

BS 7121-5:2019



BSI Standards Publication

Code of practice for safe use of cranes

Part 5: Tower cranes

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Summary of pages

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Foreword

Publishing information

This part of BS 7121 is published by BSI Standards Limited, under licence from The British Standards Institution, and came into effect on 30 September 2019. 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This part of BS 7121 supersedes [BS 7121-5:2006](#), which is withdrawn.

Relationship with other publications

The Lifting Operations and Lifting Equipment Regulations (LOLER) [1] and the Provision and Use of Work Equipment Regulations (PUWER) [2] came into force on 5 December 1998. Details of the Regulations, an Approved Code of Practice plus HSE guidance can be found in the HSE Approved Codes of Practice *Safe use of lifting equipment* [3] and *Safe use of work equipment* [4].

This part of BS 7121 is intended to be read in conjunction with [BS 7121-1](#), which provides general recommendations for crane types not covered in an additional part of BS 7121. BS 7121-2 covers in-service inspection, thorough examination and, where appropriate, testing for the safe use of all types of crane. Subsequent parts of BS 7121 deal (or will eventually deal) with the specific crane types as follows:

- Part 3: Mobile cranes;
- Part 4: Lorry loaders;
- Part 5: Tower cranes;
- Part 6: Derrick cranes;
- Part 7: Bridge and gantry cranes, including light crane systems;
- Part 8: High pedestal and portal jib dockside cranes;
- Part 9: Container handling cranes;
- Part 10: Rail-mounted cranes;
- Part 11: Offshore cranes;
- Part 12: Recovery vehicles and equipment;
- Part 13: Hydraulic gantry lifting systems;
- Part 14: Side boom pipe layers.

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

Information about this document

This is a full revision of the standard, and introduces the following principal changes:

- alignment with [BS 7121-1:2016](#); and
- addition of recommendations from CPA Technical Information Notes.

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.

This publication can be withdrawn, revised, partially superseded or superseded. Information regarding the status of this publication can be found in the Standards Catalogue on the BSI website at bsigroup.com/standards, or by contacting the Customer Services team.

Where websites and webpages have been cited, they are provided for ease of reference and are correct at the time of publication. The location of a webpage or website, or its contents, cannot be guaranteed.

Use of this document

As a code of practice, this part of BS 7121 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 part of BS 7121 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.

Where words have alternative spellings, the preferred spelling of the Shorter Oxford English Dictionary is used (e.g. “organization” rather than “organisation”).

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.

1 Scope

This part of BS 7121 gives recommendations for the safe use of tower cranes, including self-erecting tower cranes other than mobile self-erecting tower cranes (which are covered in [BS 7121-3](#)).

NOTE The types of tower crane are set out in [Annex A](#).

Subjects covered include safe systems of work, selection, erection, extension (including climbing), dismantling, maintenance, inspection, thorough examination (including testing), operation, and the planning and management of lifting operations. It also covers the appropriate selection and training of personnel involved in the safe installation and use of tower cranes.

This part of BS 7121 is intended to be read in conjunction with [BS 7121-1](#).

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes provisions of this document¹. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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 the safe use of cranes*

[BS 7121-1:2016](#), *Code of practice for safe use of cranes – Part 1: General*

BS 7121-2 (all parts), *Code of practice for the safe use of cranes*

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

[BS 7121-2-3](#), *Code of practice for the safe use of cranes – Part 2-3: Inspection, maintenance and thorough examination – Mobile cranes*²

BS 7121-2-5:2012, *Code of practice for the safe use of cranes – Part 2-5: Inspection, maintenance and thorough examination – Tower cranes*

[BS 7375](#), *Distribution of electricity on construction and demolition sites – Code of practice*

[BS 7671](#), *Requirements for Electrical Installations – IET Wiring Regulations*

[BS 8454](#), *Code of practice for the delivery of training and education for work at height and rescue*

BS EN 13586, *Cranes – Access*

BS EN 14399-1, *High-strength structural bolting assemblies for preloading – Part 1: General requirements*

BS EN 15048-1, *Non-preloaded structural bolting assemblies – Part 1: General requirements*

BS EN ISO 148-1, *Metallic materials – Charpy pendulum impact test – Part 1: Test method*

BS EN ISO 898-1:2013, *Mechanical properties of fasteners made of carbon steel and alloy steel – Part 1: Bolts, screws and studs with specified property classes – Coarse thread and fine pitch thread*

BS EN ISO 898-2, *Mechanical properties of fasteners made of carbon steel and alloy steel – Part 2: Nuts with specified property classes – Coarse thread and fine pitch thread*

¹ Documents that are referred to solely in an informative manner are listed in the Bibliography.

² This standard also gives an informative reference to BS 7121-2-3:2012.

BS EN ISO 6507-1, *Metallic materials – Vickers hardness test – Part 1: Test method*

BS EN ISO 6892-1, *Metallic materials – Tensile testing – Part 1: Method of test at room temperature*

FEM 1.005, *Recommendations for the calculation of tower cranes' structures in out of service conditions"*

NA to BS EN 1991-1-4:2005+A1:2010, *UK National Annex to Eurocode 1 – Actions on structures – Part 1-4: General actions – Wind actions*

3 Terms and definitions

For the purposes of this part of BS 7121, the terms and definitions given in [BS 7121-1](#) and the following apply.

3.1 alteration

addition or removal of a structural element, e.g. changing height of mast or jib length

3.2 blind lift

lifting operation where the crane operator cannot see the complete load path from the operating position, e.g. unable to see pick-up and/or set-down points

3.3 climbing

increasing or decreasing the tower height of a crane using a means other than another crane

NOTE Tower crane climbing, also known as "telescoping", is a specialized technique used in the installation of tower cranes.

3.4 competent engineer

person who has such theoretical knowledge, qualifications and experience of the design of the lifting equipment as enables them to assess the design of tower crane bases, ties and supporting structure connections, together with the adequacy of supporting structures to take the loads imposed by the crane

3.5 dismantling

de-rigging and disassembly of a tower crane

3.6 erection

assembly, rigging, testing, commissioning and initial thorough examination of a tower crane

3.7 erection team

3.7.1 erection supervisor

person in control of a team of tower crane erectors on site, who is a senior erector with sufficient experience and additional skills to enable them to supervise, and take responsibility for, the team

3.7.2 erector

person trained and assessed in tower crane erection and dismantling, working under the supervision of an erection supervisor

3.7.3 senior erector

erector with sufficient experience and additional skills to enable them to work with and directly oversee a trainee erector

3.7.4 trainee erector

person undergoing training in the erection/dismantling of cranes and working at all times under the direct supervision of a senior erector

3.8 hold point

critical point at which an operation stops until checks have been carried out by the erection supervisor

3.9 installation

group of activities associated with the erection, climbing, alteration and dismantling of a tower crane

3.10 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. A separate plan is necessary for erection and dismantling.

