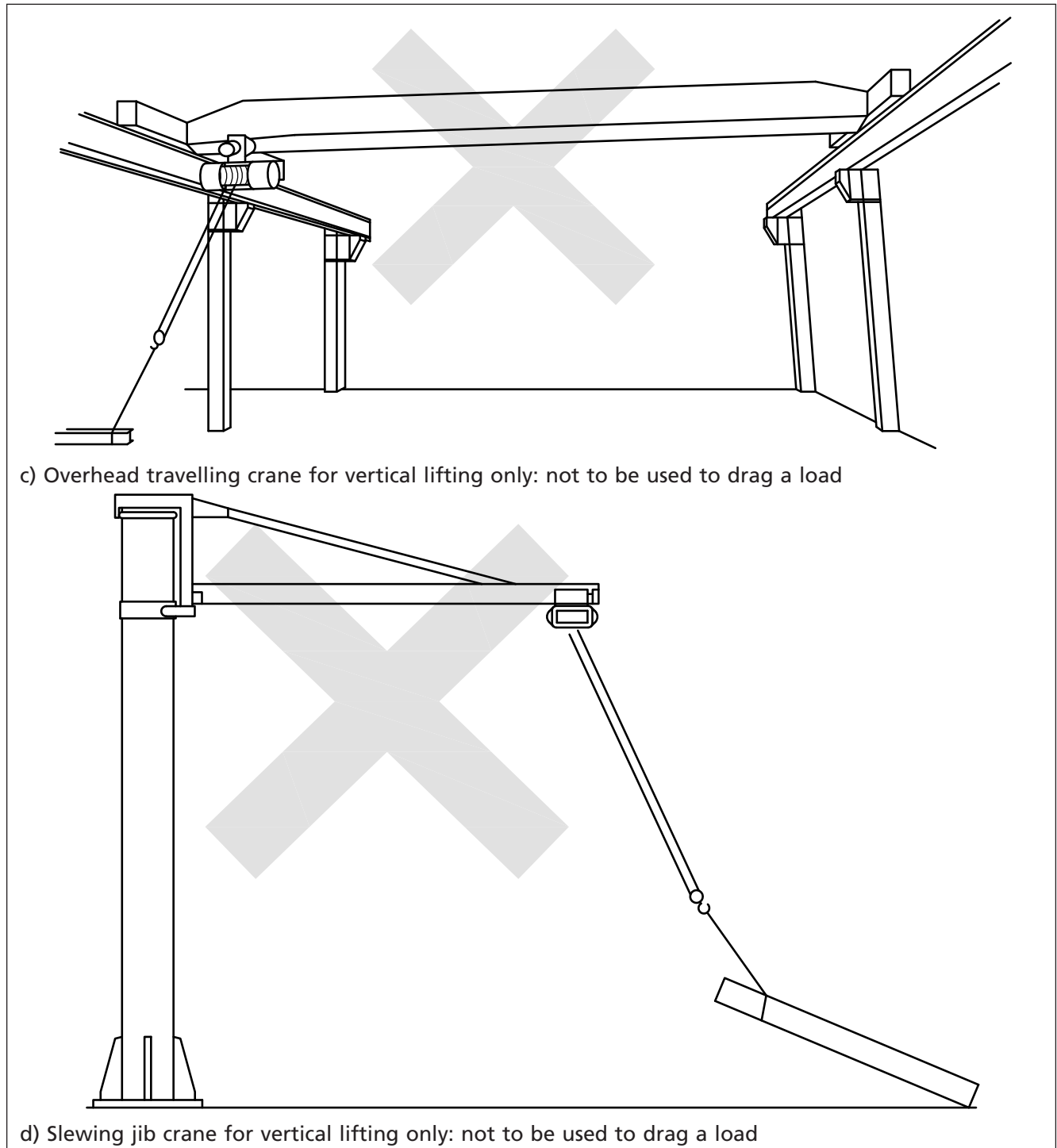


Figure 4 Out of vertical lifting



13.2 Mode of operation and control

13.2.1 General

13.2.1.1 To ensure safe use of the crane, each control should be marked to identify the motion controlled and the direction of movement. Markings should either be in the appropriate language(s) or consist of internationally agreed symbols (see ISO 7296-1), which should be adequately maintained.

13.2.1.2 The operator should not tamper with any controls, mechanisms or equipment, including limiting and indicating devices, either to enable the crane

to function outside the operational range or loads specified by the crane manufacturer or other competent person, or to attempt to correct any suspected defect.

13.2.1.3 Before starting any lifting operation with a crane the crane operator should:

- a) be trained and deemed competent on the particular crane;
- b) have a clear and unrestricted view of the load and operational area or act under the directions of a slinger-signaller or an authorized signaller who is positioned to have a clear and uninterrupted view;
- c) agree with the signaller the signals to be used (see Clause 17);
- d) ensure that the calling signal is functioning satisfactorily and that verbal messages can be clearly heard, especially where telephone, radio or closed-circuit television communications are being used;
- e) be in a position to receive warnings from any indicating devices; and
- f) ensure that lifts can be carried out without causing damage and that loads and crane hoist ropes or hooks are suitably clear of obstructions.

13.2.1.4 The hoist rope, hoist hook or, if applicable, the hoist chain should be vertical at the start of and throughout the hoisting operation. The load should 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. Care should be exercised by the operator at all times to avoid shock or side loadings on the jib or structure. Care should also be taken to avoid the load-lifting attachment or accessories coming into contact with the structure.

13.2.1.5 The crane safety devices should not be regarded as routine means of stopping the motion(s).

13.2.1.6 Where necessary, all travelling cranes that move close to where personnel have to pass or work should be distinguished at the leading end of the crane by a suitable warning, e.g. a lamp.

13.2.1.7 Before any crane is moved along its track(s), a warning should be given to all personnel who might be endangered. A warning bell or klaxon may be fitted for this purpose.

13.2.2 Remote-controlled cranes

13.2.2.1 Provision should be made for the security of the transmitter when the crane is not in use [see 11.4.1e)].

13.2.2.2 When the transmitter is fitted with a belt or harness, the operator should put on the harness before switching on the transmitter so that accidental operation of the crane is prevented. The transmitter should only be switched on while the crane is operated and be switched off before the harness is removed.

13.2.2.3 Where the crane is controlled by a hand-held push-button box, rather than a harness-mounted unit, precautions should be taken to prevent the box being dropped, e.g. attachment by lanyard or via a lanyard and pull-out key.

13.2.2.4 Where provided, the operator should test the controlled-range feature at regular intervals. The controlled-range feature should also either be checked at the beginning of each shift or whenever there is a change of operator to ensure that it operates within the limits specified.

NOTE Requirements for cableless controls and control systems are specified in BS EN 13557:2003, Annex C.

13.3 Handling of loads near persons

13.3.1 When a load has to be handled in the vicinity of personnel, extreme care should be exercised and adequate clearances allowed. The route of the load should be planned to avoid lifting over persons [see 5.3.3c)]. Operators and signallers should pay particular attention to possible dangers of personnel working out of sight.

13.3.2 All personnel should be instructed to stand clear of the load being lifted. When lifting a load from a stack, all personnel should be instructed to stand away from the stack in case adjacent materials or objects are displaced.

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

14 Multiple lifting and lowering

14.1 General

14.1.1 Greater attention should be given to the planning and supervision of a lift involving two or more cranes than a lift involving only one crane, as the effects of the relative motion between the cranes can induce additional loads on the cranes, the load and the lifting accessories/attachments. Because of this and the difficulty in monitoring these additional loads, multiple lifting should only be used when the physical dimensions, characteristics, weight or required movement of the load prevent the operation being carried out by a single crane.

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

14.1.3 Loads should not be pulled or dragged sideways using either the slewing motion or the hoist line. The hoist line should always be in the plane of the jib and hanging vertical. Side-loading of the jib should be avoided.

14.1.4 Multiple lifting usually also involves multiple lowering. When lowering, a crane can transfer load to another crane involved in the operation. During lifting, a crane operator can monitor and control the amount of load the crane is taking during lowering, but the operator of the crane receiving the load has no direct control of the amount of load the crane is receiving. This becomes more complex if more than two cranes are involved in the operation. The lift plan should therefore address the means of controlling the distribution of load during lowering. In particular, the rating of the cranes should allow for foreseeable variations of load share, taking account of the response time of the operators and cranes. The means of communication between the crane supervisor and the crane operators should be such as to facilitate a reliable and timely exchange of information and instructions. Where technically possible, the use of additional load monitoring equipment should be considered, for example, providing the crane supervisor with remote load readouts for all the cranes.

14.1.5 Multiple lifting should not be carried out using tower cranes (see BS 7121-5).

14.2 Main factors to be considered when planning multiple lifting

14.2.1 Weight of the load

The total weight of the load and its distribution should be calculated if not already known. Where the information is taken from a drawing, allowance should be made for casting and rolling margins and manufacturing tolerances.

14.2.2 Centre of gravity

Due to the variable effect of manufacturing tolerances and rolling margins, quantity of weld metal, etc., the centre of gravity of the load might not be known accurately and the proportion of the load being carried by each crane could therefore be uncertain. Wherever possible, the position of the centre of gravity of the load should be established by calculation or weighting.

14.2.3 Weight of the lifting accessories/attachments

14.2.3.1 The weight of the lifting accessories/attachments should be part of the calculated load on the crane. When handling heavy or awkwardly-shaped loads, the deduction from the rated capacity of the crane to allow for the weight of the lifting accessories/attachments might be significant. The weight of the lifting accessories/attachments and hook blocks, where appropriate, and its distribution should therefore be accurately known.

14.2.3.2 Where the crane ropes are reeved round pulleys that are part of a specially-designed lifting accessory/attachment, e.g. a lifting beam, the weight of the removed hook block and hook should be taken into account when determining the net weight of the lifting accessories/attachments.

14.2.4 Capacities of the lifting accessories/attachments

The distribution within the lifting accessories/attachments of the forces that arise during the lifting operation should be established. The lifting accessories/attachments used should, unless specially designed for the particular lifting operation, have a capacity margin well in excess of that needed for its proportioned load.

NOTE Special lifting accessories/attachments might be necessary to suit the maximum variation in distribution and direction of application of loads or forces that can occur during multiple lifting.

14.2.5 Choice of cranes

14.2.5.1 To minimize the variations in the direction and magnitude of the forces acting on the crane during the multiple lift, the crane motions should be synchronous in their effect. Cranes of equal capacity and similar characteristics (make, model, configuration and reeving) should therefore be used whenever possible.

NOTE In practice, there is always some variation due to differences in response to the activation of the motion controller and the setting and efficiency of the braking system.

14.2.5.2 The rated capacity of a crane should be calculated on the assumption that the load is raised and lowered in a vertical plane. The crane structure should be 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-vertical lifts.

14.2.5.3 If the cranes have dissimilar characteristics, it is unlikely that the motions of the cranes are accurately synchronized. The effect of the hoist ropes

being out-of-vertical, which could arise from inequalities of speed, should be assessed, and means for minimizing such inequalities should be determined.

14.2.6 Positioning of cranes

14.2.6.1 The risk of jib side loads is very high during slewing operations, so cranes should be positioned to minimize side loads on their jibs and arranged to avoid slewing wherever possible.

14.2.6.2 Crane positions should be checked at each stage of the lifting operation to ensure that no collisions can occur between the cranes themselves and external obstacles.

14.2.7 Instrumentation

Instruments are available to monitor the angle of the load and verticality and the force in each hoist rope or hook constantly throughout the lifting operation. Such instruments and the restriction of the motion speeds, together with the strict use of one motion at any one time, should be used to control the loads on the cranes within the planned values.

14.2.8 Supervision

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

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

14.2.8.3 Effective communication should be arranged between all persons involved in the lifting operation.

14.2.9 Rated capacity during multiple lifting

If the appointed person is satisfied that all the relevant factors given in 14.2.1 to 14.2.8 have been accurately identified and are being monitored by instruments, each crane may be used up to its rated capacity. When all the factors cannot be accurately evaluated, an appropriate down-rating (possibly 30% or more) should be applied to all the cranes involved.

15 Weather conditions

15.1 General

The operation of cranes in situations where they are likely to be affected by the weather should be given careful consideration during planning.

NOTE Certain weather conditions, such as electric storms, strong wind, heavy rains, ice or snow, can impose loads on a crane and adversely affect the safety of crane operations.

15.2 Wind

15.2.1 A crane should not be operated in wind speeds that are in excess of those specified in the operating instructions for the crane. Gusting wind conditions can 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 should be

taken when handling loads presenting large wind catching areas, which can act as sails and affect their ability to be handled safely or the stability of the crane.

15.2.2 The wind areas of the crane, and hence the forces acting on it, should not be increased by the addition of signs, banners or panels without the written approval of the crane manufacturer.

NOTE Information on the effect of wind and down-rating of the in-service lifting capacity is given in Annex D. Guidance on the assessment of wind loading is given in CIRIA C654 [28] and BS 2573-1.

15.2.3 The limitations on wind speed for erecting, testing and dismantling the crane could be lower than the limitations for normal operation and, in cases of doubt, advice should be obtained from the designer or a competent engineer.

15.2.4 Test sites (see BS 7121-2-1:2012, **10.11.5.1**) should not be located in areas which are known to be exposed to extreme weather conditions.

15.2.5 Advice issued by the crane manufacturer regarding the out-of-service conditions should be strictly followed (see Annex D).

15.3 Wind speed indication

15.3.1 If a crane is positioned where it could be adversely affected by high winds, an anemometer should be located/mounted at a suitable point(s), preferably on the crane structure, and supplemented with a hand-held anemometer(s) where necessary.

15.3.2 The wind speed should be monitored with the anemometer throughout a crane operation.

NOTE Wind speed increases with height and could be greater at a height of 20 m above ground level.

15.4 Visibility

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

15.5 Rain or snow/ice

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

15.6 Sea state

Where a crane is mounted on a vessel and subject to adverse sea states, account should be taken of the angles of heel being experienced and of the vessel stability.

16 Slinging and handling of loads

16.1 General

16.1.1 The appointed person should plan how the load is to be slung. Details should be recorded in the lift plan.

16.1.2 If lifting eyes are provided as an integral part of the load, they should be checked by the appointed person to ensure they are suitable for the intended lifting operation. If they are suitable, they should be used. If lifting eyes are

provided on containers (tanks, silos, etc.), the appointed person should ascertain whether the containers can be lifted full or whether they need to be empty. If the lifting eye is not large enough to allow the sling hook to seat correctly, a shackle of at least the same capacity as the sling hook should be used to connect the two.

16.1.3 If lifting eyes are not provided, slings should be attached to points on the load with sufficient strength to take any additional loads that could be induced by the slinging method. Care should be taken when using lifting eyes to ensure they are of the correct thread form to match the item to be lifted. Slings should be protected by suitable packing material to prevent contact with any sharp edges that could cause damage. If the packing could be dislodged during, or at the end of, the lifting operation, it should be lashed securely in place.

16.1.4 Once the slings are attached, they should be monitored as the tension increases, so that they do not slip or become fouled during the initial raising of the load.

16.1.5 Before lifting the load clear of the support, a check should be made as to whether the point of attachment to the load is vertically above its centre of gravity so that any hoist rope, hoist chain or hook hangs vertically. As the load is lifted clear of the support, a check should be carried out to ensure that it remains orientated as intended. If either condition is not met, any necessary corrections should be made before proceeding.

NOTE Any inclination of the crane, or poor adjustment of the side wear pads of a telescopic boom system, can lead to side deflections that could cause structural damage to the crane or make the load swing sideways as it is lifted clear.

16.2 Use of tag lines

16.2.1 Tag lines should be used:

- a) if there is a possibility that the load could come into contact with any other object during the lifting operation;
- b) to prevent loads from spinning due to wind; and
- c) to orientate or align the load for landing.

16.2.2 The safe system of work should identify how many tag lines are to be used and how they are to be attached to the load.

16.2.3 Care should be taken that tag lines cannot become fouled during use.

WARNING. Persons holding tag lines should not wrap a line around any part of their body or attach a tag line to any structure. The tag lines should not be knotted or looped.

16.3 Weight and centre of gravity of the load

16.3.1 Weight of the load

The weight of the load to be lifted should be established to a reasonable accuracy. The weight should be determined by any of the following procedures.

- a) Look to see if the weight is marked on the load. If it is, check to ensure that it is the weight of all parts of the load (a machine tool, for example, might not include the drive motor).
- b) Check the weight stated on any documentation.
- c) Look at a drawing of the load. If the weight is marked, check in the same way as in item a) to ensure it includes all parts of the load. If the load is still on a trailer or truck, use a weighbridge.

- d) Estimate the weight of the load by using tables of weights. BS 4-1 gives the weight of rolled steel sections and Table 3 gives weights for other materials.

Table 3 Weight of materials

Material	Weight ^{A), B), C)}	
	kg/m ³	lb/ft ³
Aluminium	2 700	170
Brass	8 500	530
Brick	2 100	130
Coal	1 450	90
Concrete	2 400	150
Copper	8 800	550
Earth	1 600	100
Iron and steel	7 700	480
Lead	11 200	700
Magnesium	1 750	110
Oil	800	50
Paper	1 120	70
Water	1 000	62
Wood	800	50

^{A)} In some cases the values given are an average and the actual weight could vary according to the particular composition/water content, etc.

^{B)} All values have been rounded for convenience of use.

^{C)} When dealing with a hollow body, check whether or not it contains anything and whether or not any such contents are liable to move.

16.3.2 Centre of gravity

Where the centre of gravity of the load is not known, the appointed person should make an assessment of the approximate position.

16.4 Use of lifting accessories/attachments

16.4.1 General

16.4.1.1 Only slings and other lifting accessories/attachments for which a current report of thorough examination has been issued within the previous six months or in accordance with a scheme of thorough examination, and which shows that the items are safe to use, should be used.

