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Part 2-1: Inspection, maintenance and thorough examination - General

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Introduction

Your comments on this draft are invited and will assist in the preparation of the resulting British Standard. If no comments are received to the contrary, this draft may be implemented unchanged as a British Standard.

Please note that this is a draft and not a typeset document. Editorial comments are welcome, but you are advised not to comment on detailed matters of typography and layout.

Submission of Comments

- The guidance given below is intended to ensure that all comments receive efficient and appropriate attention by the responsible BSI committee.

- This draft British Standard is available for review and comment online via the BSI British Standards Draft Review system (DRS) as **http://drafts.bsigroup.com.** Registration is free and takes less than a minute.

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BS 7121-2-1

Code of practice for the safe use of cranes

Part 2-1: Inspection, maintenance and thorough examination – General

Contents

Foreword

Publishing information

This sub-part of BS 7121-2 is published by BSI Standards Limited, under license from the British Standards Institution and came into effect on XX Month 200X. 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

Together with BS 7121-2-3, BS 7121-2-4, BS 7121-2-5, BS 7121-2-7 and BS 7121-2-9, this sub-part of BS 7121 supersedes BS 7121-2:2003, which will be withdrawn when all the sub-parts have been published.

Relationship with other publications

The BS 7121 series is being revised. The following new sub-parts of BS 7121-2 are currently in preparation:

- Part 2-1: *Inspection, maintenance and thorough examination – General;*
- Part 2-3: *Inspection, maintenance and thorough examination – Mobile cranes;*
- Part 2-4: *Inspection, maintenance and thorough examination – Loader cranes;*
- Part 2-5: *Inspection, maintenance and thorough examination – Tower cranes;*
- Part 2-7: *Inspection, maintenance and thorough examination – Overhead travelling cranes including portal and semi-portal cranes;*
- Part 2-9: *Inspection, maintenance and thorough examination – Cargo handling and container cranes.*

When all sub-parts of BS 7121-2 have been published, CP 3010 will be withdrawn and BS 5744 will be revised to cover manually operated and light cranes only.

This sub-part of BS 7121-2 is intended to be read in conjunction with the appropriate sub-part(s) of BS 7121-2 dealing with the relevant crane type(s).

Information about this document

The Health and Safety Executive (HSE) commends the use of this British Standard to those who have duties under the Health and Safety at Work etc. Act 1974 [1]. This standard was drawn up with the participation of HSE representatives and it will be referred to in the relevant HSE publications.

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

Hazard warnings

WARNING. This British Standard calls for the use of procedures that can be injurious to health if adequate precautions are not taken. It refers only to technical suitability and does not absolve the user from legal obligations relating to health and safety at any stage.

Use of this document

As a code of practice, this sub-part of BS 7121-2 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 sub-part of BS 7121-2 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.

Particular attention is drawn to the following specific regulations:

- Health and Safety at Work etc. Act 1974 [1].
- Lifting Operations and Lifting Equipment Regulations (LOLER) 1998 [2].
- Provision and Use of Work Equipment Regulations (PUWER) 1998 [3].
- Supply of Machinery (Safety) Regulations 2008 (as amended) [4].
- Merchant Shipping Act 1995 [5].
- Road Vehicles (Construction and Use) Regulations 1986 (as amended) [6].

NOTE 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 *[7] and* Safe use of work equipment *[8].*

1 Scope

This sub-part of BS 7121-2 gives general recommendations for the pre-use checks, in-service inspection, maintenance, thorough examination (following installation, in service and following exceptional circumstances) and supplementary testing of cranes and associated equipment, including gantries, runways and other supporting structures.

This sub-part of BS 7121-2 is also applicable to hoists, derricks, telehandlers, fork lift trucks and excavators when used to lift suspended loads. For the purposes of this standard all these are included under the term “cranes”.

It is not applicable to construction hoists, mast climbing work platforms, mobile elevating work platforms, jacks and suspended access equipment.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensible 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.

BS 7121-1:2006, *Code of practice for safe use of cranes – General*

BS 7262, *Specification of automatic safe load indicators*

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

BS ISO 4309:2010, *Cranes – Wire ropes – Care and maintenance, inspection and discard*

3 Terms and definitions

For the purposes of this sub-part of BS 7121-2, the following terms and definitions apply.

3.1 competent person
person who has such practical and theoretical knowledge and experience of the lifting equipment to be thoroughly examined which enables them to detect defects or weaknesses and to assess and report on their importance in relation to the safety and use of the lifting equipment

*NOTE The competent person may be a member of the organization’s staff. See **5.3**.*

3.2 continuing professional development (CPD)
conscious updating of technical knowledge and the improvement of skills throughout a person’s working life

3.3 crane
lifting machine for suspended loads

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

3.5 inspection body
employer of the competent person(s) who provide examination and testing services

NOTE BS EN ISO/IEC 17020 gives definitions of different types of inspection body.

3.6 lifting
movement of loads or persons necessitating, at a given moment, a change of level

3.7 load radius indicator
device fitted to a crane that shows the radius at which the crane is operating and its corresponding rated capacity

3.8 radius
horizontal distance between the point at which the centre of rotation of the crane meets the ground and the vertical centreline passing through the load lifting attachment

NOTE In the case of a non-slewing crane, 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.

3.9 rated capacity
maximum load that can be safely handled by a crane in a specified configuration and under specified conditions

NOTE The rated capacity is also known as "safe working load" or "working load limit".

3.10 rated capacity indicator (RCI)
device that gives a warning when the crane is approaching its rated capacity

NOTE This was previously known as an "automatic safe load indicator".