3.11 radius indicator

device that shows the radius at which the crane is operating

3.12 rotation of crane**3.12.1 free slew**

condition in which the slewing brakes are released to allow the crane to freely rotate in the wind, which results in a reduction in out-of-service loads

3.12.2 weathervane

movement of the crane where it freely rotates in line with the wind in order to minimize structural loads

NOTE Weathervane can only occur if the crane is in free slew.

3.13 tower crane**3.13.1 conventional tower crane**

slewing jib type crane with jib located at the top of a vertical tower which is assembled on site from components

3.13.2 self-erecting tower crane (SETC)

jib type crane with jib located at the top of a vertical slewing tower which is a pre-assembled unit transported to site and deployed from its travelling configuration for use

3.14 work at height

work in any place, including a place at or below ground level, and obtaining access to or egress from such place while at work, except by a staircase in a permanent workplace

[SOURCE: Work at Height Regulations [\[5\]](#)]

3.15 limiting devices

3.15.1 anti-collision device

electromechanical/electronic device to prevent a crane colliding with another crane, structure or ropes

3.15.2 zoning device

electromechanical/electronic device to control the area in which a tower crane works

Section 1: General management of lifting operations with tower cranes

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 be 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 1 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) erection/dismantling plans, including 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), including the need to ensure that bases, ties, outriggers, jacks, etc., are adequately supported for their imposed loads;
- 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 [\[6\]](#);
- 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 adjacent cranes and other items of plant, structures or unauthorized areas;
- 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.

NOTE 2 Further information on the hierarchy of appointed persons on construction sites with multiple contractors is given in [4.2.1.3](#).

4.1.3 The safe system of work should be communicated 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. [Figure 1](#) shows the flow of information and control of lifting operations between personnel.

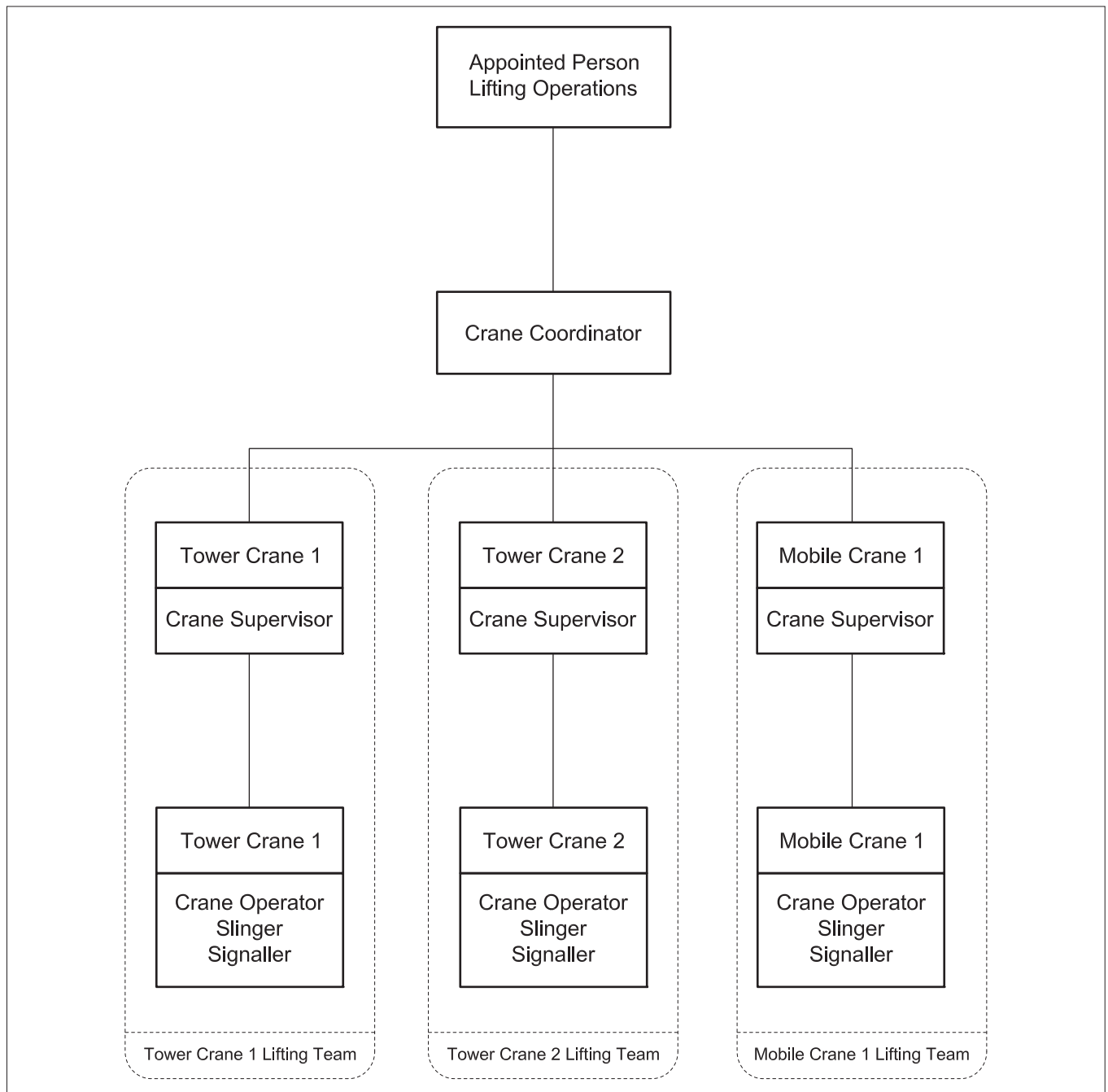
4.2 Control of the installation or lifting operation

4.2.1 General

4.2.1.1 In order to implement the safe system of work effectively, one appropriately competent person (see [BS 7121-1:2016](#), [4.3.1](#)) should be appointed to plan the lifting operation, acting on behalf of the management of the employing organization.

NOTE 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.

Figure 1 — Flow of information between personnel involved in lifting operations



4.2.1.2 The appointed person should nominate one person to control the lifting operation. This individual may be the appointed person, the lifting supervisor, the slinger-signaller, the crane coordinator or the crane operator. The person nominated should have adequate training and experience to enable them to carry out their duties (see [BS 7121-1:2016](#)) competently.

4.2.1.3 The appointed person should have adequate training and experience to enable them to carry out their duties (see [4.3.1](#)) competently.

NOTE The appointed person has a duty to ensure that the crane selected has adequate capacity for the intended use and utilization. The crane user has a duty to ensure that all lifts are carried out in accordance with the lift plan.

- 4.2.1.4** 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.

NOTE Although the principal contractor's appointed person will review the subcontractor's own lift plans, the responsibility for the adequacy of the individual safe system of work remains with the appointed person who planned the lift (see principal contractor duties under the Construction (Design and Management) (CDM) Regulations 2015 [7]).

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. Different appointed persons might be required for erection/dismantling and operation of the tower crane.

- 4.2.2.2** An appointed person should be trained in accordance with [BS 7121-1:2016](#), Annex A.

- 4.2.2.3** The employing organization should review the competence of the appointed person at planned intervals as the construction project changes. Written records should be kept of these reviews.