16.4.1.2 Lifting accessories/attachments should:

- be clearly identified and marked with the working load limit (WLL);
- be visually inspected on each occasion before and after use; and
- not be dragged along the ground or floor.

16.4.1.3 Lifting accessories should be stored appropriately to prevent damage or deterioration.

16.4.1.4 The safe system of work should include any special instructions to protect the slings from damage. Slinger-signallers should be instructed to take care to prevent textile slings from slipping during the initial tensioning stage of the lifting operation, as this is when the material of the sling is most susceptible to wear or damage.

16.4.1.5 Textile slings should be checked carefully each time before attachment to, and after removal from, the load. Textile slings should be withdrawn from use immediately if there are any signs of cuts or fraying in the fabric.

16.4.1.6 When slings are used for one lift only (sacrificial), they should be cut off as close to the load as practicable and disposed of after use.

16.4.1.7 Under no circumstances should slings be knotted.

16.4.1.8 Under no circumstances should chains be joined by means of bolts or wire and, when shackles are used, the correct pins should be fitted.

16.4.1.9 When used in connection with the handling of molten metal or slag, the rated capacity of all lifting accessories/attachments should be down-rated to half the normal rated capacity.

16.4.1.10 Consideration should be given to the effect of the operating environment on lifting accessories/attachments.

NOTE 1 Guidance on the use of Grade 8 or Grade T lifting chains and accessories in acidic environments is given in HSE Publication PM39 [29].

NOTE 2 The Code of Practice for the Safe Use of Lifting Equipment [30] provides further information regarding the selection and use of equipment. See also BS 6166-3.

16.4.2 Hooks and hook blocks

16.4.2.1 Hooks and hook blocks should be of sufficient capacity for the load.

16.4.2.2 Hooks and hook blocks should not be loaded beyond their working load limit.

16.4.2.3 The tip of a hook should not be used for lifting.

16.4.2.4 Hooks should either:

- a) have a safety catch or other efficient device to prevent displacement of the sling or load; or
- b) be of a shape that minimizes the risk of the sling or load becoming detached.

16.4.2.5 Slings should engage with the seat of the hook. Overcrowding the hook with multiple slings can result in the hook being loaded incorrectly and overstressed, so this should be avoided by, for example, using shackles or other lifting accessories to connect the slings.

WARNING. If multiple slings are not attached via a ring, link or shackle before placing on the hook, the hook could be strained due to spreading of the slings, the hook safety catch could be damaged or the slings could slip over the nose of the hook.

16.4.2.6 If setting a load down using a single fall of hoist rope, and consequently relieving the tension of the rope, the hook can spin. The slinger-signaller should take care when approaching a hook to disconnect the slings.

17 Signalling systems

17.1 Where the risk assessment (see 5.2) shows that a signalling system is required, all personnel involved in the lift should be conversant with the chosen signalling method.

NOTE Example hand signals are shown in Figure 3.

17.2 In situations where hand signals alone are inadequate, other forms of communication should be used, either radio or hard-wired, to supplement the hand signal code.

17.3 When radio is used as a means of signalling, the channel selected should be kept clear of all other communications. All personnel involved in the signalling should be given a clear and unique call sign and all communications should be preceded by this call sign. The crane operator should not respond to any command that is not preceded by the given call sign.

17.4 During the lifting operation, hand signals and any voice instruction to the crane operator(s) should only be given by one person at a time.

NOTE Additional information on radio communication for lifting operations is given in Annex F.

18 Thorough examination, including testing

18.1 General

Thorough examination of cranes, including testing, should be carried out in accordance with BS 7121-2.

18.2 Responsibilities of the crane user

18.2.1 General

18.2.1.1 The crane user should ensure that the crane is taken out of use for the period of time required by the competent person to carry out the thorough examination. The user should also ensure that a safe system of work is in place to prevent the competent person from being exposed to danger by inadvertent operation of the crane.

18.2.1.2 Where the crane is hired from a third party, the user should ensure that the thorough examinations are undertaken at the required intervals. Where the user comes to an arrangement with the owner whereby the owner carries out the thorough examinations, the user should ensure they are carried out.

18.2.2 Provision of facilities and services

The crane user should ensure that facilities or services, such as the following, which are required by the competent person to carry out the thorough examination, are provided:

- a) appropriate area, cordoned off to prevent access by persons not directly involved in the examination;
- b) operator for the crane;
- c) person(s) to remove covers or open up parts of the crane; and
- d) preparation of parts or areas of the crane for non-destructive testing.

18.2.3 Provision of information

18.2.3.1 Information regarding, for example, rated capacities, alterations, maintenance repairs, renewals and operators' instructions, should be made available to the competent person if these are necessary to carry out the thorough examination.

18.2.3.2 A "Report of thorough examination after installation" should be supplied where appropriate, and retained.

NOTE Attention is drawn to the requirements of LOLER 1998 [2] and, where appropriate, the requirements of the Merchant Shipping (Hatches and Lifting Plant) Regulations 1988 [31] for the format and content of the report.

19 Ropes

19.1 Rope replacement

Only a rope of the size, type, strength and construction specified in the crane manufacturer's handbook should be fitted to the crane, unless an alternative rope has been approved by the crane designer, rope manufacturer or other competent engineer (see BS EN 12385-1, BS EN 12385-2, BS EN 12385-3 and BS EN 12385-4).

19.2 Rope length

The length of the rope used should be sufficient for the particular application for which the crane is to be used and be such that in the extreme positions:

- a) there are at least two turns of rope, or more if specified by the manufacturer, left on the drum; and
- b) the drum flanges project at least two rope diameters beyond the outer layer of the rope.

19.3 Offloading, storage, uncoiling and handling, installation and running-in

19.3.1 Offloading

To avoid physical damage, ropes should be offloaded with care. The reels or coils should not be dropped. Coils of wire rope may only be lifted by their securing bands if it is known that the bands are specially designed for this purpose.

19.3.2 Storage

19.3.2.1 Ropes that have been removed from a machine for future use should be thoroughly cleaned and a dressing applied before storage.

19.3.2.2 Ropes should be stored in a cool, dry building and not be in contact with the floor or where they are liable to be affected by chemical fumes, steam or other corrosive agents. Ropes in storage should be examined regularly and a rope dressing applied if necessary.

19.3.2.3 Ropes having a length in excess of 30 m should be stored on a reel.

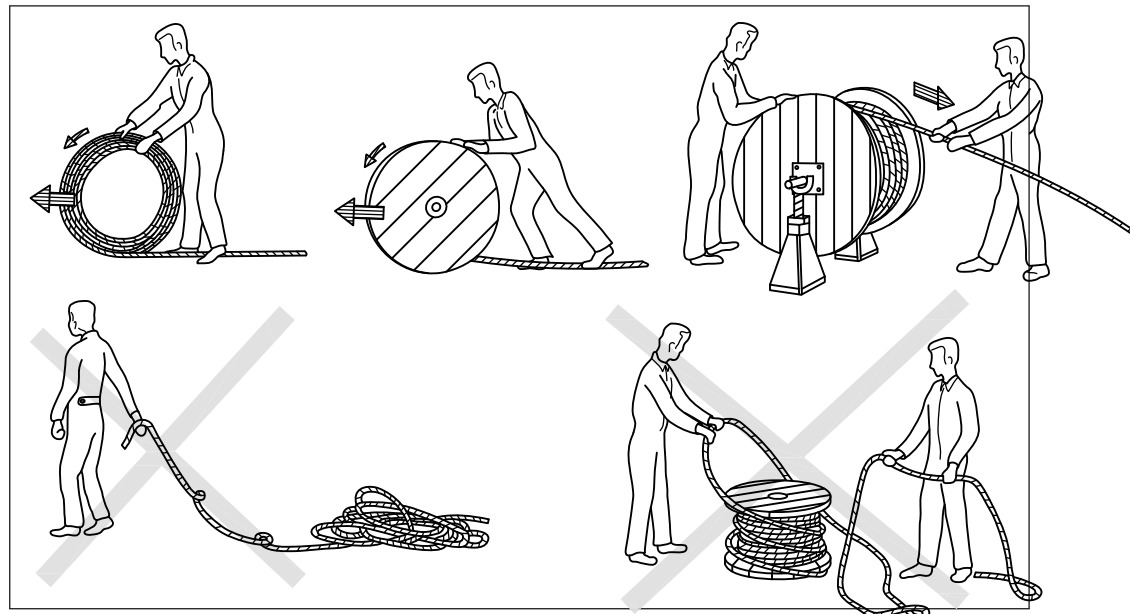
19.3.3 Uncoiling and handling

19.3.3.1 General

19.3.3.1.1 To prevent kinking or disturbance of the lay, ropes should be paid out without slack and in a straight line (see Figure 5).

19.3.3.1.2 Coils of rope should preferably be paid out from a turntable. Alternatively, where a coil is short, one end may be made free and the remainder rolled along the ground. For ease of handling, the inside end should first be secured to an adjacent turn. A rope should not be unwound by throwing off turns with the coil or reel flat on the ground (see Figure 5). The rope should be kept as clean as possible during this operation.

Figure 5 Paying out rope



19.3.3.1.3 When any rope is cut, the manufacturer's instructions should be followed.

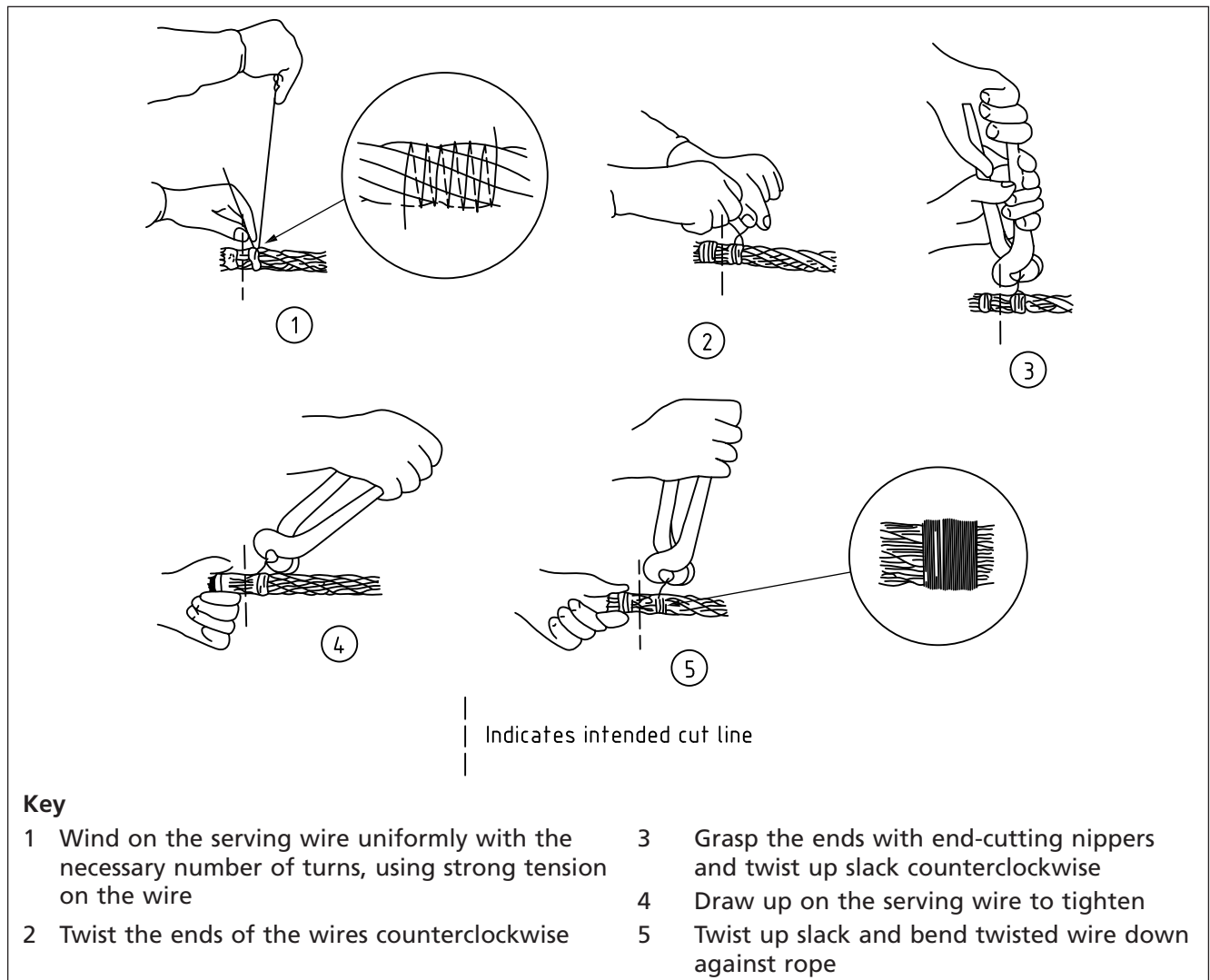
NOTE The manufacturer's instructions for cutting rope generally entail serving the rope on either side of the intended cut. Figure 6 shows a commonly used method.

19.3.3.2 Multi-strand ropes

Great care should be taken with multi-strand ropes to ensure that they are installed without imparting any rotation to the rope. A free end has no pronounced tendency to rotate, but caution should be exercised to ensure that the lay of the rope is not disturbed, either by turns in or turns out.

NOTE If the strands are disturbed, malformation of the rope can develop during subsequent use.

Figure 6 Serving of ropes before cutting



19.3.4 Installing and transferring rope from reel to reel/drum

NOTE Figure 7 illustrates how to transfer rope from reel to reel.

The lay of the rope should not be disturbed during installation, i.e. turn should neither be put in nor taken out of the rope. Lay ropes are usually stable, but special care should be taken with Lang's lay and multi-strand ropes. When winding a rope from a reel to a drum, the rope should be bent in the same direction. Re-reeling should be from the top of the reel to the top of the reel/drum or from the bottom of the reel to the bottom of the reel/drum. A tensioning load should also be applied to the rope to achieve good coiling. A simple brake, such as a plank rigged to bear against the reel flanges, can provide ample rope tension. The reel and the reel/drum should be spaced well apart to facilitate even coiling.

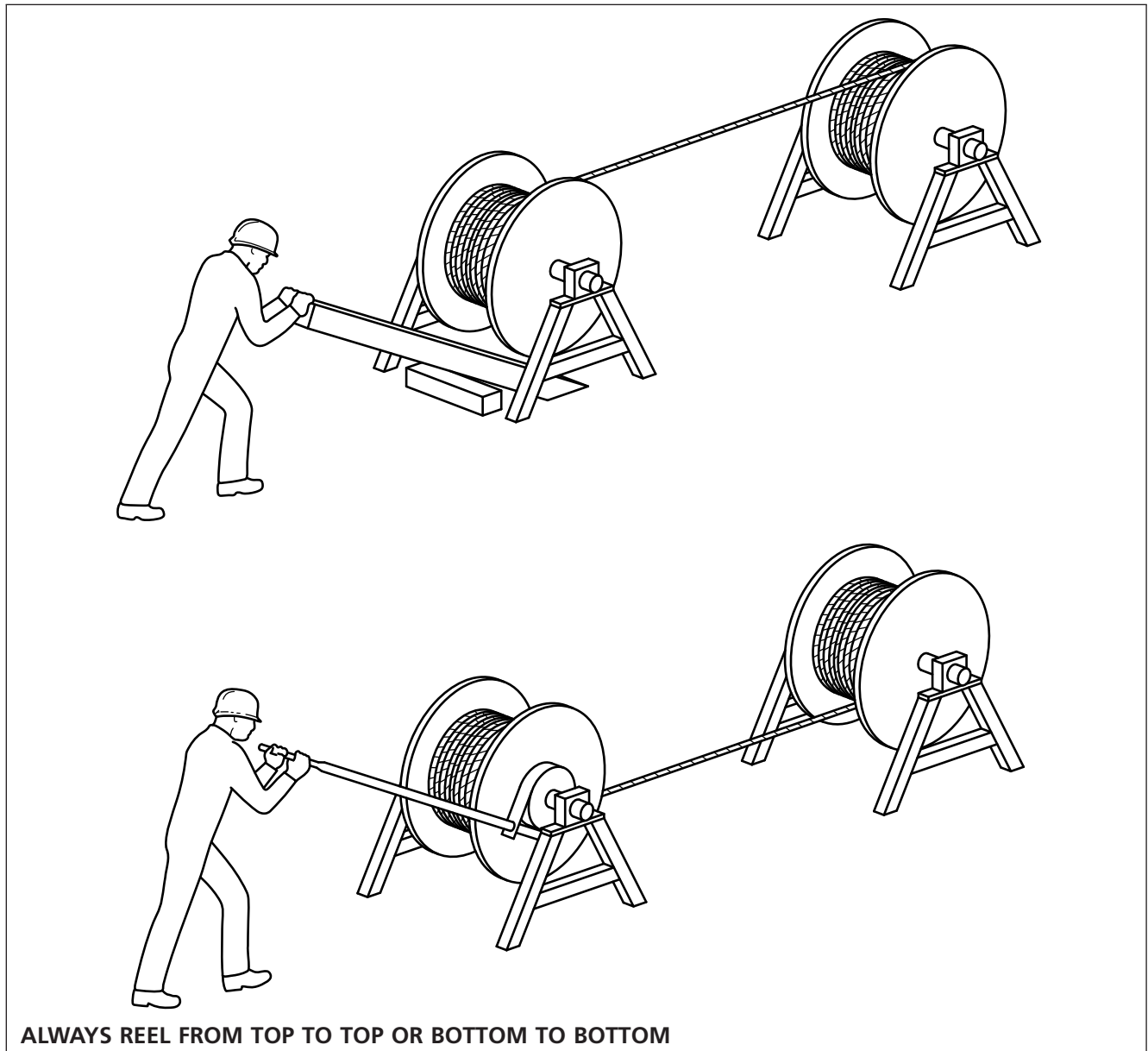
19.3.5 Running-in

When a new running rope is fitted, it should be run through its operating cycle for a number of operations at reduced speeds and loads to permit it to adjust to the working conditions.