3.11 rated capacity limiter (RCL)
device that prevents the crane from being overloaded

NOTE This was previously known as an "overload protector".

3.12 testing

3.12.1 functional testing
operation of each motion of the crane without a load

3.12.2 performance testing
operation of each motion of the crane with a load equal to or less than the rated capacity

3.12.3 overload testing
operation of the crane with a load exceeding the rated capacity

3.12.4 non-destructive testing NDT
application of measurement techniques to parts of the crane to check for the presence, location and extent of any defects that could affect the integrity of the crane

NOTE The techniques employed for non-destructive testing are such that they do not damage or alter the material under test. NDT is also known as non-destructive examination (NDE).

3.13 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 take into use or 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 regime.

3.14 user
person or organization that has control of the crane and the lifting operation

4 General

Regular pre-use checking, in-service inspection, maintenance and thorough examination of cranes are essential if cranes are to function safely and reliably. The nature of these activities can be summarized as follows.

- Pre-use checks are visual checks which are carried out to ensure that the crane has not suffered any damage or failure, and is safe to use.
- In-service inspections and maintenance are carried out to ensure that components are repaired or replaced before they deteriorate to a point at which they would become unsafe.
- Thorough examinations are carried out at specified intervals, after installation on a new site, after major alteration or repair or after the occurrence of exceptional circumstances which could jeopardize the safety of the crane.
- Supplementary testing is carried out in support of thorough examination and the extent and nature of any testing are specified by the competent person carrying out the thorough examination.

5 Personnel carrying out pre-use checks, in-service inspections, maintenance and thorough examinations

5.1 Personnel carrying out pre-use checks

It is essential that the pre-use checks of cranes are always carried out by personnel who have been assessed by their employer as competent. This competence should be achieved through a training and assessment scheme consisting of the following:

- initial training and assessment of competence;
- periodic reassessment of that competence.

Crane operators may perform pre-use checks provided that they meet these criteria.

5.2 Personnel carrying out in-service inspections and maintenance

5.2.1 General

It is essential that the in-service inspection and maintenance of cranes is always carried out by personnel who have been assessed by their employer as competent and have adequate training and information to carry out the work required.

NOTE Attention is drawn to the Provision and Use of Work Equipment Regulations 1998 [3] which require maintenance work only to be done by those who are competent to do the work.

5.2.2 Attributes

Maintenance personnel and those carrying out in-service inspections should:

- be physically fit for the tasks they are to undertake
- have adequate eyesight (with correction if needed);
- be comfortable working at height (if required);
- have a responsible attitude;
- be able to communicate clearly with other personnel in the location where maintenance or inspection is taking place;
- be able to demonstrate adequate literacy and numeracy;
- be aware of their own limitations in knowledge and experience.

5.2.3 Competencies

Maintenance personnel and those carrying out in-service inspections should be:

- fully conversant with the machinery they are required to maintain and its hazards, including operation necessary for maintenance activities;
- properly instructed and trained. Where special machinery is involved this should include attending appropriate courses given by the manufacturer/supplier of the equipment;
- familiar with the procedures and precautions required for safe work at height (where required);
- fully conversant with the appropriate sections of the manufacturer's instruction manual;
- familiar with the use of permit to work systems where they are required by the safe system of work, and able to operate them correctly;
- familiar with site specific safety requirements (e.g. manufacturing, construction, process plant, nuclear, docks, airports, railways);
- trained and competent in the selection, pre-use inspection and correct use of their personal protective equipment.

5.2.4 Competency assessment and training

5.2.4.1 Basic skills

All crane maintenance personnel and those carrying out in-service inspections should be trained in a set of basic skills to enable them to work safely and participate effectively in the maintenance and inspection processes. They should not be required to undertake tasks for which they have not been trained and assessed as competent to carry out. These basic skills should include the following.

- understanding basic health and safety requirements, including the risk assessment process, together with need for location/site specific safety;
- slinging and signalling;
- tool skills, including the selection and use of tools;
- identification, selection and fitting of fasteners (including threaded fasteners);
- selection, use, inspection and maintenance of fall protection equipment for working at height (if required);
- interpretation of technical information, use of manuals;
- basic assessment of weather and ground conditions;
- generic skills in maintaining cranes within a safe system of work;
- product familiarity, including installation, rigging and other relevant operational aspects, on all makes and models of crane on which maintenance and/or inspection is being carried out;
- preparing equipment for use (isolation of power sources etc);
- effective communication (including the use of radio equipment);
- carrying out basic adjustments to the crane;
- identifying and rectifying basic faults in the crane;
- functional testing;
- identifying proximity hazards.

5.2.4.2 Additional skills

The basic skills should be augmented by the following as required:

- wire rope inspection and termination;
- chain inspection and termination;
- webbing inspection and termination;
- use of specialist tools and equipment appropriate to the work being carried out (including torque wrenches, multipliers and hydraulic tensioning equipment);
- checking and setting of safety devices, including RCIs and RCLs;
- downloading data from data acquisition systems;
- carrying out complex adjustments;
- electrical testing;
- identifying and rectifying electrical faults;
- identifying and rectifying complex faults in equipment (including pneumatic and hydraulic equipment);
- welding and repair techniques.

5.2.4.3 Training plans

An individual training plan should be drawn up for each person carrying out maintenance and/or in-service inspection on cranes. This plan should take into account previous experience, qualifications and underpinning knowledge. Persons undergoing training should be closely supervised, where appropriate.