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;

NOTE 1 Where the crane is selected before the competent person is appointed, the appointed person ensures that the crane and accessories are suitable for the intended lifting operations.

- 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 examinations of the equipment have been carried out;

NOTE 2 For further information see [BS 7121-2-5](#).

- 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) on a multiple contractor site, understanding the hierarchy of appointed persons (see [4.2.1.4](#), including Note);
- g) 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 3 This is generally acknowledged by the recipients by signing the briefing document.

- h) 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 CDM Regulations 2015 [\[7\]](#) apply.

NOTE 4 Further guidance on roles and responsibilities under the CDM Regulations 2015 [\[7\]](#) is given in the HSE's Managing health and safety in construction: Construction (Design and Management) Regulations 2015. Guidance on Regulations [\[8\]](#) and A short guide for clients on the Construction (Design and Management) Regulations 2015 [\[9\]](#).

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 The appointed person should be aware of the limits of their knowledge and experience about lifting operations and, when conditions exceed these limits, further advice should be obtained from a competent person.

4.3.1.4 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	Fog
Complex slinging arrangements	Sea state
Uncertainty of weight of load	Railways
Multi-crane lifting	Roads
Integrity of load	Petrochemical plants
Dynamics of the load, e.g. floating load	Nuclear plants
High surface area and/or drag coefficient	Corrosive atmospheres
Aerial load transfer	Adjacent cranes or other plant
Orientation of the load	Power lines: overhead and underground
Load stability	Public places
Fragility	Partially-obscured load path, e.g. blind lift
Sharp edges	Ground suction
Load restraint	Partially-secured load (demolition)
	Lightning
	Insufficient daylight/ poor visibility
	People (consequence of failure)
	Poor ground conditions as applicable

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:

- basic, e.g. the weight of the load(s) can be simply established and there are no significant hazards within the working area;
- intermediate, e.g. there are significant hazards, either within the working area of the crane; or
- complex, e.g. the crane is used to lift complex loads or persons or is, exceptionally, used as part of a multi-crane lift, where the lifting operation is complex, 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 and lifting operation complexity (L)				
Key 1 Low 2 Medium 3 High <i>NOTE 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.</i>				

4.3.2.2 Basic lift

- 4.3.2.2.1** For a basic lift (see [Table 2](#)), 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, based on:
 - 1) information with which they have been provided; and
 - 2) a visit to the site they make personally or delegate to 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;
 - 4) the rated capacity of the crane, as specified by the manufacturer/installer in the information for use supplied with the crane; and

NOTE 1 The manufacturer's sales leaflets ought not to be relied on for the rated capacity for a specific crane.

 - 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;

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, e.g. blind lift.	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

- 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 14.1 for guidance and recommendations on in-service 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 (at increased frequency inspection in a harsh or intensive-use environment), 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;

NOTE 3 For guidance on the combination of roles during a basic lift, see [BS 7121-1:2016](#), 6.2.8.

- 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 (see CPA TIN 032 [10]);
- 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 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 (or suitable alternative) 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 (see [7.1.6](#)); and
- q) ensuring that a crane supervisor is designated to direct personnel and to identify any hazards not identified in the lift plan, that the operation is carried out in accordance with the method statement, and that, where hazards are identified on site that are not in the lift plan/method statement, the appointed person is consulted to produce a new lift plan/method statement or amend it.

- 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 obtained from a competent person.

4.3.2.3 Intermediate lift

For an intermediate lift (see [Table 2](#)), 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, e.g. blind lift, including any areas required for access or setting up of the crane, which should 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 (see [Table 2](#)), 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 [BS 7121-1:2016, 20.1](#), are followed;
- e) being present on the site during the lift, unless they select a competent deputy to attend in their place;
- f) ensuring that, where the lifting operation requires more than one crane to lift the load, the recommendations of [11.4](#) are followed; and
- g) ensuring that multi-crane lifting is only undertaken with tower cranes in exceptional circumstances where it is not practicable to undertake the lift by other means, following a rigorous risk assessment and planning of the lift, taking account of the following:
 - 1) the different characteristics and operation modes of the equipment used;
 - 2) the distribution of the weight between the cranes;
 - 3) the verticality of the hoist ropes;
 - 4) the potential for structure-to-structure and structure-to-hoist-rope clashes;
 - 5) the effect of atmospheric conditions; and
 - 6) the effect of horizontal loads on the lifting systems.

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 eliminated or mitigated so far as is reasonably practical. Planning should be carried out by an appointed person who has the appropriate knowledge for the lifting operation 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) a realistic programme identifying any points at which work is not to be commenced unless it can be completed;
- c) any adhesion between the load and its support and any other forms of resistance to lifting;
- d) the stability of the load when being lifted and set down;
- e) maximum motion speeds, acceleration and deceleration;
- f) 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 [Clause 7](#));
- g) the selection of lifting accessories/attachments, the weight to be taken into account when assessing the load on the crane(s);
- h) the position of the crane(s) and of the load before, during and after the operation;
- i) the site of the lifting operation, including proximity hazards, space availability and suitability of the ground or foundations and other environmental conditions;
- j) where there is a possibility of collision between cranes and other equipment, the need to plan the sequence of crane movements to prevent collisions (see [5.1.3](#));
- k) the proximity of other cranes and/or other plant/structures;
- l) zones where the crane and/or parts of the crane and load-lifting attachments are prohibited from entering or oversailing, including set-up, calibration and verification of limiting systems;

NOTE See [BS 7121-1:2016, 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.

- m) any necessary set-up (configuration) of the crane(s), including erection and dismantling;
- n) the identification and selection of personnel for the lifting operation, including effective communication taking account of language differences between members of the lifting team;
- o) 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. wind, ice, lightning, snow, low light levels;
- p) management of change: the need for any deviations from the plan or site changes to be referred back to the appointed person before the lifting operation proceeds;
- q) the need to avoid lone working where possible and, where this cannot be avoided, the necessity for suitable measures to be put in place to minimize the risk to a lone worker; and
- r) requirements from external bodies, such as Network Rail, London Underground and the Civil Aviation Authority (CAA).

5.1.3 Avoidance of collisions

The crane coordinator should establish the loads to be positioned that day for each crane, taking into account loading and offloading points, and ensure wherever possible that lifting operations have sufficient separation to avoid collision, liaising where necessary with site management and logistics. The use of electronic anti-collision devices should be a secondary aid only to planning and communication (see [9.9.5](#)).

Any corresponding instructions from the crane coordinator to the crane operators should be given via the respective signallers. In such circumstances, the slinger-signallers should obtain the agreement of the crane coordinator before carrying out any operation.

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) [[11](#)], which require that a risk assessment is 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 statements

- 5.3.1** Once the risk assessment has been carried out, the appointed person (see [4.3](#)) should ensure that a full method statement is prepared, detailing the safe system of work (see [4.1](#)) for the transportation, movement, erection, use and dismantling of the crane at the site.