NOTE 1 This is particularly important for multi-strand ropes.

NOTE 2 All new ropes when first installed stretch due to the wires and strands bedding in. This is normally accommodated by the installation. If not, it might be necessary to cut and re-terminate the rope.

Figure 7 Transferring rope for reel to reel



19.4 Rollers and guide sheaves

Rollers or guide sheaves are sometimes fitted on the jib of a crane to ensure that the rope does not rub against the jib structure. A seized roller or sheaf causes serious damage to a rope, leading to its premature failure, so rollers and guide sheaves should be checked at regular intervals to ensure they are free to rotate.

19.5 Rope drums and sheaves

19.5.1 Where an alternative drum and/or laggings can be fitted, the drum or laggings should be compatible with the size of rope and the duty requirements.

19.5.2 Sheaves are usually manufactured from ferrous materials, but the use of plastics sheaves and sheaves with plastics inserts is increasing. For many uses plastics sheaves and inserts give an increase in rope life, but there can be a change in the failure mode of the rope. Special attention should be given to the examination of ropes used with plastics sheaves and inserts (see BS 7121-2-1:2012, Clause 14).

19.6 Rope terminations

Only rope termination methods specified by the crane and/or rope manufacturer should be used.

19.7 Maintenance

19.7.1 General

COMMENTARY ON 19.7.1

Good maintenance generally increases rope life, and regular cleaning and service dressing is a necessary part of good maintenance.

19.7.1.1 Records should be kept of the maintenance of wire ropes (see 9.4). The maintenance of wire ropes is normally confined to cleaning and application of dressings.

19.7.1.2 Corrosion is a common cause of deterioration of ropes, especially those working out of doors. Internal and external corrosion can occur, and the former is more dangerous because it can lead to an appreciable reduction in the strength of the rope before becoming apparent. The dressings used for ropes should therefore penetrate easily into the rope, displace moisture from metal surfaces, give good corrosion protection, be resistant to wash-off by water, be reasonably resistant to emulsification, and not cause build-up on the surface such as to cause displacement of the rope.

NOTE The dressings are usually of mineral oil origin and are used to provide lubrication of the wires and strands and protection against corrosion.

19.7.1.3 In certain environmental conditions, the application of a dressing might aggravate the wear, e.g. by retaining abrasive materials, and in these conditions a dressing should not be applied unless it is required to protect the rope against corrosion.

19.7.1.4 The dressing should be compatible with the type of lubricant applied during the manufacture of the rope and the rope manufacturer's advice on this should be obtained.

19.7.2 Frequency of dressing

The frequency of dressing depends on the installation and on the environment in which the rope is working, but the following general principles should be followed in order to obtain the best rope life.

- a) Wherever practical, a dressing should be applied when the rope is fitted to the crane.
- b) The dressing should be reapplied at regular intervals and before the rope shows signs of corrosion or dryness.

19.7.3 Application of dressing

COMMENTARY ON 19.7.3

There are several methods of applying dressings and the most suitable for any particular rope depends upon the viscosity of the dressing and the length of rope involved. The methods of application include brushing, spraying, drip-feed and by automatic applicators.

19.7.3.1 Where possible, the lubricant should be applied to the rope where it "opens up" as it travels over a sheaf or winds on to a drum.

19.7.3.2 If the existing dressing on the rope is heavily loaded with dirt, sand, grit, etc., or if loose corrosion products are present, these should be removed with a wire brush or other suitable means.

19.8 Assessment of rope condition and discard criteria

Wire rope condition should be assessed in accordance with, and discarded as necessary using the criteria given in, BS 7121-2-1:2012, Clause 14.

20 Special applications of cranes

20.1 Raising or lowering of personnel

20.1.1 General

20.1.1.1 Raising and lowering of personnel by equipment that is not specifically designed for this purpose should only be carried out in exceptional circumstances, when it is not practicable to do so by other, less hazardous means.

20.1.1.2 Careful planning should be carried out prior to each raising and lowering operation.

NOTE 1 Attention is drawn to LOLER 1998 [2] regarding the planning of lifting operations.

NOTE 2 Further information on raising and lowering personnel is given in ISO 12480-1 and BS EN 14502-1.

20.1.2 Carrier

The type of carrier selected when raising/lowering personnel should be based on a risk assessment and vary according to the application, for example construction, forestry, rescue. New carriers selected for use should conform to BS EN 14502-1.

20.1.3 Compatibility of carrier and crane

20.1.3.1 Capacity

The crane selected to lift the carrier should have a rated capacity for the crane configuration to be used which is at least twice the weight of the carrier, its lifting accessories and its load.

20.1.3.2 Motion control system

20.1.3.2.1 The crane should be equipped with a motion control system that brings motion to rest automatically when the controls are released.

20.1.3.2.2 The crane should be equipped with power lowering. A crane with free-fall capability should not be used to lower and raise persons unless the free-fall facility is locked out.

20.1.3.2.3 Load-bearing hydraulic cylinders should be fitted with a device to stop movement in case of hose rupture or pipe fracture.

20.1.3.2.4 The crane control system should be able to provide a smooth transition of the carrier. The working speed of the carrier should be limited to a maximum of 0.5 m/s on all motions.

20.1.3.2.5 Means should be provided so that, if the power supply or control system fails, the carrier can be positioned to enable access/egress without risk.

20.1.3.3 Ropes

Ropes used for hoisting and lowering the carrier should have a minimum diameter of 8 mm.

20.1.3.4 Hook

The crane hook should be provided with a safety catch.

20.1.4 Thorough examination and pre-use checks

Thorough examination and pre-use checks of cranes and carriers for lifting persons should be carried out in accordance with BS 7121-2-1:2012, Clause 12.

20.1.5 Other devices/facilities**20.1.5.1 Anemometer**

The crane should be fitted with an anemometer or other device to monitor in-service wind speeds.

20.1.5.2 Storage

Storage accommodation for equipment, including any emergency egress equipment, should be provided in the carrier.

20.1.5.3 Rated capacity limiter/rated capacity indicator

20.1.5.3.1 The rated capacity limiter/rated capacity indicator on the crane should be maintained in good working order.

20.1.5.3.2 Limit switches should be provided to prevent over-hoisting, over-lowering or over-derricking.

20.1.5.3.3 The operator should check limit switches for correct operation each day before personnel carrying operations are carried out.

20.1.5.3.4 Limit switches are not necessarily fail-safe, so care should be taken if motion limits are approached.

20.1.5.3.5 A fail-safe procedure should be provided to ensure that sufficient hoist rope remains on the winch drum at all times to prevent the end of the rope running off the drum while lowering the empty carrier.

20.1.5.3.6 To ensure that sufficient rope remains on the drum at all times, the carrier should be lowered to the bottom of the shaft, cofferdam or caisson:

- a) prior to first use;
- b) after each time the shaft, cofferdam or caisson depth increases; and
- c) after the crane hoist rope or hook is replaced.

20.1.5.3.7 Care should be taken when the crane is moved to different locations to ensure that sufficient rope is fitted for each operation.

20.1.5.3.8 Operation of limit switches, check valves and similar devices could prevent some motions of the crane with the carrier still suspended. Precautions should be taken to ensure that persons in the carrier are not left suspended for an excessive period, and/or a procedure for raising or lowering the carrier to a safe position should be provided.

20.1.6 Operation

20.1.6.1 Organizational requirements

20.1.6.1.1 Lifting, lowering and supporting the carrier should be carried out by the operator in controlled conditions, directed by a slinger-signaller who should be present at all times during the lifting operation. The slinger-signaller should be positioned such that they can see both the carrier and the crane operator at all times.

20.1.6.1.2 The crane operator should be present at the normal crane control station when the carrier is occupied. Audible communication should be possible between the persons in the carrier and the crane operator at all times during the lifting operation.

NOTE This may be provided by dedicated radio or wired telephone.

20.1.6.1.3 During the operation:

- a) an adequately trained and briefed person should be present to perform any emergency recovery procedure;
- b) the crane operator and signaller should not perform any other work at the same time, and should only be responsible for operating one crane or directing one carrier;
- c) cranes and other machines should not operate simultaneously in the same place if there could be a risk of collision;
- d) all movements should proceed gently and not exceed 0.5 m/s; and
- e) load-lifting attachments for carriers should not be used for any other purpose.

20.1.6.1.4 Carriers should not be used in the following conditions:

- a) winds exceeding 7 m/s (25 km/h), measured with a calibrated hand-held anemometer at a similar level to that to which the carrier will be lifted;
- b) electrical storms;
- c) snow or ice;
- d) fog;
- e) sleet; and
- f) other weather conditions that could affect the safety of personnel.

20.1.6.1.5 Unintentional rotation of the carrier should be prevented, for example by using guide ropes or anchoring. The means of preventing unintentional rotation should not inhibit any emergency procedures and otherwise interfere with the safe operation of the carrier.

20.1.6.1.6 Lifts should not be made on any other hoist lines of the crane while any person occupies a carrier attached to the crane.

20.1.6.1.7 The crane, load-lifting attachments and carrier should be inspected every working day during use.

NOTE For further information on inspections, see BS 7121-2. An example of a personnel carrier pre-use check form is given in BS 7121-2-1:2012, Annex C.

20.1.6.2 Precautions for persons in the carrier

20.1.6.2.1 The payload of the carrier should not be exceeded.

20.1.6.2.2 The stability of the carrier should not be affected by the operation. Additional care should be taken if the carrier is of a length that could lead to excessive tilting through movement of persons or tools within the carrier.

20.1.6.2.3 Users of a carrier should wear suitable full-body harnesses with work restraint systems attached to a suitable anchorage point in the carrier. The most suitable type of work restraint system is an adjustable lanyard, adjusted to be as short as possible to ensure that a person is restrained within the carrier.

NOTE Further information on the use of personal fall protection equipment is given in BS 8437.

20.1.6.2.4 Consideration should be given to the rescue of persons from a carrier if the carrier is unable to be lowered for any reason, such as machine malfunction or carrier entanglement. Any rescue procedure should be properly planned, taking into account the reasons why the carrier is stranded at height and any need for urgent action.

NOTE In many circumstances the rescue plan simply involves lowering of the carrier by the supporting crane.

20.1.6.2.5 In the event that fall-arrest equipment is selected, a rescue plan should be prepared to avoid the consequences of suspension trauma when a person is suspended from a fall-arrest harness.

20.1.6.2.6 Any tools/materials in the carrier should be secured to prevent displacement, tipping and/or falling out.

20.1.6.2.7 Personnel should remain entirely inside the carrier during raising, lowering and positioning to avoid pinch points. Personnel should only stand on or work from the floor of the carrier.

20.1.6.2.8 Carriers should be secured so that access and egress can be accomplished without danger.

20.1.6.2.9 Crane-suspended man riding cages should not generally be provided instead of fixed access/egress.

20.1.7 Work from a carrier

COMMENTARY ON 20.1.7

Exposed electrical conductors in the vicinity of the lifting operation can present electrical hazards. Exposed high-voltage conductors can cause electric shocks or burns even if not touched by personnel. If there are electrical conductors adjacent to the work area, seek advice from the owner of the conductor. Overhead lines usually belong to the local electricity supplier or the National Grid company. These suppliers can provide advice on safe working distances from electrical conductors.

20.1.7.1 If electric arc welding is carried out from a carrier, precautions should be taken to prevent stray welding return currents from flowing through the load-lifting attachments, crane hoist rope or hook, or other part of the crane. Electric arc welding should be carried out in accordance with HSG 118 [N4]. The return welding current lead should be secured to the welded part, as close as practicable to the point of the weld.

NOTE Complete insulation of the crane hoist rope or use of clean dry webbing lifting attachments can also prevent stray currents.

20.1.7.2 Electric-powered hand tools, if used, should be battery-powered.

20.1.7.3 Power cables provided to the carrier should not interfere with safe operation of the carrier.

20.1.7.4 Power cables should not be used as tag lines.

20.2 Other special applications

The recommendations for the following special applications in BS 7121-3 and BS 7121-4 should be followed:

- a) grabbing and magnet crane services (BS 7121-3 and BS 7121-4);
- b) vacuum lifting devices (BS 7121-3);
- c) piling operations (BS 7121-3);
- d) demolition and balling operations (BS 7121-3);
- e) dismantling operations (BS 7121-3);
- f) dynamic compaction (BS 7121-3);
- g) manipulators (BS 7121-4); and
- h) tyre handlers (BS 7121-4).

Annex A
(normative)

Training of appointed persons and crane supervisors for lifting operations

COMMENTARY ON ANNEX A

The employment of a competent person to manage lifting operations is one of the most important factors in the safe use of cranes. Poor management, including planning and supervision, is a contributory cause of crane accidents, which result not only in significant damage to plant, but also in severe injury to those doing the work or those nearby. Training enables suitable employees to learn the basic elements of managing lifting operations. After training, candidates ought to work under the supervision of an experienced appointed person or crane supervisor until their employer has assessed them as competent to perform their duties.

This annex provides general recommendations for all crane types. Further recommendations are given in crane-specific parts of BS 7121.

Detailed information about the content of training courses varies depending on the individual circumstances. The information provided in this annex is intended to assist an organization running training courses, either internally or as a service to other organizations, to determine whether their courses are adequate.

A.1 Employer's duties

Training of personnel should be treated as an important element in the overall planning and supervision of safe lifting operations. Therefore, the employer should:

- a) use appropriate procedures to ensure that suitable potential trainees are selected (see A.2);
- b) provide adequate basic training in the role of the appointed person and crane supervisor, including the principles of crane and lifting accessory selection, planning, supervision, operation, slinging, signalling, inspection, maintenance and thorough examination (see A.3);
- c) train employees in the identification of hazards on sites where lifting operations are to take place and suitable control measures to reduce the level of residual risk within a safe system of work;
- d) ensure that only employees who have been assessed as reaching an adequate level of competence are authorized to act as appointed persons (see A.5); and
- e) provide adequate supervision so that the competence of appointed persons and crane supervisors can be monitored and the need for any refresher training assessed (see A.5.5).

A.2 Selection of appointed persons and crane supervisors

A.2.1 General

Potential appointed persons and crane supervisors should be carefully selected by the employer on the basis of their:

- a) prior relevant experience;
- b) academic and vocational qualifications;
- c) numerical and literary ability; and
- d) supervisory and management skills, and experience.

NOTE Selection tests may be used as part of the process.

A.2.2 Assessment of training needs

An assessment should be made of the extent of training needed for an individual, taking account of any previous training and experience. When personnel are recruited, the employer should check that their qualifications and experience relate to the job they are to do. Where the type of crane(s) to be operated or the slinging procedures to be used are outside the employee's previous experience, additional training should be provided.

NOTE In any event, some further training is likely to be necessary to familiarize the employee with specific requirements of the new job.

A.3 Basic training of appointed persons and crane supervisors

COMMENTARY ON A.3

Basic training covers the principles, both theoretical and practical, governing the management of lifting operations with cranes.

A basic training course is usually designed with the requirements of novice potential appointed persons and crane supervisors in mind, but it would be unwise to assume that more experienced employees do not need basic training. Many training organizations acknowledge this and run short courses for those with experience, recognizing that less time is necessary for training in the fundamental aspects.

A.3.1 Training venue

A.3.1.1 Training should be given at a suitable facility that includes:

- a) a segregated area set aside for the purpose of training:
 - 1) for mobile cranes, tower cranes, lorry loader cranes and other types of mobile or portable lifting machines, the area should be equivalent to the crane's maximum radius throughout its full slewing range, plus a provision for any protruding load, plus two metres; and of firm, level ground which can take the weight of the crane and the forces imposed by the crane;
 - 2) for overhead travelling cranes, portal cranes and other types of permanently installed cranes, the area should be of sufficient size to facilitate the full range of lifting operations to which the training applies;
- b) a range of different types of load, lifting accessories and simulated hazards; and
- c) a suitable classroom environment.

A.3.1.2 Where provided at the employer's premises, training should be carried out independently of the trainee's normal work. This means that the instructor and trainees, together with the crane and loads, should, during the basic training, be wholly devoted to that training.

A.3.2 Crane available for training

A crane, together with a competent operator, should be available at the training venue for the exclusive use of the instructor and trainee for the purposes of training. Certain crane types might also require a competent slinger-signaller. The crane should have similar characteristics to the type the trainee will be managing after training. It should be in good condition, safe to use and accompanied by a current report of thorough examination and all appropriate instruction manuals.

A.3.3 Appropriateness of training

A.3.3.1 As far as possible, the instructor should ensure that the training provided covers the type(s) of crane and the range of loads, lifting accessories/

attachments and conditions likely to be experienced by the trainees, including any particular hazards met in normal operations. The employer should ensure that if another organization carries out the training it is informed of the sort of work the trainee is likely to be doing.

A.3.3.2 Where the training provided is not specific to the type of lifting operations that the trainee will be undertaking, their employer should ensure that supplementary training and competency assessment is undertaken.

A.3.4 Course structure

A.3.4.1 The course should be both theoretical and practical in nature, and sufficient to enable the trainee to master the necessary skills.

A.3.4.2 The course should follow a carefully devised programme which ensures that each knowledge requirement is introduced at an appropriate point in the course, building from the simpler tasks and allowing adequate time for learning and practice before moving on.

A.3.5 Trainee/instructor ratio

The ratio of instructors and trainees should suit the particular aspect of training being covered. There should be sufficient time for the instructor to demonstrate each part of the practical training and then for each trainee to practise the skills while also being able to learn from observing other trainees.

A.4 Training programme

A.4.1 General

As a minimum, the instructor should follow a carefully devised, documented training programme covering the subjects in **A.4.2** and **A.4.3**.