Achievement of this plan, and continuing professional development (see **5.2.5**), should be monitored at frequent intervals and included in any quality system (e.g. BS EN ISO 9001) auditing process.

It is important that all maintenance personnel are regularly assessed to ensure that they can carry out their duties safely and effectively. An assessment should be undertaken of all maintenance personnel and those carrying out in-service inspections on appointment and at regular intervals thereafter. Assessment should form part of any training.

5.2.4.4 Training records

A comprehensive individual training record should be established for all maintenance personnel and those carrying out in-service inspections. This should be updated as training is undertaken and as a minimum should include:

- when the training took place;
- where the training took place;
- the scope of the training;
- the duration of the training;
- who delivered the training;
- the result of any assessment;
- when refresher training is required.

5.2.5 Continuing professional development

Continuing professional development (CPD) is a joint responsibility between the maintenance person or the person carrying out in-service inspections and their employer.

The employer should maintain a CPD record for each maintenance person and each person carrying out in-service inspections. The record should include details of how CPD is being achieved and should include for example:

- specific training towards enhancements/additions to skills
- familiarization/re-familiarization, and ongoing training and mentoring;
- training on changes in legislation and working practices;
- updating of product knowledge;
- attendance at seminars and refresher training courses.

5.3 Personnel carrying out thorough examination

5.3.1 General

LOLER 1998 [2] require that through examination is carried out by “competent persons”.

It is essential that such persons have adequate training, information and independence to carry out the work required.

5.3.2 Attributes

Competent persons should:

- be physically fit for the tasks they are to undertake;
- have adequate eyesight (with correction if needed);
- be comfortable working at height (if required);
- have a responsible attitude;
- be able to communicate clearly with other personnel in the location where thorough examination is taking place;
- be able to demonstrate adequate literacy and numeracy;
- be aware of their own limitations in knowledge and experience.

5.3.3 Competencies

Competent persons should be:

- fully conversant with the machinery they are required to examine and its hazards, including operation necessary for thorough examination activities;
- properly instructed and trained;
- familiar with the procedures and precautions required for safe work at height (where required);
- fully conversant with the appropriate sections of the manufacturer’s instruction manual;
- familiar with the use of permit to work systems where they are required by the safe system of work, and able to operate them correctly;
- familiar with site specific safety requirements (e.g. manufacturing, construction, process plant, nuclear, docks, airports, railways);
- trained and competent in the selection, pre-use inspection and correct use of their personal protective equipment.

5.3.4 Knowledge base

NOTE Attention is drawn to LOLER 1998 [2] which set out the legislative requirements for thorough examination.

Competent persons should have:

- an understanding of the applicable crane design standards and codes of practice for the selection and use of the relevant cranes, together with the applicable examination criteria;
- an understanding of the safety rules and associated codes of practice that are applicable to the relevant cranes;
- an understanding of the inspection and maintenance requirements of cranes;
- knowledge of appropriate test procedures which may be employed and the interpretation and limitations of those techniques;
- an understanding of drawings and manufacturing literature relevant to the cranes to be examined;
- knowledge of the materials and techniques used in the manufacture and assembly of the type of cranes to be examined.

5.3.5 Practical skills

Competent persons should:

- be capable of detecting defects or weaknesses in cranes which could compromise the safety of the crane;
- have sufficient knowledge and experience to assess the importance of defects or weaknesses in the crane and identify what actions need to be taken in order to rectify them. In particular they should be able to:
    - determine whether the crane is operating as intended;
    - specify the appropriate time-scales within which identified defects or weaknesses need to be rectified;
    - determine whether defects identified in the previous report of thorough examination have received attention;
    - determine whether all safety devices are functioning correctly;
    - check whether warning notices are correctly fixed and legible, and where necessary specify any limitations on the use of the crane;
    - witness any testing required as part of the thorough examination and evaluate the results;
    - report on the findings of the thorough examination.

5.3.6 Qualifications and experience

Competent persons should have the necessary attributes, competencies, knowledge and experience to enable them to carry out effective thorough examination of cranes. The nature and extent of these will depend on the complexity of the cranes to be examined and the consequences of failure of those cranes.

Employers should determine through a formally documented assessment process the competence of each individual person, both existing employees and new entrants, based on the attributes, competencies, knowledge and skills listed in **5.3.2** to **5.3.5**. A shortfall in attainment level does not necessarily preclude employment in this role but it is essential that

such shortfalls are addressed before the person is allowed to carry out unsupervised thorough examinations of cranes.

5.3.7 Training plan

An individual training plan should be drawn up for each person who is to carry out the thorough examination of cranes. Achievement of this plan and continuing professional development should be monitored at frequent intervals and included in any quality system (e.g. BS EN ISO 9001) auditing process.

5.3.8 Technical product information

Before carrying out the thorough examination of a specific make and model of crane the competent person should be provided with access to all relevant product specific technical information. This may be supplemented by information provided at briefing or training sessions delivered by the crane manufacturer or the employer. It is recommended that in-house training is carried out by a trainer who has received model specific technical training directly from the manufacturer.

5.3.9 Assessment intervals

All competent persons should be assessed on appointment, again within their first 12 months, and at regular intervals (not exceeding 4 years) thereafter. Assessment should form part of any training.

5.3.10 Training records

A comprehensive individual training record should be established for all personnel carrying out thorough examinations. This should be updated as training is undertaken and as a minimum should include:

- when the training, refresher training, assessment or reassessment took place;
- where the training took place;
- the scope of the training including types and models of crane;
- the duration of the training;
- the outcome of the training;
- who delivered the training;
- when refresher training is required.