- 5.3.2** The appointed person should, when necessary, consult with 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 and any conditions in which the crane is not to be left during adverse weather;
- b) plans for safely taking the crane out of service, taking into account manufacturer's requirements for the crane's specific configuration;
- c) details of the control measures to be followed to eliminate or minimize risk to members of the lifting team;
- d) 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.

- e) the requirement for pre-use checks to be completed;
- f) a clear statement of the allocation of tasks to all parties involved in the lifting operation;
- g) a description of the item(s) to be lifted, including its weight, dimensions and centre of gravity;
- h) lifting points/method;

- i) type of lifting accessories to be used and configuration;
- j) pick-up and landing points referenced to the site plan;
- k) the height of the lift and the maximum radius where applicable;
- l) the model and configuration of crane to be used;
- m) outrigger/stabilizer support arrangements, including assessment of ground or supporting structure;
- n) base, including cast-in, cruciform, grillage or rail track;
- o) overhead hazards;
- p) underground hazards;
- q) personnel involved, together with information as to which roles, if any, can be combined;
- r) the sequence in which lifting operations are to be undertaken;
- s) control measures to be implemented to eliminate or minimize risk;
- t) method of communication, e.g. hand signals or radios;
- u) environmental limitations, such as maximum permitted wind speed for the lifting operation;
- v) arrangements for any working at height, including rescue plans;
- w) access to attach and remove lifting accessories; and
- x) measures to be taken to ensure that the load remains stable after lifting accessories have been released.

NOTE 2 The crane supervisor has the authority to stop the lifting operation if there are any safety concerns.

- 5.3.4** The method statement should specify clear roles for each member of the team. Arrangements for effective communication among the team (and, if necessary, crane operators) should be available (see [Figure 1](#)).

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) should be available.
- 5.4.5** The briefing should be given using a language common to all lifting team members, so that they can fully understand it without the need for translation.

5.5 Selection of cranes

Cranes should be selected in accordance with [Clause 7](#).

5.6 Siting of crane

Cranes should be sited in accordance with [Clause 8](#).

5.7 Contracts

5.7.1 General

COMMENTARY ON 5.7.1

Tower cranes are generally hired from a supplier and the lifting operations managed by the employing organization.

- 5.7.1.1** 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 and expertise to carry out the work.

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

- 5.7.1.2** Whether lifting operations are being undertaken under crane hire agreements or as contract lifts, the employing organization should ensure that:

- a) a person is appointed in accordance with [4.3](#);
- b) adequate information regarding site conditions is obtained;
NOTE 1 It is the responsibility of the employer to provide this information to the contractor in writing.
- 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 the applicable part(s) of BS 7121.

NOTE 2 Compliance with BS 7121 does not relieve organizations of their statutory and common law obligations.

5.7.2 Contract lifting operations

Contract lifting operations should be carried out in accordance with [BS 7121-1](#).

5.7.3 Hybrid lifts

Hybrid lifts should not be undertaken.

NOTE Where a crane is hired by the supplier to the employing organization and the crane supplier becomes involved with the planning of the lift, e.g. unplanned ad hoc lifts, a hybrid situation exists where it is unclear who is responsible for ensuring that the recommendations of [4.1](#) are complied with. This could result in incomplete planning and an ineffective safe system of work.

5.7.4 Duties when a crane and operator are hired

- 5.7.4.1** 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 (all parts), and has a current report of thorough examination, together with a written method statement for the erection of the specific crane.
- 5.7.4.2** The user organization should nominate the appointed person in accordance with [4.3](#) and follow the recommendations of the applicable part(s) 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 tasks to be undertaken and for planning the operations remain 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 1 It is the user organization's responsibility to provide the contract lift organization with the right information to plan the lift.

NOTE 2 Where a crane is hired without an operator, all of these points still apply.

6 Selection and duties of personnel other than the appointed person

- 6.1** Personnel should be selected in accordance with [BS 7121-1:2016](#), Clause 6 and Clause 7.
- 6.2** All members of the lifting team should be aware of the limits of their knowledge and experience about lifting operations, and, when conditions exceed these limits, further advice should be obtained from a competent person.
- 6.3** The employing organization should regularly review the competence of all personnel involved in lifting operations as the construction project changes. Written records should be kept of these reviews (see CPA publication *Competence to Operate Construction Plant* [[12](#)]).

Section 2: Selection of tower cranes

7 Selection of tower cranes

COMMENTARY ON CLAUSE 7

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

7.1 General

7.1.1 Tower cranes are available in a number of forms, and the characteristics of the various cranes should be reviewed in relation to the requirements of the job, including site location and environmental limitations, e.g. weather conditions.

7.1.2 Those involved in the selection and configuration of the tower crane(s) should be competent and have sufficient technical and theoretical knowledge of the crane. The employer of those involved in the planning for the selection of the crane(s) should make a formal written assessment of the ongoing competence of these individuals.

Those involved in the operation and maintenance of the tower crane(s) should have specific familiarization on the model(s) of the crane(s).

7.1.3 Different types of crane are suited to different applications and working environments, so the appointed person planning the lifting operation should select the most appropriate lifting appliance and accessories. The repetitious nature of some lifting operations and environments also affects the equipment being selected, so the frequency of lifting and the duration of the cranes on site should be evaluated to ensure that only cranes suitable for the application are selected (see [7.1.6](#)). If necessary, the user should seek the assistance of the supplier in carrying out this evaluation.

NOTE 1 The use of a tower crane on a civil engineering site, such as a bridge, shaft, tunnel or large excavation, might require specification of a larger capacity crane to ensure that the crane's life does not get used up too quickly and lead to failure. Indicators of the type of anticipated usage and crane configuration that could arise from high-intensity operations include:

- usage in excess of 10 hours per day;
- planned lifts in excess of 6 lifts per hour;
- risk of shock loading (emptying muck skips, for instance);
- use largely within a restricted arc of operation;
- frequent use above 70% WLL;
- short mast (20 m or less);
- short jib;
- permanent siting in ship repair facilities, factories and plant yards; and
- use of radio controls with consequent loss of operator feedback.

Additional information on the effect of a high load spectrum on tower crane fatigue life and tower crane classification is given in [Annex B](#) and [Annex C](#).

NOTE 2 The use of cranes for cyclic operations can lead to early development of fatigue cracking in structural welds and premature failure of components such as the slew ring and gearing.

7.1.4 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.

7.1.5 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;
- 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 BS ISO 4301 (all parts) and [Annex C](#).

- e) length of time for which the crane is required;
- f) remaining life expectancy;
- g) suitability and condition of access roads;
- h) site, ground and environmental conditions, or restrictions arising from the use of existing buildings, including all loads imposed on the ground by the crane, e.g. outrigger, track, as even small cranes can impose high point loads;
- i) the positioning of the crane and components in the out-of-service condition, as specified by the manufacturer's instructions, is such that no collisions can take place [see [8.5](#)]; this activity should be part of the initial planning process;
- j) space available for crane access, erection, travelling, operation, dismantling and egress;
- k) account is taken of mast deflection in relation to other cranes, plant or structures for in and out-of-service conditions;
- l) the provision of access for the maintenance and inspection of the structure, in particular connections and bases;
- m) the installation, removal or lowering of climbing equipment, as required by the manufacturer;

NOTE 2 It is common for manufacturers to require the lowering or removal of the climbing frame to manage out-of-service loads;

- n) 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;

NOTE 3 Cranes are available with a range of fixed operator control stations and/or remote control.