A.4.2 Theoretical topics

Theoretical topics should include:

- a) an introduction to the course syllabus, with an explanation of the importance of training;
- b) the relevant legal requirements, including those to do with crane construction, maintenance, thorough examination, documentation, record keeping and use;
- c) the different responsibilities of all the individuals involved with a lifting operation;

NOTE Reference can be made to relevant published material, including British Standards and HSE and industry guidance.

- d) an introduction to different types of lifting equipment applicable to the course being delivered, such as loader cranes, mobile cranes, crawler cranes, lifting gantries, and overhead travelling cranes;
- e) a more detailed introduction to cranes, explaining the purpose of all main components, including the location and function of controls, instruments, indicators and safety devices;
- f) the principles of mechanical, hydraulic, pneumatic and electrical systems as they are relevant to the safe operation cranes;
- g) pre-operational checks, reporting and operator level maintenance in accordance with manufacturer's instructions;
- h) site surveys and identification of hazards;
- i) risk assessments and method statements;

- j) the siting of the crane, including the assessment of strength and stability, and ground conditions, and the calculation of the distribution of the total load;
- k) drawings showing the area of the lifting operation, including the position of the crane, pick up and lay down locations, and immediate hazards;
- l) the assessment of loads, including estimation of weights and centres of gravity, and their stability;
- m) the assessment of lift categories, load complexities and environmental complexities (see 4.3.2);
- n) load charts and the selection of cranes for different duties;
- o) weather forecasts, measurement of wind speed and determining limiting wind speeds for erection of the crane and lifting operations;
- p) down-rating of lifting capacity for multiple lifting or lifting loads with large sail areas;
- q) good operating practices, including operation near other plant equipment, precautions near overhead lines, structures, etc.;
- r) precautions to be taken when lifting persons;
- s) communication with site managers, principal contractors and others in the area of the planned lifting operation;
- t) an introduction to the different types of lifting accessories, and their functions, limitations and potential causes of failure;
- u) the routine care, inspection and maintenance of lifting accessories and reporting of defects, including the criteria for rejection and actions to be taken;
- v) the selection and correct use of appropriate lifting accessories, including methods of slinging, the methods of rating for multi-legged slings, the concepts of working load limit and rated capacity, interpretation of markings and down-rating of lifting accessories for any particular adverse conditions of use;
- w) signalling methods, including the recognized code of hand signals; and
- x) briefing of lifting team members in the details of the lift plan.

A.4.3 Practical topics

Practical topics should include:

- a) **for appointed persons:**
 - 1) carrying out a site survey and preparing a drawing showing the intended position of the crane;
 - 2) selecting suitable cranes for different lifting operations;
 - 3) assessing loads, crane lifting duties and correct lifting accessories; and
 - 4) preparing the risk assessment and method statement;
- b) **for crane supervisors and appointed persons:**
 - 1) carrying out a site survey to check that there have been no significant changes or additional hazards introduced from those identified in the lift plan;
 - 2) checking the access and egress routes of the crane from the lifting area;
 - 3) checking the load(s) to be lifted match the descriptions on the lift plan;

- 4) checking that the crane and any lifting attachments provided match those selected in the lift plan, including the lifting capacities and physical dimensions of the crane;
- 5) checking that the lifting accessories selected in the lift plan are present;
- 6) checking reports of thorough examination for the crane, lifting attachments and accessories;
- 7) checking that pre-use checks have been undertaken by the crane operator and slinger-signallers;
- 8) checking that an exclusion zone has been established around the lifting area;
- 9) briefing the lifting team (slinger-signaller and operator) on the details of the lift plan;
- 10) supervising the siting and setting up of the crane in preparation for the lifting operation;
- 11) checking that the crane has been set up in accordance with the lift plan;
- 12) supervising the lifting operation; and
- 13) checking that the crane is stowed correctly and prepared for travel.

A.4.4 Training in slinging

Appointed persons and crane supervisors should also be given training in slinging (see B.7) because they need an appreciation of those skills and they could be acting as the slinger-signaller during lifting operations.

A.4.5 Instructors

The success of any training depends largely on the effectiveness of the instructors. Training should be carried out by people who have been selected and trained for the purpose.

NOTE Recommendations for the selection and training of instructors are given in A.6.

A.5 Appraisal and authorization

A.5.1 General

Continuous assessment of a trainee's progress should be made by the instructor during training to ensure the required standards are reached at each stage, monitored and maintained.

A.5.2 Appointed person and crane supervisor tests

Potential appointed persons and crane supervisors should also be assessed by means of theoretical and practical tests which confirm their ability to perform their duties satisfactorily. The tests should include:

- a) **for appointed persons:**
 - 1) a written test, including questions relating to:
 - i) health and safety legislation;
 - ii) British standards for safe use of cranes;
 - iii) identification of site hazards;
 - iv) assessment of loads;
 - v) crane selection;

- vi) where appropriate for the crane type in use, the assessment of ground conditions and the calculation of the distribution of the total load;
 - vii) selection of lifting accessories and attachments;
 - viii) crane signals; and
 - ix) operational issues and the attachment(s) used during training;
- 2) preparation of a lift plan for a theoretical lifting operation, including:
- i) a drawing of the site showing all significant hazards and the intended position of the crane;
 - ii) assessment of the load to be lifted;
 - iii) details of the crane selected for the lifting operation;
 - iv) details of the lifting accessories or attachments selected for the lifting operation; and
 - v) a risk assessment and method statement;
- b) **for crane supervisors:**
- 1) a written test, including questions relating to:
- i) health and safety legislation;
 - ii) British standards for safe use of cranes;
 - iii) identification of site hazards;
 - iv) assessment of loads;
 - v) selection and use of lifting accessories and attachments;
 - vi) crane signals; and
 - vii) operational issues and the attachment(s) used during training;
- 2) a practical test of supervising a lifting operation, including:
- i) carrying out a site survey to check that there have been no significant changes or additional hazards introduced from those identified in the lift plan, including access and egress of the crane from the lifting area;
 - ii) checking that the load(s) to be lifted matches the descriptions on the lift plan;
 - iii) checking that the crane and any lifting attachments provided match those selected in the lift plan, including a check on the lifting capacities and physical dimensions of the crane;
 - iv) checking that the lifting accessories selected in the lift plan are present;
 - v) checking reports of thorough examination for the crane, lifting attachments and accessories;
 - vi) checking that pre-use checks have been undertaken by the crane operator and slinger-signallers;
 - vii) checking that an exclusion zone has been established around the lifting area;
 - viii) briefing the lifting team (slinger-signaller and operator) on the details of the lift plan;
 - ix) supervising the siting and setting up of the crane in preparation for the lifting operation;

- x) checking that the crane has been set up in accordance with the lift plan;
- xi) checking the weather forecast and wind speed;
- xii) supervising the lifting operation; and
- xiii) checking that the crane is stowed correctly and prepared for travel.

A.5.3 Training records and certification

Trainees who have satisfactorily completed a training course should be awarded a certificate to that effect. The employee, or the employer on their behalf, and the accrediting body should keep records of training carried out and the results of tests undertaken.

A.5.4 Authorization of employees

The employer should give specific authorization to employees to act as appointed persons or crane supervisors. The employer should be satisfied that the employee has had appropriate training and is competent to manage and supervise lifting operations with the types of cranes they will use.

A.5.5 Continuing assessment

A.5.5.1 Even after training has been completed and authorization given, a periodic assessment of personnel should be carried out to determine continued competence. The assessment should consider the range and type of lifting operations being managed and supervised and whether prior training is suitable and sufficient. To complement this, formal refresher training, including re-assessment, should be carried out routinely every five years. It might be required earlier, for example, in the event of long periods of inactivity.

A.5.5.2 The employer should advise employees of the outcome of periodic assessment and any required supplementary training.

A.6 Selection and training of instructors

A.6.1 General

Training at both a basic and advanced level should only be carried out by those who are experienced and have been formally trained against national teaching and learning standards and/or industry-specific requirements in combination with being suitably certified by a training accreditation scheme or certification body.

A.6.2 Previous experience

Instructors should have sufficient industry-based practical experience of, and be qualified for, the role or occupation and the specific activities being taught. In addition, instructors should maintain their knowledge and understanding of current good working practices and the requirements of legislation and regulations by carrying out continuing personal and professional development.

A.6.3 Instructor qualities and abilities

In addition to sufficient industrial and technical experience, an effective and able instructor should possess sufficient knowledge and understanding of relevant health and safety matters and apply them to the learning environment, and be able as a minimum to:

- a) facilitate and support training against learning aims and objectives in both a classroom and working environments under varying conditions;

- b) organize and implement the appropriate training and assessment resources, including facilities, whilst providing a safe environment for learners, themselves and others;
- c) engage learners, whether they are a range of people and/or groups, by communicating effectively, confidently and patiently whilst promoting inclusive practice;
- d) train effectively using, and where necessary adapting, a variety of resources and training delivery methods and/or approaches to accommodate all learning situations;
- e) lead and maintain control of groups and situations at all times; and
- f) impartially and consistently measure candidates' performance and knowledge against pre-devised assessment programmes, ensuring learning outcomes are met.

A.6.4 Instructor training course content

Instructor training programmes should be mapped and delivered against national teaching and learning standards for preparing to and teaching within lifelong learning, and cover at least the following areas:

- a) the roles, relationships and responsibilities within lifelong learning;
- b) the recognition and application of relevant theories, principles and methods of teaching and learning;
- c) the facilitation and delivery of learning and development for groups and individuals;
- d) the identification, preparation and use of various types of learning resources; and
- e) the principles and methods of assessment for vocational skills, knowledge and understanding.

A.6.5 Instructor certification

Instructors should hold relevant certification following completion of formal learning and development programmes from issuing bodies. A major element of an instructor's qualities and abilities is the maintenance and improvement of both technical knowledge and learning delivery.

Annex B (normative)

Training of crane operators and slinger-signallers

COMMENTARY ON ANNEX B

The employment of competent, trained operators and slinger-signallers is one of the important factors in the safe use of cranes. Inadequate employee training is a contributory cause of crane accidents, which result not only in significant damage to plant, but also in severe injury to those doing the work or those nearby. Training enables suitable employees to learn the basic elements of crane driving and slinging which, with experience, help them to become competent.

The recommendations of this annex are relevant to work associated with conventional types of crane. Machines which can be converted to be used as cranes (e.g. forklift trucks), which are particularly simple in operation (e.g. hoists used by machine operators) or are special in their design or use present different problems and are not covered. Further recommendations for particular types of crane are provided in crane-specific parts of BS 7121.

Detailed information about the content of training courses varies depending on the individual circumstances, so this annex is intended to assist an organization running training courses internally or as a service to other organizations, to determine whether their courses are adequate.

B.1 Employer's duties

Training of personnel should be treated as an important element in the overall safe planning and supervision of lifting operations. Therefore, the employer should:

- a) use appropriate procedures to ensure that suitable potential trainees are selected (see **B.3**);
- b) provide adequate basic training in the principles of crane operation and slinging (see **B.4** and **B.7**);
- c) train employees in the use of the particular equipment they are expected to use, and instruct them in the jobs they are required to do and any particular hazards of the sites where they could work (see **B.6**);
- d) ensure that only employees who have been assessed as reaching an adequate level of competence are authorized to operate the crane or undertake slinging duties (see **B.8**); and
- e) provide adequate supervision so that the competence of operators and slinger-signallers can be monitored and the need for any refresher training assessed.

B.2 Machine-specific training

B.2.1 General

As cranes vary widely in the way they are operated and the circumstances in which they are used, the knowledge and expertise required by the operator varies accordingly. It should be recognized that an operator who is competent to operate one type of crane might not have the necessary knowledge and experience needed to operate other types.

B.2.2 Appropriate training

Training should be related to the knowledge and experience of the operator, to likely job hazards, and to the size and complexity of the crane itself.

NOTE For example, a small pendant-operated overhead travelling crane used for a limited range of simple lifting operations is not likely to require a lengthy formal training course, while a large mobile crane capable of being used in different ways for various complex lifting operations and in different work locations requires wider and more detailed training.

B.2.3 Slinger-signaller training

In addition to basic slinging techniques, the training should be related to the type of load and slinging techniques that the trainee will encounter in their employment.

B.2.4 Instructors

The success of any training depends largely on the effectiveness of the instructors. Training should be carried out by people who have been selected and trained for the purpose. To guide organizations who employ trainers (part-time or full-time), recommendations for their selection and training are given in **B.9**.

B.3 Selection of operators and slinger-signallers

B.3.1 General

Potential operators and slinger-signallers should be carefully selected by the employer on the basis of appropriate criteria. Selection tests may be used as part of the process.

NOTE Careful selection of employees before training starts helps to ensure that resources are not wasted.

B.3.2 Selection criteria

The criteria used when selecting a potential crane operator or slinger-signaller should include the following.

- a) The candidate should be reliable, with the ability to work in a responsible and safe manner and, if necessary, an appropriate current driving licence.

NOTE 1 Attention is drawn to *The Management of Health and Safety at Work Regulations 1999, as amended [17]*, which require crane operators to be over 18 unless they are under the direct supervision of a competent person for the purpose of training.

- b) The candidate should be able to demonstrate an understanding of what is involved in safe operation.

NOTE 2 Some cranes have complex controls or require a detailed understanding of load charts, etc. Crane operators and slinger-signallers might need to estimate or calculate loads, assess angles and use charts. A reasonable level of mathematical and mechanical aptitude is therefore likely to be required.

- c) The candidate should be able to demonstrate their fitness to do the job, both physically and mentally. People with handicaps or disabilities are not necessarily unable to work safely with cranes, but extra care might be needed in their selection. Where the employer has reason to believe medical advice might be needed about the candidate's suitability, it should be obtained.

B.3.3 Assessment of training needs

Following selection, or as part of it, an assessment should be made of the extent of training which is needed for an individual, bearing in mind that this could be influenced by any previous training and experience. When an operator or slinger-signaller is recruited, the employer should check that their qualifications and experience relate to the job they are to do. Where the type of crane to be operated or the slinging procedures to be used are outside the employee's previous experience, additional training should be provided. In any event, some further training is likely to be necessary to familiarize the employee with specific requirements of the new job. A record of the assessment should be retained and an individual training plan developed.

B.4 Basic training of operators

COMMENTARY ON B.4

Basic training covers the principles, both theoretical and practical, governing the safe operation of a given type of crane.

A basic training course is usually designed with the requirements of novice operators in mind, but it would be unwise to assume that more experienced employees do not need basic training. Many training organizations acknowledge this and run short courses for those with experience, recognizing that less time is necessary for training in the fundamental aspects. There are also short courses designed to judge the knowledge and skills of an experienced operator. These can provide an assessment of skill, an opportunity for limited instruction in weak areas, and a practical test of competence.

B.4.1 General

With such a wide range of cranes, employee experience and company requirements, some training organizations arrange for a basic course to be tailored to meet a client company's requirements. This should be discussed with them before the course commences. Similarly, those companies designing internal courses might wish to fit the basic course to their more special needs. The content of such courses should match the information provided by the employer.

B.4.2 Training venue

Training should be given either at a suitable training centre or at the employer's premises. Where it is given at the employer's premises, it should (at least for the larger and more complex cranes) be carried out independently of the trainee's normal work. This means that the instructors and trainees, together with the crane and loads should, during the basic training, be wholly devoted to that training.

B.4.3 Cranes used for training

A crane used for training should have similar characteristics to the type the trainee would normally use after training. It should be in good condition, have a current report of thorough examination and be suitable for the particular lifting operations that will be undertaken.

B.4.4 Training area access

Where possible, access to the training area should, for safety reasons, be restricted to the instructor and trainees. If there is access by other people, e.g. when training on an overhead travelling crane is conducted in an occupied workshop, precautions should be taken to ensure that all personnel are made aware of the situation, the area is appropriately marked, and people not involved in the training are adequately protected.

B.4.5 Appropriateness of training

As far as possible the training should include practice in the range of loads and conditions likely to be met by the trainees, including any particular hazards met in normal operations. The employer should ensure that if another organization carries out the training it is informed of the sort of work which the trainee is likely to be doing. Where this is not achievable, further work-based instruction in company-specific procedures and handling of products should be provided by the employer. This should be a documented process.

B.4.6 Facilities and training aids

Suitable facilities and training aids should be available so that the instructor can cover the theory of crane operation under reasonable conditions.

B.4.7 Course duration

The course should be largely practical in nature and sufficiently long to enable trainees to master the necessary skills.

B.4.8 Course structure

B.4.8.1 The course should follow a carefully devised programme which ensures that each operation is introduced at an appropriate point, building on what has gone before and allowing adequate time for learning and practice before moving on to subsequent operations. At each stage the instructor should explain and demonstrate the operation, and trainees should then practise it under supervision.

B.4.8.2 The simpler tasks with less potential hazard should be covered first before progressing to more complex operations. Training in safe operation should be provided as an integral part of the course and not separately. The course should not be altered to suit immediate operational requirements.

B.4.9 Multiple crane types

If there is a requirement to operate more than one type of crane, training should be given for each type. Although this does not normally require a rerun of the complete basic training course, it should cater for the differences between types of crane. Practical experience of each type should be enough to enable the trainee to pass a test on each.

B.4.10 Trainee/instructor ratio

The ratio of instructors, machines and trainees should suit the particular aspect of training being covered. There should be sufficient time for the instructor to demonstrate each part of the practical training and then for each trainee to practise the skills while also being able to learn from observing other trainees. While one instructor can deal with a number of trainees when teaching in a classroom, practical work should have a more individual approach. During the practical training there should be a maximum ratio of one instructor to four trainees.

B.5 The training programme

B.5.1 General

As a minimum the training programme should cover those subjects given in **B.5.2** and **B.5.3** which are relevant to the type of crane for which training is being given.

B.5.2 Theoretical topics

Theoretical topics covered should include:

- a) an introduction to the course syllabus, with reasons for the importance of training;
- b) the relevant legal requirements, including those relating to crane construction, maintenance, examination, certification and use, and the different responsibilities of all the individuals involved with a lifting operation.