5.3.11 Continuing professional development

Continuing professional development is a joint responsibility between the competent person and their employer.

The employer should maintain a CPD record for each competent person. The record should include details of how CPD is being achieved and should include for example:

- specific training towards enhancements/additions to competency;
- familiarization/re-familiarization, ongoing training and mentoring;
- any alterations and/or withdrawals of competency;
- enhancements to qualifications;
- membership of professional bodies/institutions;
- attendance at seminars and refresher training courses;
- visits to manufacturers and trade shows.

6 Pre-use checks and in-service inspections

6.1 General

Pre-use checks and in-service inspection of cranes, together with a system to rectify any defects disclosed, are required by the Health and Safety at Work etc Act 1974 [1] (Section 2 (2)(a)); PUWER 1998 [3] (Regulation 6) and LOLER 1998 [2] (Regulation 9 (3)(b)) to ensure that the crane is safe to use and that any deterioration is detected and rectified before the crane becomes unsafe.

Pre-use checks and in-service inspections should only be carried out by personnel who have been adequately trained and assessed as competent to carry out the required tasks (see Clause **5**). LOLER 1998 [2] requires that results of all in-service inspections are recorded in writing. It is recommended that the results of all pre-use checks are also recorded in writing.

The crane user should ensure that sufficient time is allowed for pre-use checks to be carried before the crane starts work. The user should also ensure that a safe system of work is in place to prevent the person who is carrying out the checks/inspections from being exposed to danger.

6.2 Pre-use checking and in-service inspection intervals

Pre-use checks should be carried out at the start of each shift during which the crane is to be used. In-service inspections should be carried out at intervals which ensure that any deterioration is identified before there is a risk of failure of the crane or injury to persons. Further guidance is given in HSE document L113 [7].

6.3 Reporting of defects

All defects identified during pre-use checks and in service inspections should be recorded and notified to the user. LOLER 1998 [2] requires that defects identified by in-service inspections which are, or could become, a danger to persons are notified to the employer (user) forthwith.

6.4 Use of checklists and clearance of defects

Checklists are extremely useful when carrying out in-service inspections, both as a reminder of the items to be checked and as a means of recording the results of the inspection.

Examples of checklists are included in the sub-parts of BS 7121-2 covering specific crane types.

Defects identified during checks and inspections should be classified as follows and rectified before they can affect the safety of persons:

- defects affecting the safety of persons that need to be remedied immediately;
- defects that need to be remedied prior to the next scheduled maintenance activity;
- defects that need to be remedied at the next scheduled maintenance activity.

The rectification of all defects identified should be recorded as evidence that the work has been carried out.

A system should be put in place to ensure that a crane cannot be used if safety-critical defects have not been rectified.

6.5 Record of in-service inspection

After every in-service inspection a record should be prepared and kept by those responsible for the crane and a copy should be sent to the owner of the crane from whom it has been leased or hired, if applicable. The record of inspection should include at least the following information:

- date and location of the inspection;
- name of person carrying out the inspection;
- description and unique identification number of the equipment inspected;
- results of the inspection.

7 Maintenance

7.1 Maintenance system elements

The maintenance of work equipment is a fundamental requirement of the Provision and Use of Work Equipment Regulations (PUWER) 1998 [3]. Regulation 5 of PUWER 1998 [3] requires employers to ensure that cranes are maintained in an efficient state, in efficient working order and in good repair.

Inspection during maintenance is an essential part of an effective maintenance system. These inspections are generally carried out by maintenance personnel and are in addition to the in-service inspections detailed in Clause **6**.

Many people have a part to play in the maintenance process from the crane operator carrying out daily and weekly checks, through the user reporting defects to the crane owner, to the maintenance personnel. To ensure adequate maintenance, an effective maintenance management system should be established which should include the following:

- a statement of maintenance policy [e.g. time based planned preventive maintenance, backed up by breakdown repairs and supplemented by, or combined with, condition based planned preventive maintenance (predictive maintenance)];
- definition of roles and responsibilities of persons involved in the maintenance activities;
- systems for the delivery of training and assessment of individual competencies;
- a maintenance plan/schedule;
- written maintenance procedures;
- maintenance records;
- a review and audit plan to ensure that the maintenance is suitable and sufficient.

NOTE Thorough examination is not part of maintenance and should never be viewed as a substitute for good maintenance.

7.2 Types of maintenance management

7.2.1 General

There are three main types of maintenance management that may be applied to the maintenance of cranes. Condition monitoring based planned preventive maintenance (predictive maintenance)(see **7.2.2**), time based planned preventive maintenance (see **7.2.3**) and breakdown maintenance (see **7.2.4**). Not all of these are appropriate for the effective maintenance of all types of crane (see **7.3**).