- o) the weight of the rope is accounted for in the lift plan, the length of the rope is adequate, a trial lift is conducted, and a fail-safe procedure provided to ensure that sufficient hoist rope remains on the winch drum at all times;
- p) any special operational requirements or limitations imposed, e.g. requirements such as down-rating, for operation in hazardous environments, such as alongside nuclear installations or railways, and the method to be used to dismantle a climbing crane once the structure is completed;
- q) where necessary, working area limitation systems, e.g. limit radius, height and slew angle;
- r) the need for special wind studies where the crane can be affected by surrounding structures, e.g. vortex shedding;

- s) the need for independent special wind studies from the crane manufacturer, based on topographical data from the proposed location of the crane (see [8.3](#));
- t) the need to consult the crane manufacturer where the free-standing height of the crane can be altered if heavy-duty or reinforced mast sections are used or where any increase in base loads are reported to the crane base designer; and
- u) where a crane is to be located adjacent to a sensitive site(s), such as a railway or airport facilities, the need for a zoning system to monitor and prevent the hook or jib from oversailing boundaries in in-service conditions.

Care should be taken when selecting, specifying and positioning cranes in such environments, as the out-of-service condition of the cranes might lead to the jib oversailing the sensitive boundary and a zoning system will not prevent the free slew of a crane when out of service.

Care should be taken when lowering a load from height.

NOTE 4 The transfer of the hoist rope weight from the hoist drum to the front jib as the load is lowered can bring the crane into an overload situation. In this situation, the crane might not be able to complete the lifting operation.

NOTE 5 For tall cranes, when changing from 2 to 4 falls and back, it is necessary to be aware that the hoist rope weight could exceed the weight of the hook block, which could result in uncontrolled descent. Consult crane supplier for further information.

The effect of transfer of weight of rope in tall tower cranes should be considered during the planning phase in consultation with the crane supplier.

- 7.1.6** When a crane is supplied for use in a high-intensity application, the hirer and owner should ensure that the frequency of inspections, maintenance and thorough examinations is significantly increased to ensure that any cracking or other structural deterioration is discovered well before structural failure occurs. Before a tower crane is erected on site, a detailed inspection should be carried out in the supplier's depot to ensure that any defects are found and rectified, as it is easier to repair a tower crane on the ground than when it is erected. All structural tower crane components (e.g. mast sections, jib and slewing ring) should be individually identified, so that the duration and intensity of their usage can be recorded and monitored.

NOTE Further information is given in [Annex B](#) and [Annex C](#).

- 7.1.7** Where a non-slewing tower is to be tied to a fixed structure, the manufacturer's instructions should be followed. The ties should be designed by a competent engineer to withstand the loads specified by the manufacturer, as a minimum to FEM 1.005, wind zone C, with a recurrence factor of 25 years (according to the crane's geographical location), and be attached to a structure capable of withstanding the imposed loads. A competent person should review the effect of the tie forces on the structure, especially where the structure is not complete. Where an undersized pin is used, the permissible deflection should be checked and the pin designed to withstand all possible loads.

NOTE Applying tie forces to partially constructed buildings can affect the lateral stability of the building. Extra external bracing can be required. In certain cases, where multiple levels of ties are required, it is necessary to release lower levels of ties in order to conform to the crane manufacturer's tying and climbing sequencing. Failure to conform to the manufacturer's requirements can lead to an increase in the tie forces. A common practice is to "soft pin" disconnected ties (replacing the original locating pin with a smaller pin, i.e. 80 mm reduced to 40 mm, allowing up to 80 mm of deflection). However, mast deflection can exceed the permissible movement, resulting in the tie becoming connected and the tie loads being exceeded.

See [8.3](#) for guidance and recommendations on out-of-service wind speed.

7.2 Remote controls

COMMENTARY ON 7.2

Remote controls have the advantage that the crane operator can be at a point of safety when the crane is in use, especially during overload testing.

Care should be taken in the use of cranes with remote controls for the following reasons:

- a) the crane operator could be at risk of tripping and falling if they are trying to move around the site over uneven ground whilst concentrating on controlling the crane;
- b) the crane operator has no feel for the machine and could, under certain circumstances, be tempted to handle the machine more dangerously than if the crane were operated via a cabin control; and
- c) infra-red remote control can be unreliable on tower cranes if the receiving sensor rotates with the crane and thus loses alignment with the transmitter.

8 Siting of crane

8.1 General

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

- a) the crane foundations and ties, and standing and support conditions (see [8.2](#));
- b) the presence and proximity of other hazards (above and below ground) (see [Table 1](#) and [8.5](#)) and the need for the crane to have a fully unobstructed free-slew path;
- 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 (see [8.3](#));
- e) the adequacy of access to allow the erection of the crane in its working position and for dismantling and removing the crane following completion of lifting operations;
- f) allowance for cranes to weathervane freely, without obstruction, in line with the manufacturer's specifications for that crane configuration; and
- g) allowance for clearance between crane structures in accordance with [8.5.1.3](#).

NOTE 1 Cranes free-slew at different wind speeds, and even cranes with identical configurations (due to local environmental conditions, wear in the mechanisms, manufacturing tolerances, etc.) do not free-slew at the same wind speed. Therefore, it is not acceptable to rely on them to free-slew at the same wind speed in order to maintain clearance between structures.

NOTE 2 Attention is drawn to the New Roads and Street Works Act 1991 [[13](#)].

NOTE 3 Further details regarding the siting of mobile and tower cranes are given in CIRIA publication C703 [[14](#)] which might also provide information on other types of cranes, and further details regarding the siting of loader cranes are given by ALLMI [[15](#)].

NOTE 4 Further information on the siting of cranes on or adjacent to sites of exceptional hazards is provided in [BS 7121-1:2016](#), Annex E.

8.1.2 For self-erecting tower cranes, the recommendations in [8.4.10](#) and [18.14](#) should be followed.

NOTE A self-erecting tower crane is generally operated by remote control, which allows the operator to follow the load and potentially keep it in sight from the point of pick-up to point of delivery. There are, however, a number of disadvantages to this which are highlighted in [7.2](#).

8.2 Crane standing and support conditions

8.2.1 General

- 8.2.1.1** The appointed person should ensure that loads imposed by the cranes (including tower crane base and tie loads) involved can be sustained by the ground or any means of support. This should include any mobile cranes used for erection, alteration and dismantling.

NOTE 1 Guidance on the assessment of ground conditions is given in CIRIA publication C703 [14] and the SFfC publication *Ground Conditions for Construction Plant* [16].

NOTE 2 Ground assessment is normally carried out by, or on behalf of, the owner or occupier of the site.

- 8.2.1.2** Where the appointed person does not possess the necessary technical knowledge, experience or training to make this assessment, reference should be made to a suitably qualified competent person.