NOTE Reference can be made to relevant published material, including British standards and HSE or other guidance.

- c) an introduction to cranes, explaining the purpose of all main components, including the location and function of controls, instruments, indicators and safety devices;
- d) an introduction to the function of limiting and indicating devices fitted to cranes;
- e) principles of mechanical, hydraulic, pneumatic and electrical systems in so far as they are relevant to the safe operation of cranes;

- f) routine inspection, reporting, servicing, maintenance, erection and dismantling in accordance with the manufacturer's instructions, detailing those tasks which are generally within the trainee's responsibilities;
- g) limitations on the uses of cranes, including the relevance of the strength and stability of cranes, ground conditions, the distribution of the total load (i.e. the load being lifted and the load due to the equipment's weight) through the supports, e.g. outriggers or building structures, and dynamic, e.g. shock and wind, loadings;
- h) assessment of loads, including estimation of weights and centres of gravity, and their stability;
- i) good operating practices, including operation near other cranes, precautions near overhead lines, structures, etc., and multiple lifting;
- j) signalling methods, including the recognized code of manual signals (see Figure 3); and
- k) maintenance of relevant records, including, where appropriate, the relevant statutory forms.

B.5.3 Practical topics

Practical topics should include:

- a) routine inspection, maintenance and reporting of defects and, where necessary, completion of relevant records;
- b) if relevant to the type of crane, travel without a load, both between sites and, where erected, at the worksite;
- c) siting of cranes and preparation of the ground and cranes for lifting;
- d) assessment of loads, crane lifting duties and selection of correct cranes and lifting accessories for lifting/load-lifting attachments to the extent necessary to verify that the operator can safely undertake the planned lifting operation as defined within the lift plan/safe system of work;
- e) elementary operation of all controls under "no-load" conditions;
- f) using the crane to lift and position loads in progressively more demanding situations, both for the crane and the operator, using as many configurations of the crane as is practicable, including travelling with a load and, if appropriate, multiple lifting and use near structures;
- g) practice in working with a signaller – whilst not all crane types and lifts require the use of a signaller, all crane operators should be able to work with a signaller when necessary;
- h) use and testing of safety devices;
- i) use of emergency escape devices where fitted;
- j) erection and dismantling of the crane as necessary and as is within the responsibility of the trainee; and
- k) procedures for isolating the crane for maintenance, etc., including the proper use of permits to work where appropriate to the type of crane.

B.5.4 Training in slinging

Most operators should be given training in slinging (see B.7) because they need an appreciation of those skills and they are likely to be acting as the slinger-signaller as well as operating the crane.

B.6 Advanced training for operators

B.6.1 General

Advanced training of operators should follow the completion of basic training. It should be tailored to the employer's needs and include the following elements:

- a) instruction in the operating principles and controls of the specific crane(s) to be used, especially where these relate to special attachments and loads, and details of the routine inspection and servicing of the equipment in accordance with the manufacturer's handbook or instructions, to the extent that this is the trainee's responsibility; and
- b) training in the use of the equipment in the conditions the operator is likely to encounter on the job, and on the particular work to be undertaken.

B.6.2 Training venue and course content

Advanced training should either be carried out on the employer's or, in some cases, the manufacturer's premises, and include the application under normal working conditions of the skills learned during basic training. It should be carried out under supervision. The training should include particular information on site layout, emergency procedures and any other matter which it is not practicable to teach "off-the-job". The employer should ensure all such training is documented and forms part of the candidate's training portfolio/records.

B.7 Training of slinger-signallers

B.7.1 General

The training of slinger-signallers (who may also be operators) should provide information about, and practical experience of, the principles of care, maintenance, selection and use of lifting accessories for lifting/load-lifting attachments in accordance with a lift plan.

B.7.2 Training focus

The trainee and instructor should, during the training, be solely concerned with that training.

B.7.3 Training equipment

There should be a good range of lifting accessories for the lifting/load-lifting attachments available, including, where possible, any special purpose accessories for lifting/load-lifting attachments which the trainee is likely to use. The accessories for lifting/load-lifting attachments should be in good condition and safe for whatever operations are being covered. Attachments should be representative of commonly found faults.

B.7.4 Training facilities

Suitable facilities and training aids should be made available so that the instructor can cover the theoretical parts of the training. Courses should, however, be as practically based as possible.

B.7.5 Course duration

While courses for slinger-signallers do not always need to be as long as those for operators, sufficient time should be available to cover the subject adequately and to allow time for practical work. The duration of the course may take account of the knowledge and experience of the trainee.

B.7.6 Course content

B.7.6.1 Theoretical topics

Theoretical topics should include:

- a) an introduction to the course syllabus, with reasons for training;
- b) relevant legal requirements and published guidance material;
- c) an introduction to the different types of lifting accessories for lifting/load-lifting attachments, and their functions, limitations and possible causes of failure;
- d) routine care, inspection, maintenance and reporting of defects;
- e) the criteria for rejection (although it is not expected that a trainee has sufficient knowledge or experience to be able to act as a competent person to carry out a thorough examination);
- f) an introduction to lift and slinging plans;
- g) assessment of loads, including estimation of weights and centres of gravity;
- h) selection of lifting accessories in accordance with a lift plan, correct use and practice in the use of appropriate lifting accessories for lifting/load-lifting attachments, including methods of slinging, the methods of rating for multi-legged slings, the concepts of working load limit and safe working load, interpretation of markings, and down-rating of lifting accessories for lifting/load-lifting attachments for any particular adverse conditions of use;
- i) signalling methods, including the recognized code of manual signals (see Figure 3); and
- j) record keeping to the extent that it is the slinger-signaller's responsibility.

B.7.6.2 Practical topics

Practical topics should include:

- a) selecting accessories for lifting/load-lifting attachments for particular loads;
- b) pre-use checks of lifting accessories;
- c) where signalling is included, giving appropriate signals to a crane operator; and
- d) particular hazards or situations which the employee is likely to encounter in the normal job.

B.8 Appraisal and authorization

B.8.1 General

Continuous assessment of trainees' progress should be made by the instructor during training to ensure the required standards are reached at each stage.

B.8.2 Crane operator's test

At the end of the training programme, crane operators should take a test (which may be partly written) to determine their ability to perform the following tasks satisfactorily:

- a) routine maintenance, safety checks and inspections and completion of records;
- b) proper siting of the crane and use of out-riggers, etc.;
- c) if relevant, setting up, erection and dismantling of the crane;
- d) use and testing of safety devices;

- e) handling different loads in a variety of conditions and, if appropriate, crane configurations;
- f) use of correct and adequate signalling techniques (see Figure 3); and
- g) describing emergency procedures.

B.8.3 Slinger-signaller's test

Slinger-signallers should also be assessed by means of a suitable test which confirms their ability to perform their duties satisfactorily.

B.8.4 Training records and certification

Trainees who have satisfactorily completed a training course should be awarded a certificate to that effect. Where training has been given in a number of stages the trainee, or employer on their behalf, should keep a record of what training has been carried out.

B.8.5 Authorization of employees

The employer should:

- a) give specific authorization to employees to operate cranes and/or act as slinger-signallers;
- b) be satisfied that each employee has had appropriate training and is competent to do the job;
- c) keep records of all authorizations; and
- d) notify operators which individual cranes or types of crane they are authorized to operate.

B.8.6 Continuing assessment

Even after training has been completed and authorization given, a periodic assessment of personnel should be carried out to determine continued competence. Formal refresher training and re-assessment might also be considered appropriate and reference should be made to the part of BS 7121 applicable to the equipment type.

B.9 Selection and training of instructors

B.9.1 General

Training should be carried out by instructors who are competent, carefully selected and trained for the purpose.

B.9.2 Previous experience and competencies

B.9.2.1 Instructors should have sufficient industry-based practical experience and be qualified for the role or occupation and the specific activities being taught. In addition, instructors should maintain their knowledge and understanding of current good working practices and the requirements of legislation and regulations by carrying out continuing personal and professional development.

B.9.2.2 In addition, an instructor should have:

- a) suitable and sufficient industry and operating knowledge of a range of crane types, their acceptable uses and environments in which they are used;
- b) suitable and sufficient knowledge of different types of slings and lifting accessories and their safe use;
- c) suitable and sufficient knowledge of signalling methods and techniques;
- d) suitable and sufficient knowledge and experience of health and safety matters;

- e) suitable and sufficient knowledge and experience of training aims and objectives;
- f) suitable and sufficient literacy skills to produce written reports and presentations;
- g) an ability to communicate effectively and confidently to a range of persons and groups;
- h) abilities to recognize and show empathy for the learning abilities of others, show patience, and adapt the teaching approach to accommodate all learning situations;
- i) an ability to lead and maintain control at all times;
- j) abilities to plan and produce tailored training and assessment programmes to meet a trainee's needs and to organize the appropriate resources and facilities;
- k) an ability to demonstrate the required practical activities using best practice; and
- l) an ability to train effectively in both classroom and other working environments under varying conditions.

B.9.3 Instructor training course content

Instructor training should cover at least the following topics:

- a) principles of instruction, including classroom techniques and practice demonstration techniques;
- b) the systems and processes used by the accrediting body; and
- c) instruction on delivering the topics covered in **B.5**.

B.9.4 Assessment and certification

B.9.4.1 General

Instructors should be assessed and issued with a certificate if they have reached a satisfactory standard of effectiveness. Their competence as instructors should be reviewed periodically and refresher training given if needed.

B.9.4.2 Assessment

B.9.4.2.1 Assessments should include:

- a) theoretical assessments of instructors' knowledge of standards and legislation affecting cranes, technical aspects of cranes, operational requirements, training standards and instructional techniques; and
- b) practical assessments of preparing and presenting practical and classroom lessons, the administration of practical assessments and producing assessment reports.

B.9.4.2.2 An instructor's competence should be reviewed annually and refresher training given, if needed.

Annex C
(normative)**Contract lift or crane hire**

COMMENTARY ON ANNEX C

Given the wide variety of contractual arrangements used, it is important to ensure that the planning, organization, control and management of lifting operations are not compromised. In general, an organization requiring a load to be moved by crane, but which does not have its own craneage, has two basic options: hiring a crane (crane hire) or employing a contractor to carry out the lifting operation (contract lift). The difference between the two options is summarized in Figure C.1.

The contract lift includes three possibilities:

- a) *a formal contract lift where a crane owner is contracted by an employing organization to lift a load on their behalf using a crane (see C.2.1);*
- b) *lifting operations as part of the supply and delivery of goods to a non-domestic customer, e.g. where a builder's merchant is delivering packs of blocks to a construction site on a vehicle and unloads the blocks using a loader crane mounted on the delivery vehicle (see C.2.2); and*
- c) *lifting operations as part of the supply and delivery of goods to a domestic customer, e.g. where a builder's merchant is delivering packs of blocks to a householder on a vehicle and unloads the blocks using a lorry loader (see C.2.3).*

In option c), the crane supplier assumes full responsibility for all aspects of the lifting operation as the householder is not expected to have sufficient knowledge to advise the supplier of any significant hazards or be aware of the requirements of LOLER 1998 [2] and BS 7121.

C.1 General

If an individual or organization does not have expertise in lifting operations, they should not hire cranes but should opt for a contract lift. Before entering into a contract, the employing organization should satisfy itself that the contractor has the necessary competence to carry out the work. Crane hire should not be offered to domestic customers.

NOTE Responsibilities for insurance in terms of the crane, personnel, load and third parties might also need to be clarified.

C.2 Contract lifting operations**C.2.1 Formally contracted lifting**

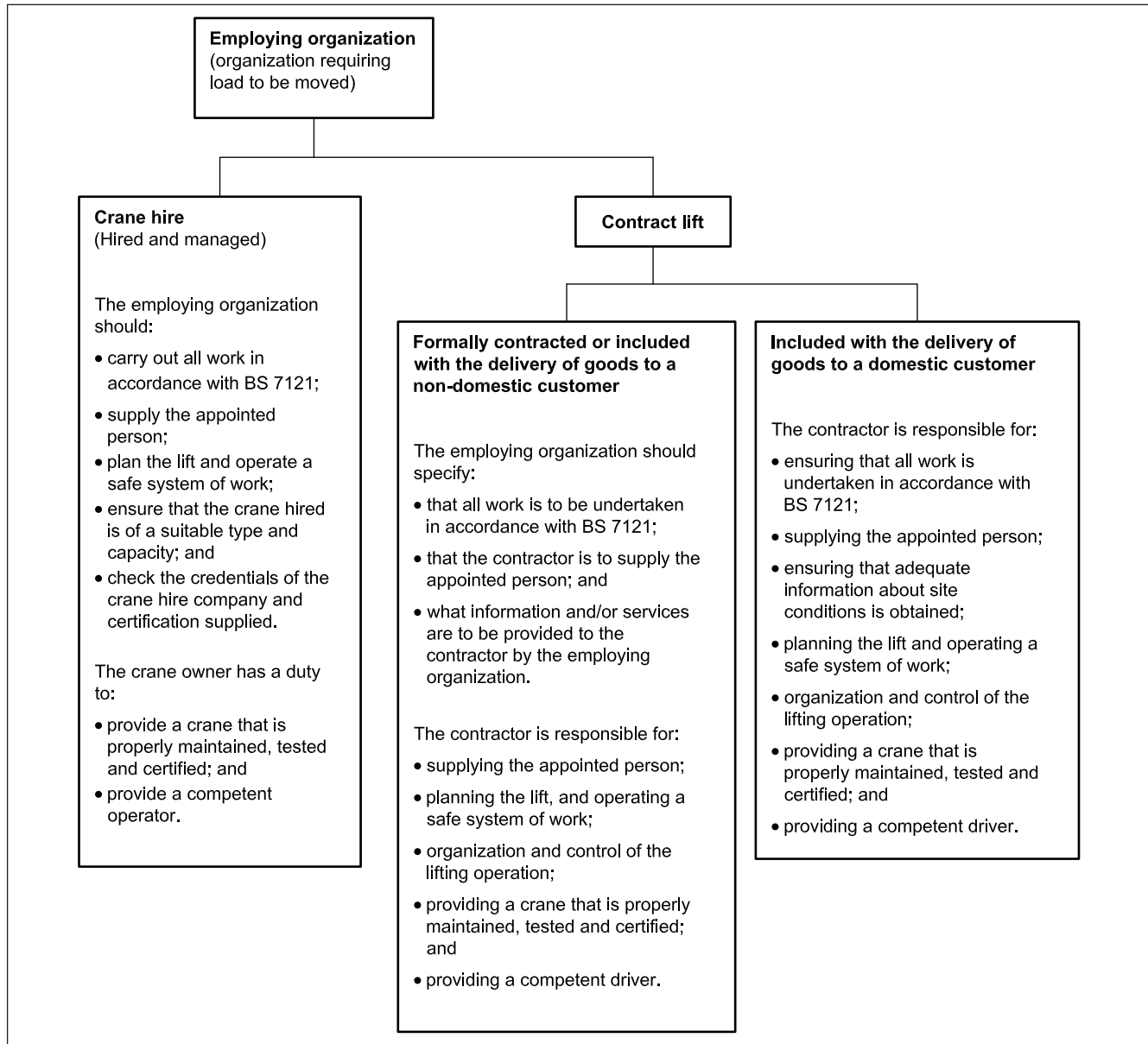
C.2.1.1 Before entering into a contract, the employing organization should confirm that a contractor has the necessary competence to carry out the work in accordance with BS 7121.

C.2.1.2 Where the employing organization enters into a contract with a contractor who undertakes the work on its behalf, the parties to the contract should ensure that:

- a) all work is carried out in accordance with the applicable part(s) of BS 7121;
- b) the contractor has full authority from the employing organization to work, including, where appropriate, authority to control and instruct the employing organization's personnel;
- c) the contractor provides an appointed person, in accordance with 4.3, to the satisfaction of the employing organization; and
- d) all information or services provided by the employing organization to facilitate compliance with BS 7121, including information on ground conditions, are notified to the contractor in writing.

NOTE Compliance with BS 7121 does not relieve organizations of their statutory and common law obligations.

Figure C.1 Contract options



C.2.2 Contract lifting as part of the supply and delivery of goods to a non-domestic customer

COMMENTARY ON C.2.2

An organization requesting the supply and delivery of goods (the employing organization) which involves a lifting operation with a crane to unload the goods from the delivery vehicle, such as a lorry loader, is entering into a de facto contract lift agreement with the person delivering the goods (the contractor).

C.2.2.1 Before entering into a contract, the employing organization should confirm that a contractor has the necessary competence to carry out the work in accordance with BS 7121.

C.2.2.2 The parties to the contract for supply should ensure that:

- a) all work is carried out in accordance with BS 7121;
- b) the contractor provides an appointed person, in accordance with 4.3, to the satisfaction of the employing organization; and
- c) all information or services provided by the employing organization to facilitate compliance with BS 7121 are notified to the contractor in writing.

C.2.2.3 The contractor should carry out lifting operations in accordance with BS 7121. The contractor should be given full authority by the employing organization to work in accordance with BS 7121, including, where appropriate, authority to control and instruct the employing organization's personnel.

NOTE Compliance with BS 7121 does not relieve organizations of their statutory and common law obligations.

C.2.3 Contract lifting as part of the supply and delivery of goods to a domestic customer

COMMENTARY ON C.2.3

The domestic customer requesting the supply and delivery of goods involving a lifting operation with a crane to unload the goods from the delivery vehicle is entering into a de facto contract lift agreement with the person delivering the goods (the contractor).

The contractor should ensure that:

- a) a person is appointed in accordance with 4.3;
- b) adequate information regarding site conditions is obtained;
- c) the lift is planned and a safe system of work is followed;
- d) the lifting operation is appropriately supervised and carried out in a safe manner;
- e) the crane provided is properly maintained, inspected and thoroughly examined;
- f) a competent operator is provided; and
- g) lifting operations are carried out in accordance with BS 7121.

NOTE 1 Compliance with BS 7121 does not relieve organizations of their statutory and common law obligations.