7.2.2 Planned preventive maintenance – condition monitoring based (predictive maintenance)

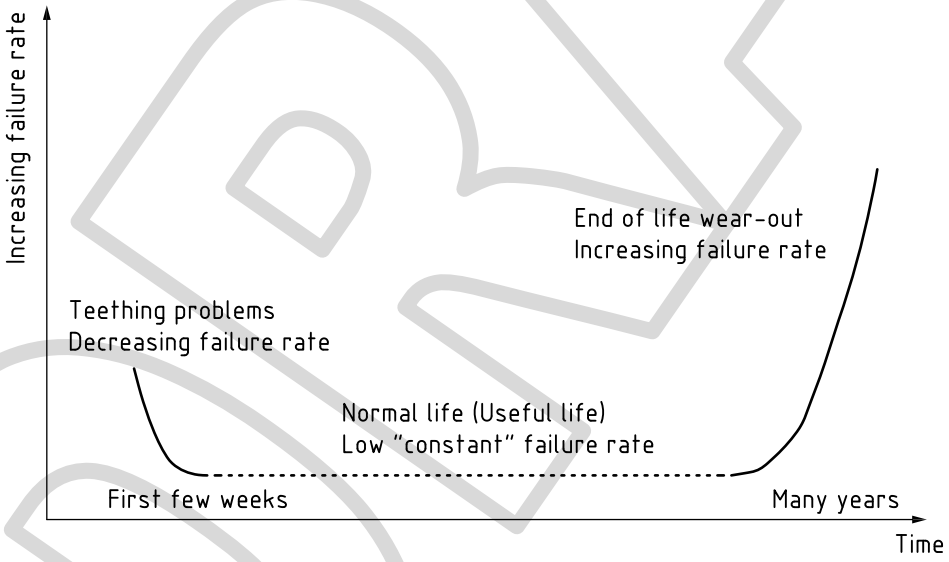
Predictive maintenance is a condition-driven preventive maintenance approach which, instead of relying on industry average life statistics (i.e. mean time to failure for cranes of that type) to determine maintenance intervals, uses direct monitoring of the crane. This may include mechanical and electrical condition, environmental factors and other indicators such as frequency of use and load spectrum. These are used to predict the actual time to failure for the individual crane and achieve the best balance between low maintenance costs and unplanned failures.

7.2.3 Planned preventive maintenance – time based

With time based planned preventive maintenance systems, maintenance tasks are carried out at intervals that are based on actual hours of operation or on an interval of time that equates to an average number of operating hours or number of operational cycles. The maintenance interval is based on experience of breakdowns or changes in the failure rate with time. A plot of failure rate against time gives what is known as a bathtub curve, as illustrated in Figure 1. Newly purchased cranes have a relatively high failure rate due to teething problems in the first few weeks of operation. Following this initial period, the failure rate is relatively low for an extended period, until wear and deterioration cause the failure rate to increase sharply with elapsed time.

The problem with this approach is that cranes wear at different rates over time depending on variety of factors such as environment, frequency of use and load spectrum. If maintenance intervals are too great the crane might break down anyway and if they are too short maintenance costs might be unnecessarily high. Inappropriate or poor maintenance can also cause breakdowns.

Figure 1 – The bathtub curve



7.2.4 Breakdown maintenance management

Breakdown or "run-to-failure" maintenance management has a simple and straightforward logic. "If it ain't broke, don't fix it" is often seen as a way of limiting expenditure on maintenance and keeping costs low. The problem with this approach for cranes is that any failure could present an immediate and unacceptable risk to persons. Additionally, repair costs might be very high when the crane does break down, often at the most inconvenient moment, with considerable downtime whilst repairs are carried out.

7.3 Best practice maintenance regime for cranes

The appropriate inspection and maintenance regime will depend on the type of crane, the environment in which it is operating, operating duty and the consequence of failure. Further details are given in the sub-parts of BS 7121-2 dealing with particular crane types. While breakdown maintenance might sometimes be necessary to fix unexpected breakdowns, a breakdown maintenance management system (see **7.2.4**) should never be adopted for cranes.

7.4 Investigation of excessive wear or failure

Where inspection and maintenance activities identify excessive, unexpected or unusual wear, or failure of crane components, it is essential that this is fully investigated, a solution sought, and the process fully documented. This might require an engineering assessment and might need to involve the manufacturer.

7.5 Review and auditing of inspection and maintenance systems

Once an inspection and maintenance system has been established, it should be regularly reviewed to ensure that the system's objectives are being achieved, and audited to ensure that the system is being adhered to, and that it is functioning correctly.

If a business has a formal quality management system, such as a BS EN ISO 9001 accredited system, the inspection and maintenance activity should be integrated into both that system and the scheduled audits.

7.6 Crane users responsibilities for maintenance

The Health and Safety at Work etc. Act 1974 [1] sets out a general duty requiring that work equipment is maintained so that it is safe. This requirement is reinforced by Regulation 5 of the Provision and Use of Work Equipment Regulations (PUWER) 1998 [3] which requires that "Every employer shall ensure that work equipment is maintained in an efficient state, in efficient working order and in good repair." In the case of a hired-in crane the actual undertaking of the inspection and maintenance is often delegated to the crane owner by the user. The user however, remains legally responsible for ensuring that the maintenance, including the rectification of defects, is carried out. This point is of particular importance where cranes are on long term hire on a site.

7.7 Inspection and maintenance intervals for time based systems

The frequency at which inspection and maintenance for a time based system (see **7.2.3**) is carried out should be based on the recommendations contained in the manufacturer's manual for the crane. This should however generally be taken as the maximum interval, as various factors, including the following, might require the interval to be reduced.

- *Usage* – Double shifting, frequent lifting at or near the rated capacity, high cycling, long hoist ropes and excessive slewing, which might accelerate wear of all components.
- *Road use* – Excessive travel on the highway or on site.
- *Environment* – Corrosive environments, such as marine or industrial sites, which might accelerate corrosion of electrical connectors and components, drive train, structural components, fasteners and wire ropes.

- *Feedback* – Feedback from maintenance records, condition monitoring and thorough examination reports which might indicate accelerated rates of wear and deterioration.