- 8.2.1.3** The loads imposed by the crane(s) involved should be obtained from the crane manufacturer or other authority on crane design and construction. The ground loadings should be obtained for the following conditions:

- a) in service;
- b) out of service; and
- c) during erection, alteration and dismantling of the crane.

- 8.2.1.4** The loadings should include the combined effects of the following:

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

- 8.2.1.5** All load conditions should be taken into account, i.e. in-service, out-of-service, erection, alteration and dismantling.

- 8.2.1.6** Account should be taken of the limited range of correction of the self-levelling function of any crawler-mounted cranes, and great care should be taken when travelling over uneven ground. Crawler-mounted cranes without self-levelling should not be moved over uneven ground when rigged, unless permitted by the manufacturer.

- 8.2.1.7** The manufacturer's provided corner loads are dynamic and vary between in-service and out-of-service load cases, so an allowance should be made for the worst-case combination during the design of the supporting structure.

8.3 Out-of-service wind speed

- 8.3.1** Region C and Region D out-of-service wind loads (see [Figure 3](#)) with a minimum recurrence factor of 25 years should be applied to all tower cranes regardless of age. The load cases specified in FEM 1.005 should also be applied.

COMMENTARY ON 8.3.1

Tower cranes produced since 2010 have been designed to BS EN 14439, which specifies that tower cranes are designed to take account of out-of-service wind speeds laid down in the FEM standard 1.005. FEM 1.005 allows the use of precise national wind maps and the UK wind map is shown in [Figure 3](#). Most tower cranes designed to BS EN 14439 are supplied with out-of-service wind loads to Region C with a recurrence interval of 25 years. Consequently, where tower cranes are to be erected in those parts of the UK falling into Region D, new build configurations and base/tie loadings have to be obtained from the crane manufacturer.

Effect of increased out-of-service wind speeds

Applying higher out-of-service wind speeds to a given height and configuration of tower crane increases the loads, both in the tower and on the base. This results in one or more of the following:

- a) reduction of the maximum free-standing height for a given tower specification;
- b) the need to use stronger tower sections to obtain the required height under hook (HuH);
- c) higher out-of-service base loads and moments;
- d) greater mass of base ballast;
- e) the need for larger bases for a given free-standing height; and
- f) increased size and number of crane ties, plus alternative tie collars.

The overall effect is that cranes operated in Region D (See [Figure 3](#)) require stronger tower sections and larger bases than identical cranes operating in Region C.

The maximum wind speeds in which a tower crane may be operated, erected or climbed are fixed values for each make and model of crane and are independent of geographical location.

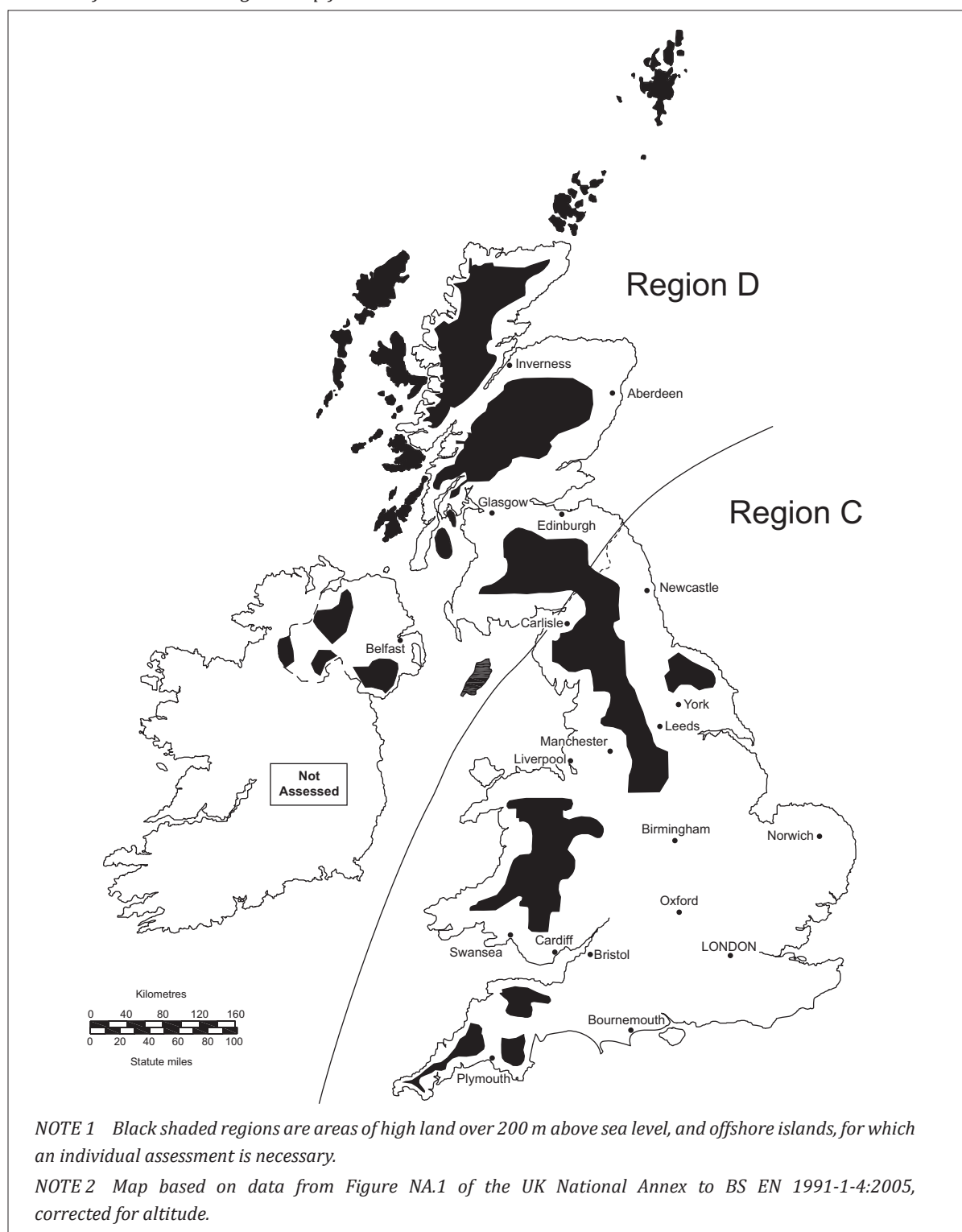
BS EN 1991-1-4, the UK National Annex and [Figure 3](#)

[Figure 3](#) considers the fundamental basic wind velocity, $v_{b,map}$, from the National Annex to BS EN 1991-1-4 and correcting the values obtained for height for those areas of the UK up to 200 m using an Ordnance Survey relief map. Comparison of the values obtained with the reference storm wind velocities for Regions C, D and E from FEM 1.004 has enabled the Region C/D dividing line to be plotted on a map of the UK. The Regions do not apply to the black shaded areas of higher ground and offshore islands. For these areas, an independent site-specific assessment is necessary.