NOTE 2 The crane supplier assumes full responsibility for all aspects of the lifting operation as the customer is not be expected to have sufficient knowledge to advise the supplier of any significant hazards or be aware of the requirements of LOLER 1998 [2] and BS 7121.

C.3 Duties when a crane and operator are hired

C.3.1 When a crane is hired out together with an operator, the crane owner should provide a competent operator and a crane that is properly maintained, inspected and tested in accordance with BS 7121-2 and has a current report of thorough examination.

C.3.2 The user organization should nominate the appointed person in accordance with 4.3 and follow the recommendations of BS 7121. Notwithstanding any advice the crane owner provides about crane selection or any other relevant matter, such as clearances and ground conditions, the responsibility for ensuring that the crane is of a suitable type, size and capacity for the task to be undertaken and for planning the operation remains with the user organization. Therefore, if the user organization does not have expertise in lifting operations, it should not hire cranes, but opt instead for a contract lift.

NOTE Where a crane is hired without an operator, all of these points still apply.

Annex D
(informative)

Effect of wind and down-rating

The wind forces exerted on both a crane and the load suspended from it can be large and affect both the strength and stability of the crane, and safe handling of the load.

It is not always appreciated that these forces are due to wind pressure, not wind speed, and that wind pressure varies as the square of the wind speed. Consequently, if the wind speed doubles, the wind pressure increases by a factor of **four**. This means that a small increase of wind speed can have a significant effect on the safe operation of a crane.

Cranes are designed for a maximum in-service wind speed, and with specific characteristics for the wind acting on the load being lifted. The load due to the wind depends on:

- a) the aerodynamic drag on the load; and
- b) the area and weight of the load.

Crane design standards set values for load area/weight ratios and drag factors for different types of crane (see Table D.1). If a load with a higher load area/weight ratio and/or drag factor than the standard value is lifted, it leads to higher loads on the crane than it is designed to take at the maximum in-service wind speed specified on the crane's duty chart (see Table D.2). This is a particular problem for cranes which lift a wide variety of loads of differing weights, shapes and sizes, such as mobile cranes, tower cranes and lorry loaders. It is less of an issue for cranes, such as container handling cranes, where the load seldom varies.

In the case of a crane supported on outriggers, wind influence on the crane and load creates outrigger loads which differ significantly from values published in manuals or given by software lift planning tools.

Depending on the direction of the wind, the load can move in a direction which can increase or decrease the load moment or place side loads on the jib.

Table D.1 Typical area/weight and drag factors for typical loads

Load	Area/Weight	Drag factor, C_w
Standard values from BS EN 13000	1.2 m ² /tonne	1.2
Standard values from FEM 1.004 [32]	0.5 m ² /tonne	2.5
Standard values from BS EN 13001-2	0.5 m ² /tonne	2.4

Table D.2 Typical area/weight and drag factors for typical loads

Load	Area/Weight	Drag factor, C_w
12 m container cabin	14 m ² /tonne	1.55
System shutter panel 3 m high × 1.9 m wide	42 m ² /tonne	1.4
Wind turbine rotor	5 m ² –10 m ² /tonne	1.5 to 1.8

Where a load with a higher load area/weight ratio and/or drag factor than that specified in the crane design standard is lifted, the appointed person planning the lift needs to establish the limiting wind speed for the crane and configuration. This may be achieved by consulting the crane manufacturer or, for mobile cranes, using the approach given in FEM 5.016 *Guideline – Safety Issues in Wind Turbine Installation and Transportation* [33].

A simplified method for determining the maximum permitted wind speed for a load of given area/weight ratio and drag factor is given in Figure D.1, and examples of shapes and corresponding drag coefficients are given in Table D.3.

Figure D.1 Simplified method for determining the maximum allowed wind speed for mobile cranes

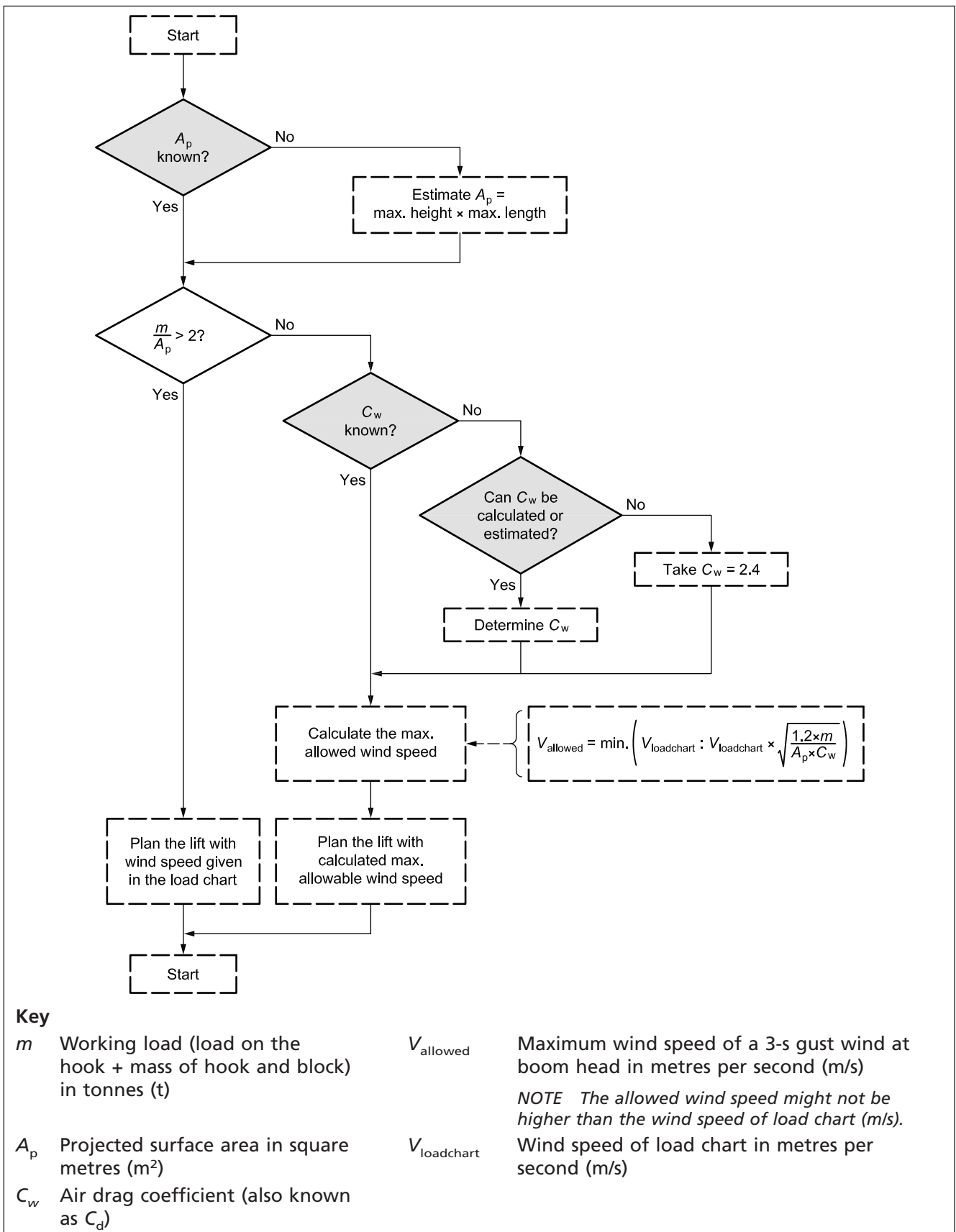

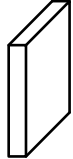
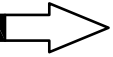


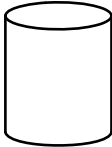





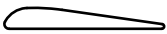
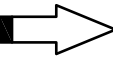



Table D.3 Typical shapes and corresponding C_w values

Shape	Example	Drag coefficient, C_w
 	Plate, shutter or sheet pile	1.1 to 2.0
 	Ball, spherical reservoir	0.3 to 0.4
 	Silo, reactor vessel	0.6 to 1.0
 	Half sphere	0.8 to 1.2
 	Half sphere	0.2 to 0.3
 	Wind turbine blade or complete rotor	0.05 to 0.1
 	Wind turbine blade or complete rotor	Approx. 1.6

Annex E
(normative)

Additional recommendations for operation of cranes on or adjacent to sites of exceptional hazards

COMMENTARY ON ANNEX E

The use of cranes during temporary works, construction, commissioning, engineering and maintenance activities on or adjacent to sites of exceptional hazards, such as railways, chemical plants and nuclear installations, requires particular attention during planning, set-up, use, maintenance and dismantling. If the crane or its load falls onto high-hazard areas within the site, a catastrophic accident might result with multiple fatalities or long-lasting environmental issues.

Cranes that are permanently installed at such sites are excluded from this annex.

E.1 General

The recommendations of E.2 to E.8 should be followed if cranes are to be used on or adjacent to sites of exceptional hazards.

E.2 Management of risk

E.2.1 Lifting operations by their very nature involve risk. Consideration should be given to the need to carry out lifting operations, or whether other, less

hazardous, techniques can be used. Where lifting operations are to be carried out, cranes should be configured to eliminate any risk to sites of exceptional hazards.

E.2.2 To eliminate the risk, a crane should be positioned such that, if it fails, the compound collapse radius is at least 4 m or the distance specified by site operator from the site boundary or area within the site of exceptional hazards. The compound collapse radius depends on the type and size of crane being used. In determining the compound collapse radius the worst possible collapse should be considered, as should the possibility that the slewing structure of a crane with slewing could collapse in any direction (i.e. 360°). This could also include the crane falling backwards away from the load being lifted or collapsing when not undertaking a lift. Consideration should also be given to the final resting position of any load being lifted during the collapse and the positions of the hook block and counterweight.

NOTE Compound collapse radius (CC) can be calculated by adding the crane collapse radius (C) to the load collapse radius (L) (see Figure E.1). Examples of calculations for different cranes are given in Figure E.2 to Figure E.5. Examples of how to calculate the load collapse radius are given in Figure E.6. The compound collapse radius of a tower crane may be reduced by tying the crane to an adjacent structure.