Once established, the inspection and maintenance interval should be recorded in the machine history file. It is essential that any variation from the manufacturer's recommended intervals is recorded and justified each time a change is made.

NOTE The manufacturer's recommended service interval may be extended in certain circumstances where predictive maintenance techniques are used.

7.8 Information for inspection and maintenance

7.8.1 General

The wide variation of designs and the increasing complexity of crane technology make it essential that all maintenance personnel are supplied with adequate information to enable them to carry out their duties effectively and safely. Inspection and maintenance information comes in various forms and from several sources.

It is essential that crane owners ensure that a robust system is in place to provide adequate up-to-date information to maintenance personnel. This may be achieved in a number of ways including:

- provision of paper manuals using a system which ensures frequent updating is taking place;
- provision of electronic manuals using a system which ensures frequent updating is taking place;
- a central technical information function which can be contacted for up-to-date information whenever inspection and maintenance is taking place.

It is essential that a system is in place to ensure that manual updates, safety alerts and other information are communicated speedily to those who need to know.

7.8.2 Manufacturer's information for inspection and maintenance

Information supplied by the crane manufacturer should be used as the main source of instructions and specifications when carrying out inspection and maintenance. The primary document should be the manual for the specific crane model (and in some cases serial number), supplemented by technical information bulletins.

Care should be taken to ensure that the information is up to date and relevant to the crane on which inspection and maintenance is being carried out.

Manufacturer's manuals are not always complete and in the case where a particular task is not covered, the manufacturer should be contacted for information. It is essential that this is done before the task is undertaken. Manuals might not always contain an appropriate inspection and maintenance regime for older cranes, in which case the specific advice of the manufacturer should be sought.

When purchasing a second-hand crane care should be taken to ensure that any manuals supplied with the crane are appropriate for the specific model of crane.

Some crane manuals and other information are available to download from the manufacturer's web site.

If the crane manufacturer is no longer in business, a competent engineer should be consulted.

7.8.3 In-house technical information

Some crane owners have their own technical information dealing with specific issues relating to the cranes in their fleet. This can be a useful source of information for maintenance personnel but care should be taken to ensure that information is current and obsolete data have been withdrawn.

7.8.4 Method statements and work instructions

Much inspection and maintenance work on cranes is of a routine nature and can be covered by generic risk assessments, method statements and work instructions. On occasions however, unusual and potentially hazardous tasks have to be undertaken. Such tasks should be planned thoroughly and a job specific safe system of work (risk assessment, method statement and briefing) put in place. This planning should include consideration of falling object hazards (hand tools, components etc.).

This system of work should be described in a brief, focused job specific method statement on which all members of the maintenance team undertaking the task should be fully briefed. This briefing, which should be recorded, should concentrate on the task to be undertaken and highlight any unusual features of the job.

7.8.5 Generic information

Maintenance personnel might also need to refer to generic information such as other standards and industry guidance. For example, for wire ropes BS ISO 4309 and wire rope manufacturers' literature should be consulted.

Care should be taken to ensure that the information is up to date.

7.8.6 Machine history

The history of the repairs and maintenance carried out on a crane is often very helpful when trying to diagnose faults and repeated failures. Maintenance personnel should be advised to contact their manager or supervisor to request relevant machine history details when appropriate.

7.8.7 Information formats

Paper information such as manuals and bulletins is rapidly being replaced by electronic formats such as CD-ROM and website downloads. This has the advantage that physical storage space is kept to a minimum and, in the case of website downloads, information can be expected to be up to date at the point of access. However the use of electronic display devices, such as laptop computers, during inspection and maintenance is not always easy or practical. Information might therefore have to be printed out for use on site, in which case care should be taken that for any subsequent use the data is still current and relevant.

7.8.8 Management of information

Information should be managed effectively if it is to be of maximum benefit to those involved in the maintenance process. Outdated information can at best waste time and at worst can affect safety. It is therefore essential that organizations carrying out maintenance on cranes ensure that they have robust systems and procedures to ensure that maintenance personnel are supplied with adequate information that is both up to date and accurate. The crane manufacturer should be consulted to ensure that information is current.

7.9 Maintenance records

7.9.1 General

Comprehensive maintenance records are essential to the safe, efficient and economical operation of cranes. They provide a complete "cradle to grave" history of the individual crane giving the following benefits:

- evidence of adequate maintenance as part of the management system;
- establishing breakdown trends over time and providing information for the review of maintenance frequency;
- identification of component failure trends for feedback to the manufacturer;
- evidence of adequate maintenance for presentation to the enforcing authorities in the event of an incident;

- enabling the performance of the crane to be reviewed over time to inform future purchases.

7.9.2 Maintenance record format

Maintenance records can be kept in either paper or electronic format. Paper records are often easier to update as the input will often be in paper format, such as inspection reports or work sheets. Electronic records are however more secure against loss and damage, and the data is more readily analysed. There are many maintenance record software packages on the market but care should be taken when considering purchase to ensure that the system is flexible enough to accommodate possible future changes in types of input and output.

7.9.3 Machine history files

Each crane should have its own machine history file, in either paper or electronic format, in which all records of maintenance activities are kept by the crane owner. These should include the following (as applicable):

- EC Declaration of Conformity;
- special maintenance procedures;
- service reports and worksheets;
- breakdown reports and worksheets;
- daily and weekly inspection reports;
- records of component replacement;
- records of major overhaul;
- test reports;
- wire rope and hook test certificates;
- thorough examination reports;
- records of defect rectification;
- data logger records;
- records of supplementary tests;
- record of modifications and upgrades;
- safety alerts from manufacturers;
- records of extraordinary events (e.g. replacement or repair of significant load bearing components, severe overloading or wind loading);
- records of unusual applications.