Site-specific approach

FEM 1.005 specifies that the calculation of out-of-service wind loads to be carried out using the roughness factors for "flat open country" ($\alpha = 0.14$ and $\beta = 1$). Different roughness coefficients can be used as specified in Appendix 2 of FEM 1.004, in which case, wind force is calculated using the appropriate reference wind velocity for the region in which the crane is to be erected, applying appropriate roughness factors determined by a site-specific wind assessment. The site-specific assessment determines which of the three roughness locations, flat open country, suburban or urban, is appropriate for the site, taking account of such factors as the site location, presence of high buildings and the closeness of buildings.

The application of different roughness factors does not always result in lower foundation loads or an improved tower configuration as the governing factor might be the wind from the front or wind from the side load cases required by FEM 1.005. Before embarking on a site-specific wind survey, it might be worth asking the crane manufacturer which is the governing load case.

Figure 3 — UK out-of-service wind region map for tower cranes

- 8.3.2** Site-specific wind surveys should only be undertaken by a suitably qualified and experienced independent organization, in accordance with the UK National Annex to BS EN 1991-1-4:2005+A1:2010 or an applicable wind tunnel test report. The report should be submitted to the crane manufacturer and, on acceptance, revised loadings issued clearly stating the load considerations utilized to allow a crane to be erected at a reduced roughness factor.

8.4 Tower crane foundations

8.4.1 General

- 8.4.1.1** The base loads used for foundation design should be based on the highest of the manufacturer's stated loads, which can be during erection, in service or out of service, using the wind region appropriate to the crane's location, and should be not less than FEM 1.005 Wind zone C25.
- 8.4.1.2** The foundation should be designed by a competent engineer using the loads and moments specified by the crane manufacturer for the specific crane configuration.
- 8.4.1.3** Where the foundation design limits the free-standing height of the crane, the maximum permitted free-standing height should be marked at the base of the crane and entered into the documentation.

8.4.2 Rail tracks for tower cranes

- 8.4.2.1** Rail track should be designed and installed in accordance with the crane manufacturer's instructions, and should incorporate correctly positioned travel limit ramps and end stops. Particular attention should be paid to tolerances for line and level. If the rail track is to contain curves, the inner and outer rails should be formed to the correct radii and "curve going" bogies should be used, with the drive bogies located on the same rail.
- 8.4.2.2** Before a travelling tower crane is sent to site, the bogies and associated parts should be inspected and overhauled to ensure that they last for the duration of the crane's time on site.

NOTE Repairs to these components in situ are likely to be time-consuming and costly, and might require the crane to be dismantled.

- 8.4.2.3** The user (hirer) should ensure that the particular requirements for travelling tower cranes are taken into account in the planning of lifting operations, in particular:

- a) determining the need for rail clamps to secure the crane when out of service and their removal before putting the crane back in service;
- b) the need to monitor the track for movement, ensuring it remains within manufacturer's tolerances;
- c) establishing a procedure for ensuring that the crane is secured well before the maximum in-service wind speed is reached;
- d) ensuring that when rail clamps are being fitted, there is adequate communication between the crane operator and those applying the clamps;
- e) establishing a lower limiting wind speed for travelling, in consultation with the crane supplier;
- f) establishing from the crane manufacturer's instruction the conditions applying to travelling; and

NOTE Some manufacturers permit the use of other motions when travelling with a load, whilst others prohibit lifting, lowering, trolleying and slewing whilst travelling. Some manufacturers also require the jib to be in line with the track.

- g) establishing a procedure for travelling to ensure that a slinger-signaller always walks with the travelling crane base to ensure that the track is free of obstructions and act as the crane operator's "eyes and ears".

- 8.4.2.4** During operation, the operating procedures set out in the manufacturer's manual should be followed.

- 8.4.2.5** Inspection, maintenance and thorough examination should be conducted in accordance with [BS 7121-2-5](#), with particular attention to:
- a) the travel brakes on the chassis bogies;
 - b) the end stops on the rails;
 - c) wear on wheel flanges to avoid derailment; and
 - d) the increased wear on bogie components from low-height tower cranes erected in pre-cast yards or stockyards on civil engineering sites.
- 8.4.2.6** A suitable regime should be put in place to ensure that all materials supplied for rail track satisfy the designer's specification.
- 8.4.2.7** Base ballast weights should be adequately secured to prevent accidental displacement or removal, and the detail of the ballast should be given on the notice near the base of the crane giving the crane capacities.
- 8.4.2.8** The area between the tracks should not be used for the storage of materials. The total area of the rail track in use should be fenced off to prevent access by unauthorized persons.
- 8.4.2.9** Any point at which vehicles cross the rail track should be carefully controlled to prevent accidental collision, and precautions should be taken to ensure that the track is not overloaded by the vehicles crossing it.
- 8.4.2.10** The gauge of rail track should be maintained by suitable means, for example, tie bars.
- 8.4.2.11** Rail track should not be welded or subjected to heating, unless specified by a specialist manufacturer/supplier.
- 8.4.2.12** End stops or buffers should be positively fixed (bolted or pinned) to the rail and precisely adjusted to ensure that the crane makes contact with both sides simultaneously. These end stops should be shock-absorbing or sprung, and should be moved hard against the crane chassis if the machine is to be used in a static position for any period of time. Rail stops should not be taken into account when calculating the stability of the machine.
- 8.4.2.13** Where two or more tower cranes run on the same track, physical stops should be provided to segregate the track and prevent adjacent crane structures or loads colliding.
- 8.4.2.14** Any rail clamps provided by the crane manufacturer to prevent the crane from rolling along the track in storm conditions should be fitted whenever the machine is out of service. If such clamps are not supplied, adequate means should be adopted to achieve the same result.
- 8.4.2.15** Rail track of all types should be periodically inspected, and if any defect or out-of-level is identified, corrective action should be taken immediately.
- 8.4.2.16** Attention should be paid to the design and layout of the power supply (trailing cable) for any travelling tower crane to ensure that it is protected from damage.

8.4.2.17 The rail track should be adequately earthed (see [9.11](#) and [18.5](#)) and should be segregated from pedestrians and vehicles by the use of appropriate barriers.

8.4.2.18 An audible travel alarm should be fitted (see [9.14](#)).

8.4.3 Cast-in base (see [A.3](#))

8.4.3.1 The foundation anchors or expendable tower section should be installed within the manufacturer's tolerance of accuracy to ensure that the erected crane is within operational limits.

8.4.3.2 This concrete foundation block should have sufficient weight and base area to resist the moments and forces imposed by the crane. These foundations should be designed by a competent engineer.

8.4.4 Cruciform base (see [A.3](#))

8.4.4.1 The supporting structure and any connections to the cruciform base should be designed by a competent engineer.

8.4.4.2 Where ballast blocks are used there should be a notice attached indicating the position and weight of the blocks, and that the blocks should be adequately secured to prevent accidental displacement. The ballast arrangement should not be altered after the crane has been tested for constructional or any other reasons.

8.4.5 Travelling base (see [A.3](#))

The design of a travelling base structure should be carried out by a competent engineer.