Figure E.1 Compound collapse radius

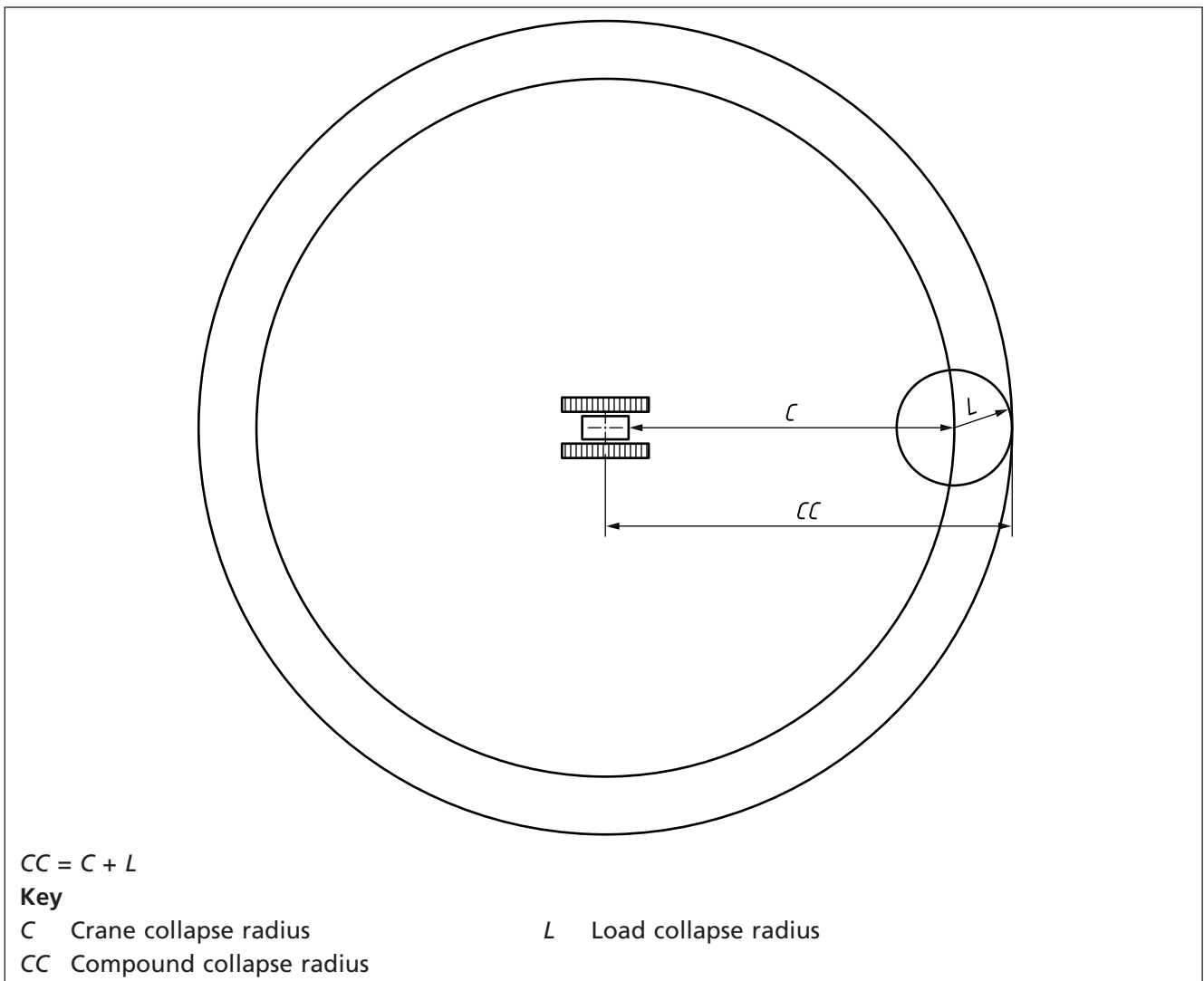


Figure E.2 Crawler crane collapse radius

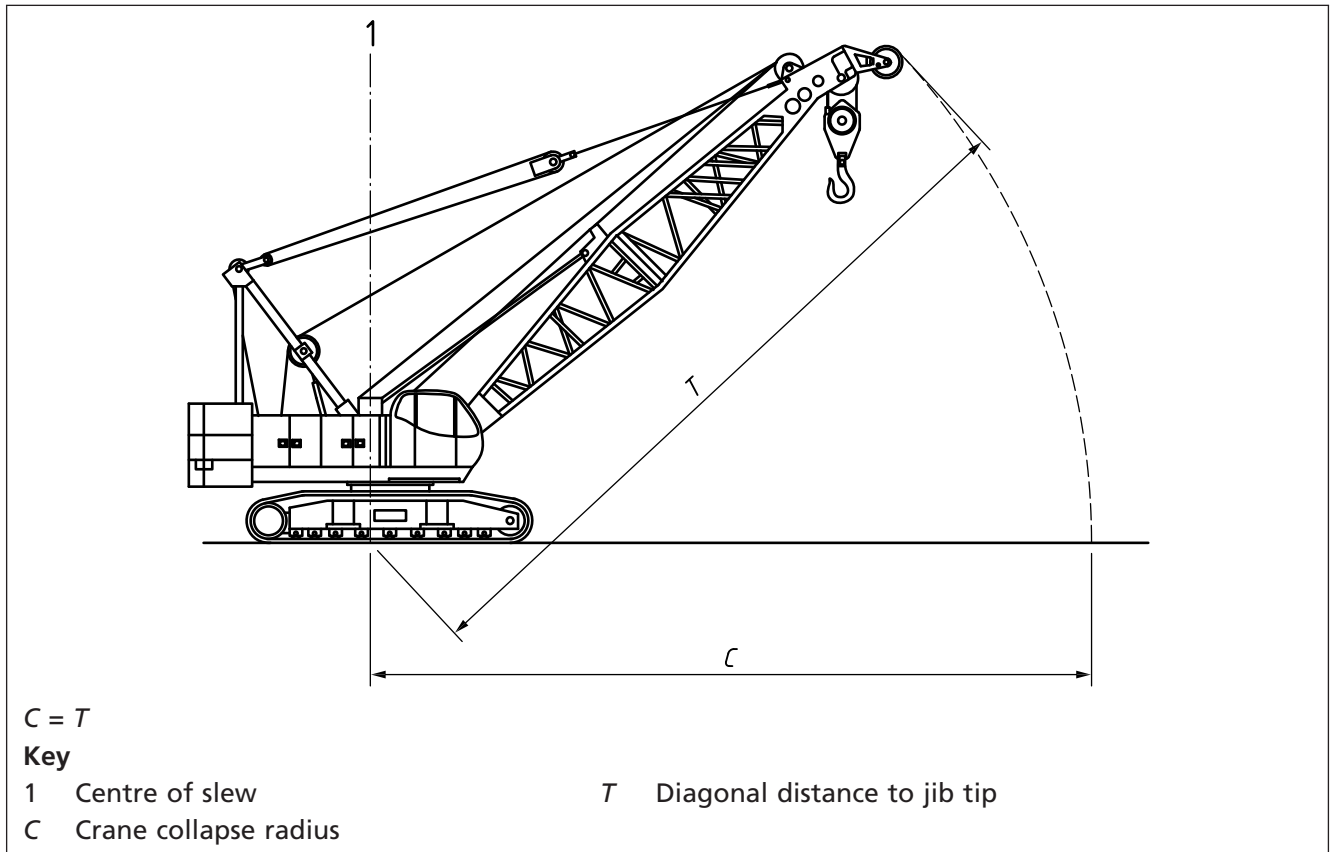


Figure E.3 Saddle jib tower crane collapse radius

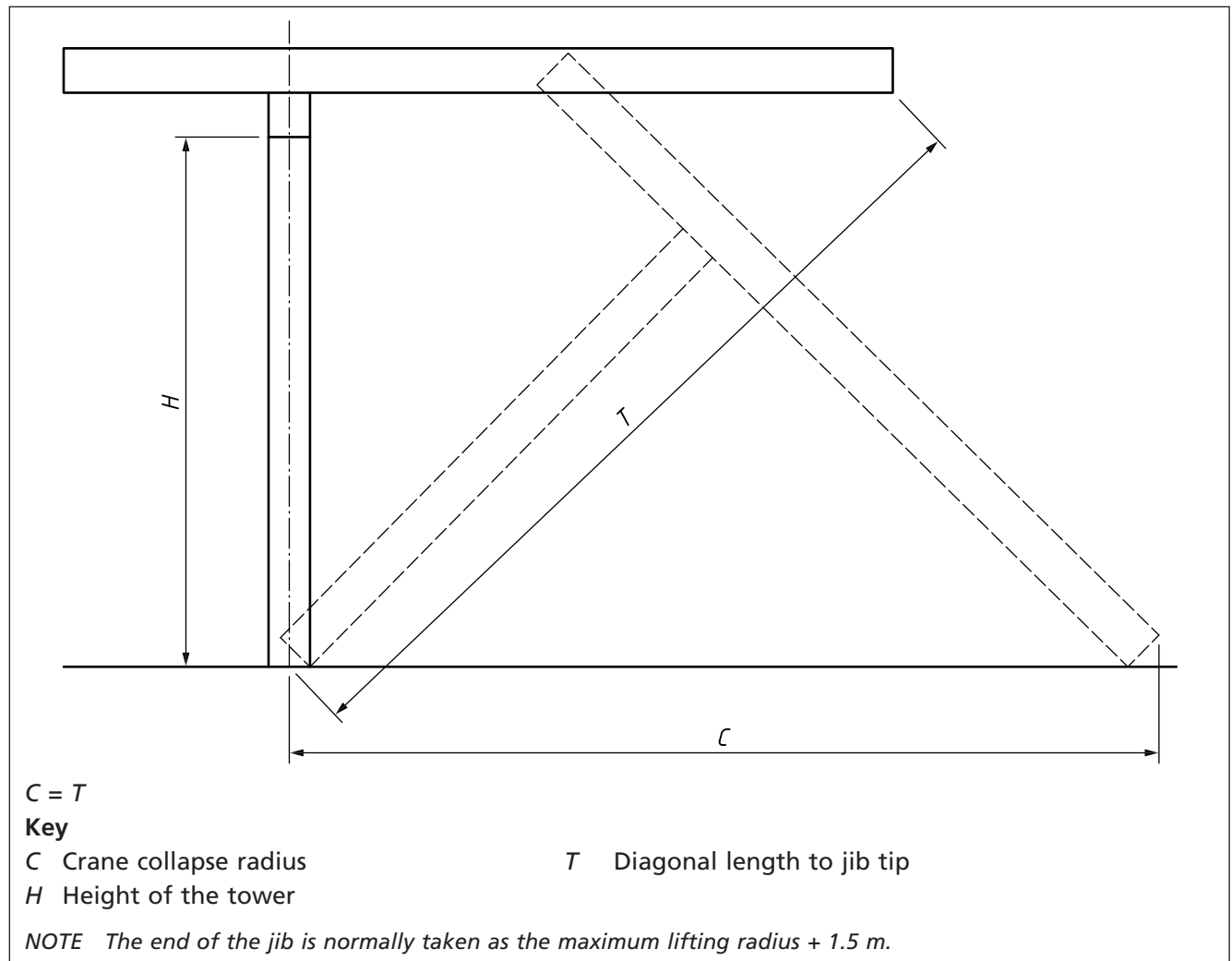


Figure E.4 Luffing jib tower crane collapse radius

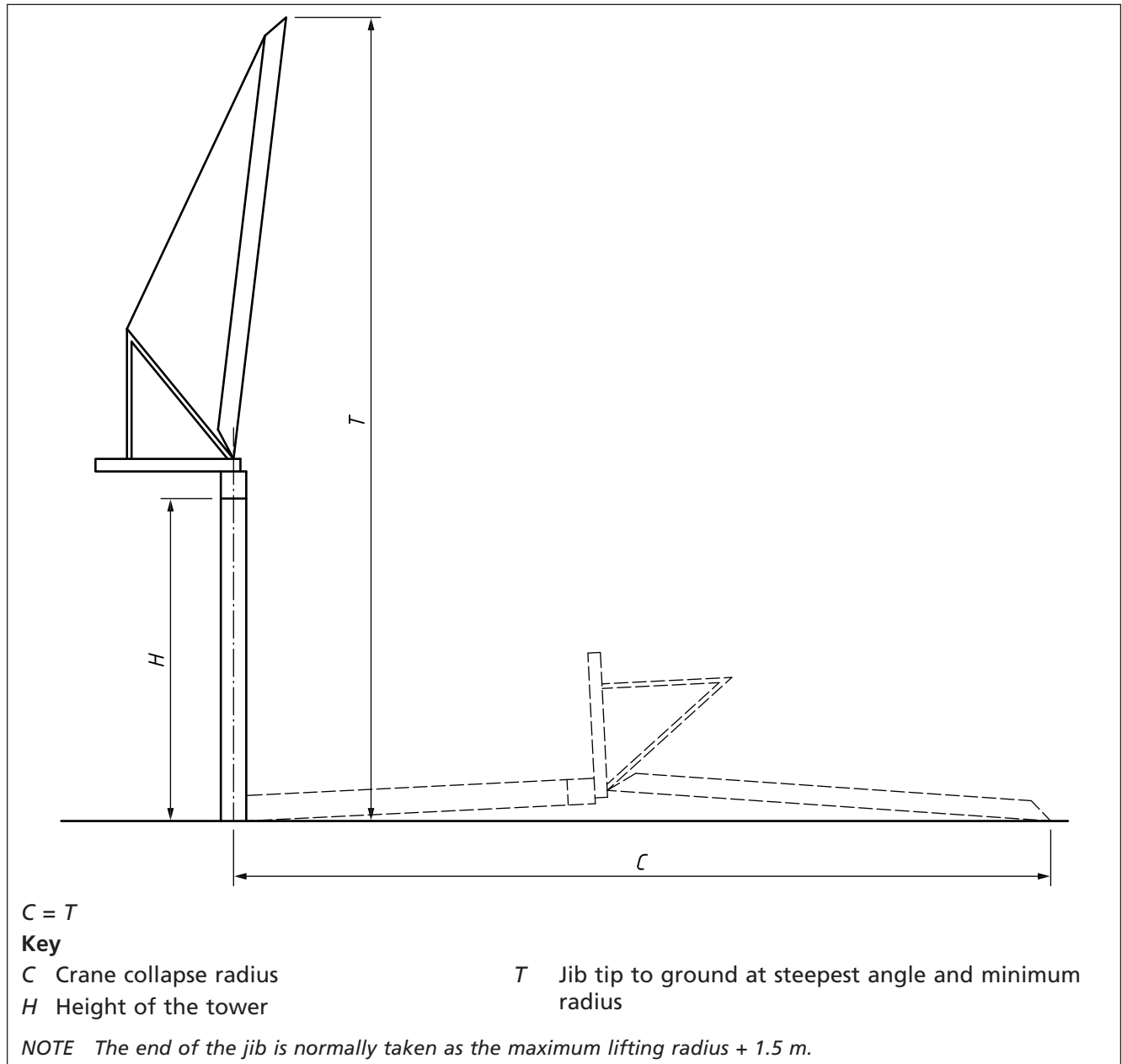


Figure E.5 Wheeled mobile crane collapse radius

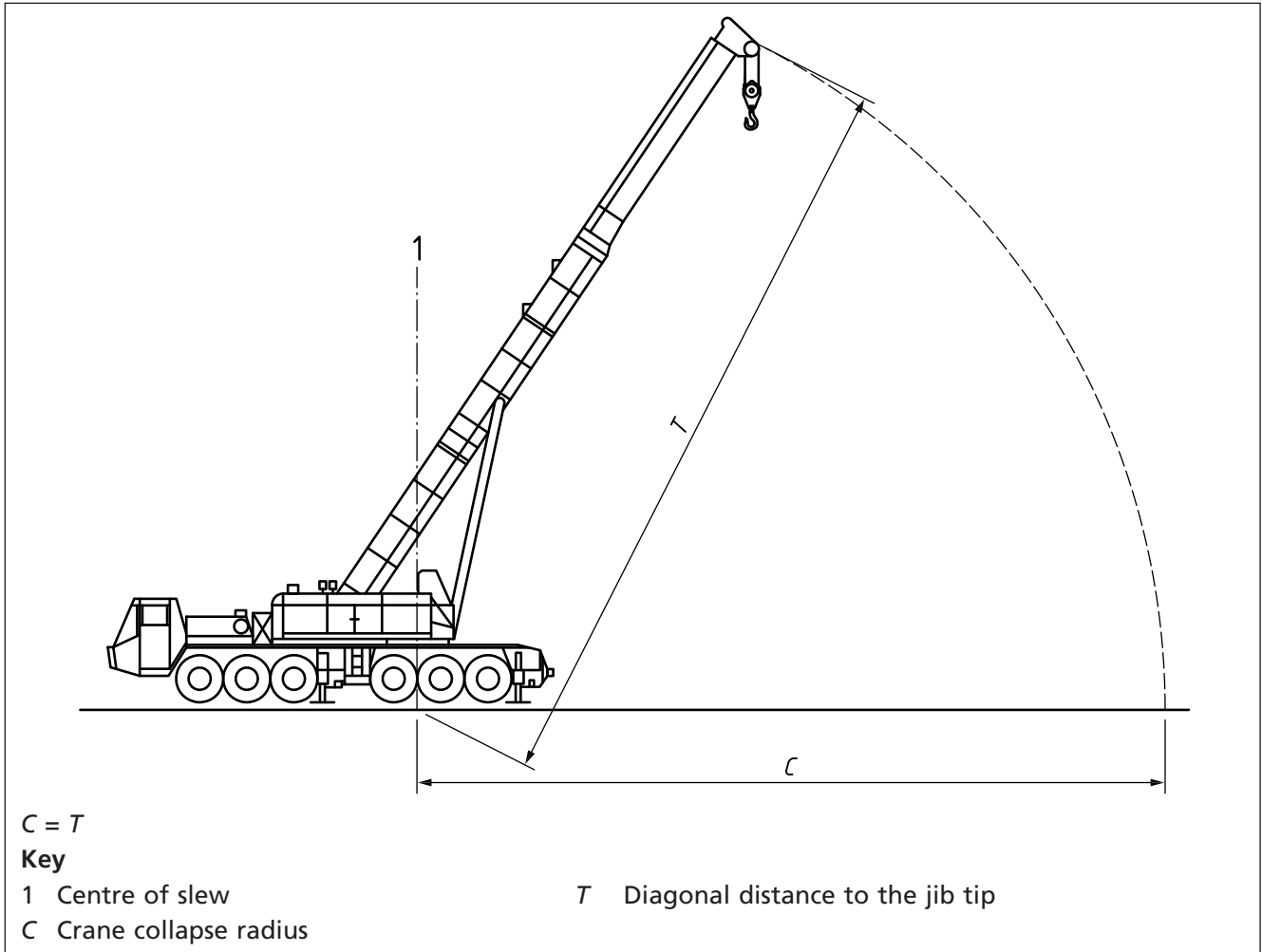
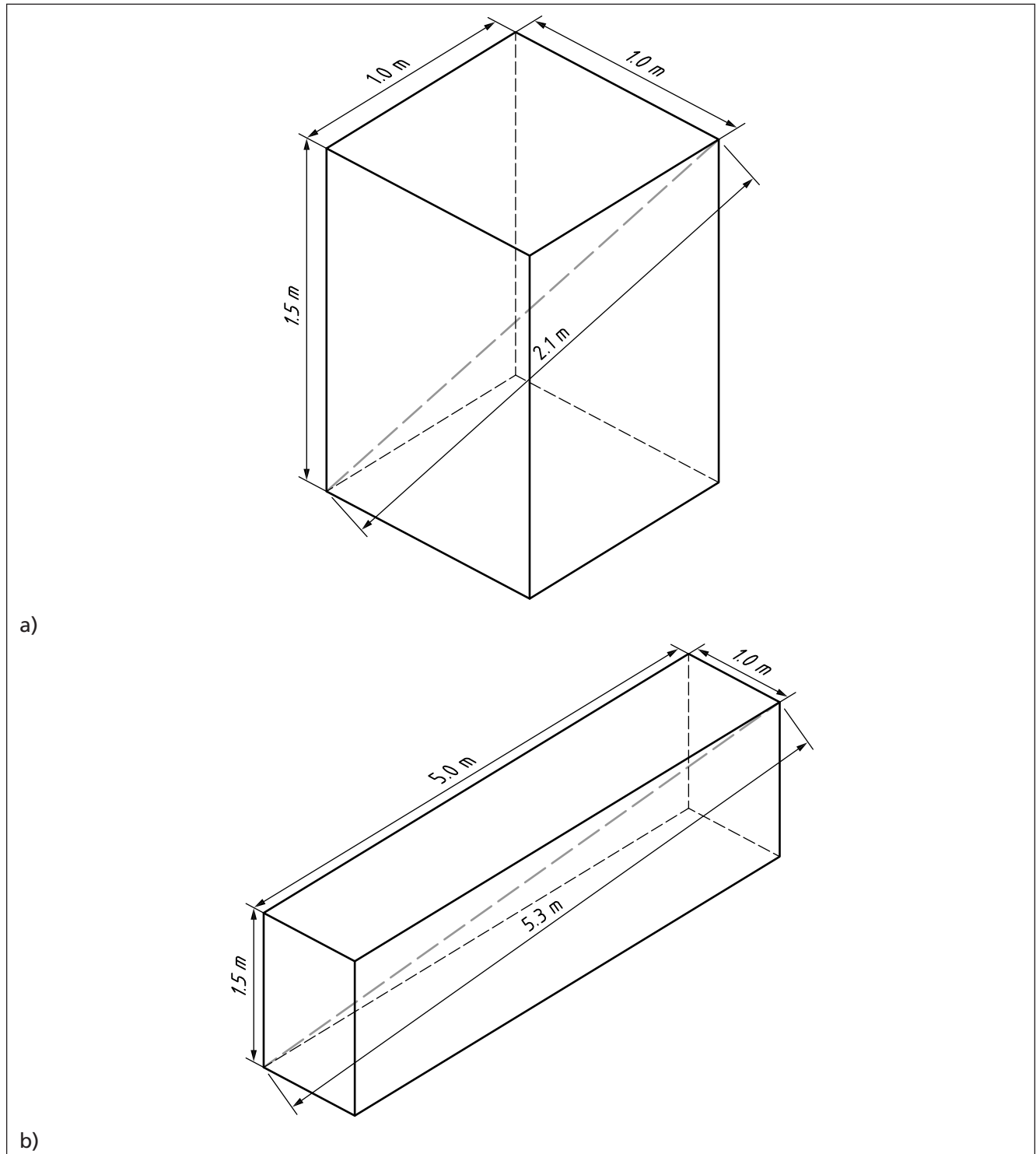


Figure E.6 Example calculations of load collapse radius



E.2.3 Permanent or temporary structures may be relied on to provide shielding in the event of a collapse. Before this approach is adopted, though, the appointed person should consult a temporary works or structural engineer to ensure that the structure will be able to absorb the loads from collapse of the crane.

E.2.4 Where the crane cannot be positioned such that the compound collapse radius is 4 m or the distance specified by the site operator away from the site boundary or area within the site of exceptional hazards, consideration should be given to the type of crane to be used and the consequences of the crane failing. Selection of the crane type should be based on an evaluation of the balance of

risk, rather than economics and availability. Site constraints such as site dimensions, lifting radii, access arrangements and the weight of the loads to be lifted might, however, ultimately dictate the final selection of the crane(s).

E.3 Planning

E.3.1 Consultation

E.3.1.1 If lifting close to the site boundary cannot be avoided and the crane or its load can collapse within 4 m of the boundary, the appointed person planning the lifting operation should consult the site operator. Cranes should not be sited and used until permission from the site operator has been granted and any requirements from the site operator have been satisfied. Any special requirements should be included in the lift plan. The site operator may require special measures to be taken to eliminate or reduce the risk of a load falling or the crane collapsing. These may include for railways a temporary possession and, if appropriate, isolation for which considerable lead time might be required.

E.3.1.2 The site operator should be consulted to identify areas within the critical areas where the collapse of the crane or the load being dropped could have serious consequences.

NOTE Within sites of exceptional hazards there might be areas where collapse of the crane or the load being dropped does not give rise to serious consequences.

E.3.2 Planning requirements

E.3.2.1 Down-rating of the lifting capacity

If the crane or its load can collapse within 4 m of a critical area within the site of exceptional hazards, the maximum planned load to be lifted should not exceed 75% of the manufacturer's specified rated capacity for the crane configuration chosen unless, in consultation with the site operator, an alternative down-rating figure is agreed, based on the findings of a risk assessment. Where possible, the rated capacity indicator and limiter should be programmed with the reduced duty and the calibration verified by testing. A copy of the revised load chart should be made available to the crane operator.

E.3.2.2 Up-rating of the crane foundations or support structure

E.3.2.2.1 Cranes mounted on fixed foundations

Where the crane is mounted on fixed foundations, the base foundation should be designed using the in-service, erection and out-of-service foundation loads of the crane before any down-rating of the rated capacity. The maximum moment and horizontal loads should be up-rated by a factor of 1.33 before being used in the base design.

NOTE 1 Vertical loads are not up-rated as it is not possible to increase the crane's mass by this amount and to do so would reduce the tension loads in piled foundations.

NOTE 2 The effect of this is to increase the factor of safety of the base design.

NOTE 3 The foundation anchors are not subjected to up-rating as they are part of the crane's structure and fall under the recommendations of **E.3.2.3**.