Under the PUWER 1998 [3] (Regulation 5) where a crane is on site for an extended period the user is required to be able to demonstrate that the crane has been adequately maintained The user should ensure that they obtain sufficient evidence from the crane owner to be able to demonstrate this.

8 Thorough examinations

8.1 General

The thorough examination of cranes is required under LOLER 1998 [2] to ensure that a crane is safe to be taken into, or to continue in, use. It is in addition to any inspection carried out as a part of the maintenance regime.

Cranes frequently operate in high risk environments in close proximity to people. LOLER 1998 [2] require such factors to be taken into account by the competent person when determining the scope and nature of the thorough examination.

WARNING. A thorough examination does not include assessment of roadworthiness as required by the Road Traffic Act 1991 [9] and regulations made under it.

NOTE 1 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 regime. The competent person may require supplementary tests as part of thorough examination.

NOTE 2 The legal requirements covering thorough examination are set out in HSE publication L113 Safe use of lifting equipment. Lifting Operations and Lifting Equipment Regulations 1998. Approved code of practice and guidance [7]. *It is essential that anyone undertaking thorough examinations of cranes or the management of the thorough examination of cranes obtains and familiarizes themselves with this document.*

8.2 Selection of competent person

It is essential that the competent person undertaking the thorough examination of a crane has not been involved in the maintenance of the crane.

8.3 Types of thorough examination

There are five situations where thorough examination of a crane is required by LOLER 1998 [2], Regulation 9:

- before being put into use for the first time, LOLER Regulation 9(1);
- after installation in a new location or after reconfiguration, LOLER Regulation 9(2);
- periodically whilst in service, LOLER Regulation 9(3)(a)(i)&(ii);
- in accordance with an examination scheme, LOLER Regulation 9(3)(a)(iii);
- after exceptional circumstances have occurred, LOLER Regulation 9(3)(a)(iv).

8.4 Initial thorough examination

LOLER 1998 [2] requires that before being put into use for the first time a crane has to be thoroughly examined to ensure that it is safe to use. The only exception to this is if the crane is new and the owner has an EC Declaration of Conformity that was made not more than 12 months prior to the crane being used for the first time. In this case the Declaration of Conformity will cover the use of the crane for the first 6 month or 12 month period.

8.5 Thorough examination after installation in a new location, or after reconfiguration

LOLER 1998 [2] requires that after installation in a new location, or after reconfiguration, and before being taken into use, the crane has to be thoroughly examined to ensure that it has been installed correctly and is safe to operate.

8.6 Periodic thorough examination

LOLER 1998 [2] requires periodic thorough examinations of cranes, the maximum interval being 6 months for cranes that lift people and 12 months for cranes that lift goods only. As an

alternative to the maximum intervals of 6 months or 12 months for periodic thorough examination, LOLER 1998 [2] allows a competent person to draw up an "examination scheme" for an item of lifting equipment such as a crane (see **8.9**).

8.7 Thorough examination interval

The statutory maximum intervals of 6 months and 12 months may be reduced to take into account environmental factors or the general age and condition of the crane etc. The decision to reduce the interval between thorough examinations may be made by the competent person, the crane owner or the crane user.

Reasons for reduction of the interval between thorough examinations include the following:

- if the crane frequently works above or near people, both personnel on a site and members of the public outside the site;
- if the crane might be used for lifting of persons in exceptional circumstances, including rescue, even if it is not initially planned;
- to take into account the intensity of use of the crane and the environment in which it is used;
- following a review by the competent person of the in-service lift plan (risk assessment, method statement and schedule of lifts) to ascertain the likely load spectrum and frequency of use of the crane.

8.8 Thorough examination after exceptional circumstances

LOLER 1998 [2] requires that if the crane is subjected to exceptional circumstances it has to be removed from service and subjected to a thorough examination to determine whether it is safe to be returned to service. Exceptional circumstances include an overload, jib clash, use for particularly arduous duties, failure of a structural component or being subjected to weather in excess of design parameters.

8.9 Examination schemes

8.9.1 General

As an alternative to the maximum intervals of 6 months or 12 months for periodic thorough examination, LOLER 1998 [2] allows a competent person to draw up an "examination scheme" for an item of lifting equipment such as a crane. LOLER 1998 [2] requires this scheme to be based on a detailed analysis of the condition of the crane, the maintenance and previous thorough examination history, the environment in which it is to be used, the number of lifting operations to be carried out and the magnitude of the loads to be lifted. On the basis of this detailed analysis of the crane's condition and use the competent person is permitted to specify the intervals at which periodic thorough examinations are to be carried out. These intervals may be shorter or longer than the 6 month or 12 month intervals and have to reflect the anticipated rate of deterioration and likelihood and consequences of failure.

When drawing up the examination scheme, the competent person should take into account the age, loading, environmental and duty cycle history of the crane, and any examination intervals which have traditionally been accepted as appropriate for that or similar crane types.

The competent person should prepare an examination scheme, which might require the co-operation of the crane manufacturer and the crane owner.

NOTE For example the manufacturer might need to be requested to provide limiting criteria based on the crane design, number of load cycles, load spectrum, critical parts, and exceptional circumstances (such as shock loading).

LOLER 1998 [2] requires that where it is not possible to comply with any of the requirements of the examination scheme, the thorough examination has to revert to the specified periodic examinations method (see **8.6**).