8.4.6 Grillage base (see [A.3](#))

The design of grillages and their connections to the supporting structure should be carried out by a competent engineer.

8.4.7 Non-crane base structure (see [A.3](#))

The design of a non-crane base structure should be carried out by a competent engineer.

8.4.8 Special base

Where the particular application calls for a special base arrangement, for example, structural steelwork, the appointed person should confirm that the base is:

- a) designed by a competent engineer, allowing for any appropriate factors (e.g. impact, dynamic), with the details of the design verified by a competent third party; and
- b) constructed in accordance with the design.

8.4.9 Ground conditions

NOTE Additional recommendations on ground conditions and foundations are given in CIRIA publication C703 [14].

8.4.9.1 Where a tower crane is to be erected close to the foundations of existing buildings or buildings to be constructed, the appointed person should ensure that the ground is consolidated as required by the designer of the crane base.

8.4.9.2 Where the ground has been disturbed in the construction of adjacent foundations, a retaining wall should be constructed or deeper foundations used for the tower crane.

8.4.10 Self-erecting tower crane

NOTE Self-erecting tower cranes derive their stability by the addition of counter-weight or base ballast in order to keep the legs of the crane in contact with the ground.

- 8.4.10.1** The amount of ballast used to stabilize a self-erecting tower should be as specified by the crane manufacturer. The crane manufacturer should also be consulted about the maximum point load imposed on any support point of the crane. This information, along with any declared shear or torsion values, should be given to a competent engineer in order for a suitable foundation to be designed.
- 8.4.10.2** Where the support point of a self-erecting tower crane is an adjustable steel bearing pad, plate or foot, these should be levelled to within the tolerance declared by the equipment manufacturer.
- 8.4.10.3** Horizontal loads should be resisted by a combination of the following three methods:
- a) the self-weight of the crane creating sufficient friction with the base concrete, in which case care should be taken to use the correct coefficient of friction, especially if one or two of the bearing points are very lightly loaded;
 - b) recessing the crane foot/support into the concrete cover zone; and
 - c) using a post-drilled anchor.

8.5 Proximity hazards

8.5.1 General

8.5.1.1 Account should be taken of proximity hazards, such as the following:

- a) overhead electric lines or cables;
- b) nearby structures;
- c) telecommunications masts and sources of electromagnetic radiation;
- d) airports, aerodromes and heliports;
- e) underground services, voids and structures, such as gas mains or electric cables;
- f) other cranes and plant/structures;
- g) other vehicles or ships being loaded or unloaded;
- h) stacked goods;
- i) public access areas, including highways, railways and rivers; and
- j) chemical plant and nuclear installations.

8.5.1.2 Suitable measures, such as the following, should be implemented to address each of the hazards identified.

- a) Where any part of the crane or 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) Where a crane or load passes an obstacle, the following steps should be taken.
 - 1) Where practicable, the crane path of a self-erecting crane should be clearly defined by marking to ensure that it is kept free from obstruction, and:
 - i) a minimum clearance of not less than 600 mm should be maintained between any part of the crane and any obstacle, taking into account any anticipated deflection; or
 - ii) 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) 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 elevated working platforms (MEWPs) or concrete booms], the crane coordinator should plan the sequence of crane movements to prevent collisions. The operators should obtain the agreement of the crane coordinator before carrying out any lifting operation. An anti-collision and/or radius-restriction system should be fitted, ensuring that this is operational, where the crane coordinator determines that this is necessary (see [9.9.5](#)).
 - 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 [BS 7121-1:2016, 14.2.6](#)).

8.5.1.3 Where tower cranes inter-arc, a distance should be maintained between any parts of the cranes' structures, rigging and hook blocks. This distance should be either:

- a) a minimum clearance of 3 m; or
- b) a minimum clearance of 600 mm, plus the manufacturer's deflections, where full details are available from the manufacturer, unless adequate measures are put in place to prevent entrapment.

8.5.1.4 For horizontal jibs [A-frame and flat-top types (see [Annex A](#))], a suitable allowance should be made for deflection when calculating the clearance between adjacent cranes.

8.5.2 Overhead electric lines and cables

Where a tower crane is to be located in proximity to overhead power lines and cables, the operator of the power lines should be consulted.

NOTE General advice on minimum safe distances from overhead cables is given in HSE Guidance Note GS6 [\[17\]](#) and ACOP L113 Safe use of lifting equipment [\[18\]](#).

8.5.3 Crane control in the vicinity of aerodromes/airfields

COMMENTARY ON 8.5.3

Restrictions can be placed on the overall height of the crane and there can 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 [\[19\]](#).

The Air Navigation Order 2000 [\[20\]](#) makes it an offence to act recklessly or negligently in a manner likely to endanger aircraft.

8.5.3.1 The hirer or principal/other contractor should, before erecting any tower crane:

- a) establish if the site is within 6 km of an aerodrome/airfield; and
- b) if the site is within 6 km of an aerodrome/airfield, determine if the highest part of the crane, when erected, exceeds 10 m or if it is higher than surrounding structures or trees (this is likely to be the case with a tower crane); and
- c) if the crane exceeds 10 m or the height of surrounding structures or trees, not less than 28 days before the crane is to be erected, inform the manager of the aerodrome/airfield of the intention to erect the crane and ask if there are to be any:
 - restrictions on the height of the crane;
 - restrictions on crane operating times;
 - crane operations depending on the runway(s) in use;
 - requirements for obstacle/aviation warning lights, including appropriate light intensity;
 - restrictions during poor visibility (fog or low cloud); or
 - other requirements.

The following information should be provided to the airfield manager:

- 1) the precise location of the equipment on an Ordnance Survey Grid, either a reference to at least six figures for Eastings and Northings or marked out on a map that shows the Ordnance Survey Grid;
- 2) the maximum operating height in metres above ordnance datum (AOD), or the height of crane above ground level (AGL) plus ground level in AOD;
NOTE Heights "above ordnance datum" are those shown on Ordnance Survey maps as "above mean sea level" (amsl).
- 3) the type of crane to be used, i.e. a tower crane;
- 4) the maximum radius of the jib;
- 5) the intended dates and times of operation;
- 6) the applicant's name and contact details; and
- 7) contact details for the crane when operating.

8.5.3.2 To determine whether a Notice to Airmen (NOTAM) is needed, a developer should contact the CAA's Airspace Utilisation Section (email: ausops@caa.co.uk / Tel: 0207 453 6599), giving accurately the location, maximum height (including any craneage) and completion date.

NOTE If the site is not within 6 km of an aerodrome, notification to the Civil Aviation Authority (CAA) is required if the highest part of a tower crane has a height of 91.4 m or more. Temporary structures, such as cranes, expected to be in situ for up to 90 days can be notified through a Notice to Airmen.

8.5.3.3 The user (contractor) of any crane that is expected to be on site for more than 90 days should provide details of the crane(s) to the Defence Geographic Centre (DGC), which maintains the UK's master database of tall structures (the Digital Vertical Obstruction File) (email: icgdgc-aero@mod.uk / Tel: 0208 818 2702).