E.3.2.2.2 Cranes mounted on rails or static cruciform base with base ballast

E.3.2.2.2.1 Where the crane is to be mounted on a travelling (rail going) base or on a static cruciform base with base ballast, the ballast should be increased by a factor of 1.33 and the resulting loads used for design of the rail track or cruciform foundation.

E.3.2.2.2 When increasing the mass of central ballast, care should be taken to ensure that the rated capacity of the travelling base or static cruciform is not exceeded.

E.3.2.2.3 Cranes sitting on outrigger mats, on tracks or wheels

Where the crane is to be set up on outriggers, the maximum in-service and erection outrigger loads prior to down-rating of the rated capacity should be used to design or verify the adequacy of the supporting ground or structure. The counterweight should remain at that required prior to down-rating.

E.3.2.3 Height requirements: Tower cranes

The free-standing height of tower cranes should be limited to the manufacturer's specified maximum freestanding height for the crane configuration chosen, calculated in accordance with BS EN 14439.

E.3.2.4 Out-of-service wind speed

E.3.2.4.1 The appointed person should establish the out-of-service wind speed for the crane(s) selected.

E.3.2.4.2 Where the crane jib is to be lowered or folded in high winds, the appointed person should establish the limiting wind speed and determine that sufficient space is available for the operation to be undertaken safely in all wind directions.

E.3.2.4.3 The effect of out-of-service wind should be calculated using the appropriate wind region for the crane's location with a minimum of Region C, a minimum 25 year recurrence interval, and the roughness factors for "flat open country".

E.3.2.4.4 Where a wind zone assessment is undertaken for Region D or above, a record of the assessment should be kept on site for inspection.

E.3.2.5 In-service wind speed

The appointed person should establish the maximum permissible in-service wind speed for each lift to be undertaken. Reduction in wind speed might be required for loads with high surface area in relation to their weight.

E.3.2.6 Temporary foundations, bases and ties

E.3.2.6.1 A ground survey should be undertaken to establish the underlying soil types, stability and load-bearing capacities. The foundation design should take account of the loads and forces to be applied by the crane and the findings of the ground survey.

E.3.2.6.2 Any loading information obtained should be for the exact configurations of the crane to be used. When establishing loads and forces imposed by the crane all conditions should be considered, including:

- a) access/egress (travelling);
- b) set-up/erection/maintenance;
- c) operating: fully laden (static and/or travelling);
- d) operating: unladen (static and/or travelling); and
- e) out-of-service (not in-use).

E.3.2.6.3 It should be established whether the forces and loads obtained include any factor of safety. The foundation designer should ensure that the factor of safety is suitable for the situation being assessed.

E.3.2.6.4 The design should then undergo an independent design check in accordance with BS 5975:2008+A1:2011, Table 1, Category 3, to ensure that the

concept, overall design and details of the foundation proposed are adequate and that the foundation designer's intentions have been properly reflected in the drawings to be supplied to site. The check should not take the place of any checking carried out by the foundation designer, who retains full responsibility for the adequacy of the foundation design.

E.3.2.6.5 Pre-erection checks of the base/foundation should be carried out prior to erection. Copies of the foundation drawings should be retained on site with the crane. Photographs of foundations under construction should be taken and retained on site. Cube tests should be taken of each batch of concrete used. Results of the tests should be retained on site. The crane should not be erected until a competent engineer has verified that the foundation has been constructed correctly and the concrete has achieved the necessary strength.

E.3.2.7 Planning for dismantling

Before the crane is erected the dismantling operation should be planned, at least in outline, to ensure that changes to the site after erection do not impede the dismantling operation, e.g. building on the area required to stand a mobile crane on for dismantling.

NOTE If a possession and, as appropriate, isolation is needed for the dismantling operation, the lead time for these will be considerable.

E.3.2.8 Crane preparation

E.3.2.8.1 Before a crane is delivered to site it should be inspected thoroughly to identify any worn or faulty components and to ensure that these are replaced. It is considerably easier and less costly to replace components and carry out lubrication and adjustments in a depot than when the crane is at a site.

E.3.2.8.2 Pre-delivery maintenance provides a good opportunity for the completion of supplementary tests before the crane is erected. All crane drive and control systems should be powered up and checked for correct functioning during pre-delivery inspection.

E.3.2.8.3 Records of the pre-delivery inspection should be retained in a file for the crane and copies made available for checking on site.

E.3.2.9 Erection alteration and dismantling

E.3.2.9.1 The erection of a crane should be planned and carried out by trained and competent personnel. A risk assessment should be carried out for each erection and a job-specific method statement prepared, taking account of the crane manufacturer's instructions. The method statement should address potential problems, such as equipment failure and rising wind speed, with appropriate contingency measures. All members of the erection team should be briefed on the method to be used and confirm that they are aware of their specific duties. The erection operation should be controlled by the erection supervisor, who should have the authority to suspend operations at any time they judge that it would be unsafe to continue.

E.3.2.9.2 The dismantling of a crane is not just the reversal of the erection process. Before dismantling is carried out a risk assessment should be undertaken to identify any changes to the site or the surrounding area which could impinge on the operation.

NOTE These might include adjacent structures, access for transport and mobile cranes, and mobile crane set-up areas.

E.3.2.9.3 Both erection and dismantling of a crane should be carried out by competent and authorized personnel who are familiar with the make and model of crane and have adequate information to undertake their tasks effectively.

E.3.2.9.4 The method statement for erection, alteration and dismantling should consider the risk to the high-risk site from the process including the use of mobile cranes.

E.3.2.9.5 The site operator should be notified in advance of any erection alteration or dismantling operations.

E.3.2.9.6 If the height of a tower crane is to be increased or reduced by erection, the limiting wind speed should be set at 75% of the maximum permitted by the manufacturer.

NOTE Further information on the erection of tower cranes can be found in BS 7121-5.

E.3.2.10 Oversailing

E.3.2.10.1 Where oversailing cannot be avoided, a formal "oversailing agreement" should be reached with the site operator to permit (subject to conditions) a crane's jib to oversail the site or a critical area within a site with exceptional hazards for weather vaning purposes or, exceptionally, when in service. Such conditions should include, but not be limited to, the load, associated lifting accessories and lifting beams not being permitted to oversail.

E.3.2.10.2 An operation where there is a risk of encroachment should be undertaken under strictly controlled conditions (suitable risk assessment and method statement and/or screening measures) or during periods of site possession.

NOTE This might require safe isolation and evacuation of the critical area.

E.3.2.11 Zoning and anti-collision systems

E.3.2.11.1 To prevent the crane oversailing the operational boundaries during use, it should be fitted with a zoning system to limit the motions. Zoning systems also assist in the avoidance of obstructions such as existing buildings and structures.

E.3.2.11.2 Where more than one crane is in use on a site, an anti-collision system should be fitted if there is a risk of a clash between the hoist rope or hook and load of one crane and the jib or counter jib of another crane.

E.3.2.11.3 The lift plan should include a drawing of the site showing the extent and position of the pre-warning and exclusions zones.

E.3.2.12 Collision protection (Ground level)

Where the crane cannot be segregated from vehicles and mobile plant it should be protected against impact from vehicles and mobile equipment travelling in the vicinity of the crane.

E.4 In-service lift plan

E.4.1 A lift plan, incorporating a risk assessment and method statement, should be prepared by the appointed person for all lifts to be undertaken. The lift plan should include drawings providing plan and side elevations.

E.4.2 The lift plan should include details of the sequence by which the crane is to be positioned, erected, dismantled and removed. The plan should also provide information about the sequence in which lifting operations are to be undertaken. Any critical hold points and control measures should be identified.

E.4.3 A copy of the plan should be available on site. The lift plan should be submitted to the site operator for comment and approval.

E.4.4 All members of the lifting team should be briefed on the contents of the plan and understand their roles.

E.5 Maintenance, inspection and thorough examination

NOTE Effective maintenance of cranes and lifting accessories is vital in ensuring that cranes remain safe and free from defects whilst on site.

E.5.1 Checks should be conducted to ensure that pre-use inspections have been correctly completed.

E.5.2 Maintenance activities should include inspection, preventive maintenance and repair of breakdowns. Adequate time should be allowed in the programme to ensure that these activities can be carried out as and when required.

E.5.3 Thorough examination is a separate activity from maintenance, but sufficient time should be allowed for thorough examination to be carried out after erection or alteration and before taking into service, and after the occurrence of exceptional circumstances. Cranes should be thoroughly examined at intervals not exceeding six months. Lifting accessories should be thoroughly examined at intervals not exceeding three months.

E.5.4 Records of thorough examination, supplementary testing and maintenance should be held on site.

E.5.5 Both maintenance and thorough examination should be carried out by competent and authorized personnel who are familiar with the make and model of the crane and have adequate information to undertake their tasks effectively. A thorough examination should be undertaken by a competent person who is sufficiently independent from the erection and maintenance activities.

E.5.6 The competent person should require load testing to be carried out to supplement thorough examination. The magnitude of the test load should be as specified by the crane manufacturer, based on the full rated capacity. The competent person should be informed that the crane is to be used on a site with exceptional hazards.

E.5.7 The following supplementary tests should be carried out:

- a) independent verification of zoning and anti-collision systems by the competent person;
- b) independent witnessing of hoist brake tests by the competent person (see Table E.1);
- c) independent witnessing of luffing brakes tests on a luffing jib crane by the competent person (see Table E.1);
- d) independent witnessing of trolley brakes tests on a saddle jib and self-erecting tower crane by the competent person (see Table E.1); and
- e) an earth continuity test for lightning protection.

E.5.8 Test loads should be kept as near to the ground as possible to minimize the effect of failure.

E.5.9 Tests should be carried out with the jib parallel to or away from the site.

Table E.1 Recommendations for dynamic supplementary brake testing

Brake	Test load	Procedure	Performance
Hoist brake	100% of rated SWL	Lower test load and actuate emergency stop	Brake should arrest load
Luffing brake	75% of down-rated SWL at 50% of max. radius	Lower jib and actuate emergency stop	Brake should arrest load
Trolley brake	100% of down-rated SWL at 75% of max. radius	Trolley out and actuate emergency stop	Brake should arrest load

E.6 Incident investigation

E.6.1 An investigation should be undertaken following any significant incident during the erection or use of the crane. The investigation should be undertaken by a competent person who is sufficiently independent of the erection or operation of the crane. A copy of the investigation report should be provided to the site operator and held on site.

NOTE Attention is drawn to RIDDOR 1995 [27].

E.6.2 When the investigation is complete, the lift plan should be reviewed to ensure that any significant findings arising from the investigation are addressed.

E.7 Records

The following records should be made available on site for inspection by the site operator where applicable:

- a) temporary works certificates;
- b) non-objections from site operator to method statements/lift plans;
- c) base and pile drawings and construction photographs;
- d) tie drawings and construction photographs;
- e) cube and pile test results (continuity);
- f) base and tie design and construction records (including check certificates);
- g) notification to airfields (if required);
- h) notification to Civil Aviation Authority (CAA) if required;
- i) build configuration of crane and load charts;
- j) power supply requirements and generator size (if any);
- k) wind zone assessment record (Region D or above);
- l) erection method statement;
- m) outline dismantle plan;
- n) in-service lift plan;
- o) drawings for anti-collision and zoning systems;
- p) certificate of setting of anti-collision and zoning systems;
- q) records of checking of anti-collision and zoning systems settings;
- r) lifting team training and competence assessment;
- s) confirmation of resetting of rated capacity;
- t) records of incident investigations;
- u) results of thorough examinations (including overload test results);
- v) results of supplementary tests;
- w) test certificates; and
- x) maintenance schedule and records.

E.8 Audit form

The appointed person should also complete and retain on site a "Management of cranes leading indicator audit" (see Figure E.7) at intervals not exceeding three months during the period that the crane is erected on site.

Figure E.7 Management of cranes leading indicator audit

Nature of project:

Date(s) of audit:

Crane number:

Pro forma completed by:

1.0	Selection	
1.1	Is the crane selected the correct type for the application?	Y/N
1.2	Is the model and size of crane selected correct?	Y/N
2.0	Erection	
2.1	Does the location of the crane take account of location hazards?	Y/N
2.2	Has the competence of the erection team been demonstrated?	Y/N
2.3	Has a site and job-specific risk assessment been carried out, a method statement been written and all personnel involved briefed?	Y/N
2.4	Have measures been put in place to avoid collisions with other cranes and high reach plant?	Y/N
2.5	Has the crane base been designed and installed correctly?	Y/N
2.6	Have any ties been designed and installed correctly?	Y/N
2.7	Has a post-installation test and through examination been carried out before handover?	Y/N
2.8	Does the method statement for erection operation contain hold points and contingency plans for rising wind speed and equipment failure during erection?	Y/N
3.0	Maintenance	
3.1	Is daily, weekly and periodic preventive maintenance being carried out and are records available?	Y/N
3.2	Are defects being reported, investigated and rectified in a timely manner?	Y/N
4.0	Thorough examination	
4.1	Are 6-monthly periodic thorough examinations being carried out for the crane?	Y/N
4.2	Are 3-monthly periodic thorough examinations being carried out for lifting accessories?	Y/N
4.3	Does the competent person have adequate independence?	Y/N
4.4	Are defects being reported, investigated and rectified in a timely manner?	Y/N
5.0	Operation	
5.1	Has the competence and medical fitness of the operators been demonstrated?	Y/N
5.2	Are there sufficient operators to allow for regular breaks and shift patterns?	Y/N
5.3	Are wind speed restrictions followed?	Y/N
5.3	Are communications between operator and slinger-signallers adequate?	Y/N
5.4	Are all lifts adequately planned and supervised?	Y/N
5.5	Is the operation of multiple cranes coordinated effectively?	Y/N
5.6	Are all cranes left out-of-service in the correct condition?	Y/N

Annex F
(normative)**Radio communication for lifting operations**

COMMENTARY ON ANNEX F

Cranes often work on congested construction sites where the signaller is out of sight of the crane operator and standard hand signals (see Figure 3) cannot be used. As an alternative, hand-held VHF/UHF (very high/ultra-high frequency) radios are often used. However, the use of these radios can lead to a number of problems which could interfere with the clear communication vital for safe lifting operations, such as:

- a) loss of signal and thus communication, resulting in the loss of control of the lifting operation (see F.1);*
- b) interference from radios on adjacent sites, which can result in the loss of communication or directions being given to the wrong crane operator; and*
- c) misunderstanding between the crane operator and the signaller, leading to problems such as a load being lifted before the slinger-signaller has their hands clear, a load colliding with the building structure or a load being lowered before people are clear of the landing area (see F.2).*

F.1 Radio specification

To avoid loss of signal and interference, the correct radio equipment for the application should be selected, taking into account:

- a) signal strength: signal strength should be checked at the beginning of each shift before lifting operations are started;

NOTE If it is too low, there is a risk of signal loss, but if it is too high, it is likely to cause interference with adjacent sites. When working blind, the structure could cause signal loss and a booster aerial might be required.
- b) frequency: a different frequency from other radios on the site or in the area should be selected to avoid interference from or to other radios;
- c) durability: radio handsets should be sufficiently durable to withstand use on site;
- d) charging: adequate charging arrangements should be made so that batteries are charged at the end of a shift and that spare charged batteries are available at all times; and
- e) battery capacity: the radio battery should have sufficient capacity to last for a full shift.

F.2 Calls signs and standard commands

To avoid misunderstandings between the crane operator and signaller:

- a) both parties should have a sufficient command of a common language (normally English) so that clear, unambiguous communication can take place;
- b) a clear, unique call sign should be allocated to each signaller and crane operator;
- c) each message should be preceded by the call sign;
- d) the crane operator should not respond to any command (other than "Stop") that is not preceded by the call sign;
- e) voice commands should only be given by one person, normally the signaller, at any one time;
- f) voice commands should be given using the signals in Table F.1; and
- g) voice commands should be acknowledged and repeated by the operator to demonstrate that the message has been received and understood.

Table F.1 Voice commands for lifting operations

No.	Voice command
1	"Start operations"
2	"Stop now" (Emergency stop)
3	"Take the weight" "Raise" ^{A)} "Lower" ^{A)} "Lower slowly"
4	"Slew left" ^{B)} "Slew right" ^{B)}
5	Jib up Jib down
6	Extend jib Retract jib
7	Travel to me
8	Travel from me
9	Cease operations

^{A)} When fine positioning control is required, the signaller should repeat the command continuously for as long as motion is required, "Lower slowly, Lower, Lower, Lower, Lower, Lower, Lower, Stop". As long as the crane operator can hear the command, it is clear that the radio is working. If the commands cease before the final "Stop", the operator knows that communication has broken down and stops the operation.

^{B)} "Left" and "Right" are defined from the viewpoint of a crane operator sitting at a control station and looking down at the load. This also applies when a crane is being operated using remote controls.

F.3 Radio system familiarization

All radio users should be familiar with the controls and operation of the model of radio that they are required to use.

NOTE Radios used for two-way communication on construction sites, and for industrial use, are referred to as private mobile radios (PMR). Some low-powered PMRs use a European system called PMR446 and do not require a licence. However, this system is limited to 8 UHF frequencies, each with 38 channels, which could lead to interference from other users. PMR446 radios are also limited to a maximum of 500 mW effective radiated power, which gives a range of 0.8 km (0.5 miles) to 1.6 km (1 mile) in built-up areas and 3.2 km (2 miles) in open country.

More powerful radios work on VHF and UHF radio frequencies, which are assigned to a user by Ofcom which also regulates the frequency bands. To obtain a licence on one of these frequencies an application needs to be made to Ofcom. The benefits of a licensed frequency are generally greater range, less interference from other users and more features available on the radio sets.

These frequencies are allocated to businesses only, on a case-by-case basis. Once a licence has been issued, radios can be purchased. The supplier needs to see a copy of the licence to program the radios to the correct frequency before shipping.

Additional guidance is given in Ofcom's Information Sheet OfW77: Business Radio Communication for Tower Cranes [34].

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