8.9.2 Details of an examination scheme

An examination scheme should contain at least the following information:

a) the name and address of the crane owner;

b) the name, qualifications and address of the person drawing up the scheme and certifying that it is suitable and sufficient. If the competent person is not working on their own account, the name of their employing organization and their position in that organization;

c) the make, model and unique identification number of the crane;

d) references of any information used in drawing up the scheme. This might include the manufacturer's instructions, and/or specific information from the designer on the design life of the structure and mechanisms;

e) details of any data logging system fitted, including a listing of the parameters monitored and the means by which data retrieval, monitoring and storage is achieved;

f) details of the environment in which the crane is to be used during the period covered by the scheme;

g) identification of those parts of the crane requiring thorough examination and the probable modes of deterioration, for example wear and corrosion;

h) frequency of thorough examination for those parts of the crane identified. This frequency might be time based, or based on loading or duty cycle limits and might vary for different parts of the crane;

i) method of thorough examination of those parts of the crane identified as requiring thorough examination, which might include the degree of dismantling required, any preparation to be carried out by the user prior to the examination, NDT techniques, timed component renewal etc.

j) an indication of the resources required to carry out the thorough examination. This might include qualified personnel, workshop facilities, specialist NDT and metallurgical facilities;

k) any changes to crane condition, operational or environmental parameters that would require a review of the scheme by the competent person. These might include damage to the structure, change of use from general use to heavy duty work, or moving from an inland location to a marine environment;

l) the date of drawing up the scheme and the date on which the next routine review of the scheme is required.

The examination scheme should determine whether all mechanisms function correctly and are free from defects and whether the crane is safe for further use.

8.10 Scope of periodic thorough examination

The competent person carrying out a thorough examination should work to a defined scope of examination that has been drawn up specifically for crane they are required to examine. Different scopes might be required for individual cranes of the same type and model to reflect different thorough examination requirements resulting from differing service histories and past and intended future use.

The defined scope of examination should be drawn up in advance of the examination by a competent person and should identify those parts of the crane that should be thoroughly examined, together with required supplementary supporting reports and tests. The defined scope of examination should specify the intervals at which the crane (or individual parts thereof) should be thoroughly examined (within the statutory maximum periods specified by

LOLER 1998 [2] of 6 months and 12 months) and, where appropriate, intervals for specific supplementary supporting reports and tests. These intervals should reflect the anticipated rate of deterioration and the likelihood and potential consequences of failure.

*NOTE A non-exhaustive list of supplementary supporting reports and tests, and some details of these tests are given in Clause **10**.*

The defined scope of examination should be drawn up by a formally appointed competent person. The competent person may be employed by the user, owner or manufacturer of the crane by or some other independent party provided they have the necessary competence. This competent person could also carry out the thorough examinations, supplementary reports and tests of the crane. However, in practice it is likely that these will be undertaken by other competent persons who are suitably knowledgeable and trained. The defined scope of examination should detail who, or which organization, should undertake thorough examinations including any supporting supplementary reports and tests and the extent to which they should be witnessed.

The defined scope of examination should take account of the crane manufacturer's information (which may include a scope of examination), maintenance history of the crane, previous thorough examination history, the environment in which it is to be used, the number of lifting operations to be carried out and the magnitude of the loads to be lifted.

It is likely that generic scopes of examination, supported by crane specific information, can be written for specific makes and models of crane. These might need to be amended by the competent person carrying out the thorough examination in the light of their findings.

The defined scope of examination should be capable of being reproduced as a paper copy when required. The master copy should be kept such that it is secure from loss and unauthorized modification, and any copies should be authenticated by the competent person who prepared it. The competent person should periodically review the defined scope of examination to take account of changes in usage of the equipment, findings of previous thorough examinations, supporting supplementary reports and tests together with any information from maintenance activities, manufacturers or other sources.

It is recommended that a defined scope of examination approach should be used for all cranes. Supporting supplementary tests may be undertaken at longer intervals at the discretion of the competent person.

It is essential that the defined scope of examination includes all components that may be used with the crane in different configurations, together with any dedicated fixings or lifting accessories. Particular attention should be paid to wire ropes, see Clause **14**.

Examples of typical defined scopes of examination are given in the sub-parts of BS 7121-2 dealing with particular crane types.

8.11 Thorough examination prior to overload testing

8.11.1 General

Prior to overload testing the competent person should determine by thorough examination with the crane in motion and at rest whether it is:

a) free from any defect that would preclude it from safely handling the test load;

b) in the correct configuration and condition according to the manufacturer's instructions;

c) equipped with sufficient falls of wire rope for the test load.

Baseline dimensional measurements should be taken and recorded, where necessary.

8.11.2 Ballast

The amount of ballast present and its disposition should be checked to determine whether it is in accordance with the manufacturer's instructions for the crane.

NOTE During the processes of erection and dismantling a crane, ballast can be mislaid or lost. The mass of all ballast should be on record and, where not marked on the ballast, the mass should be confirmed before the crane is tested.

Where loose ballast such as brick, gravel, punchings, pig iron, billets or similar material is used, it should be contained, e.g. by the use of a steel box.

8.11.3 Safety switches

All safety switches, for example over hoist, lowering limit, derricking limit, trolley limit, should be checked for correct operation.

8.11.4 Lifting accessories

Lifting accessories should be thoroughly examined before the test and the competent person should determine whether the slinging arrangements are safe.

8.12 Thorough examination after overload testing

After overload testing, a thorough examination should be undertaken by a competent person to determine whether the crane has withstood testing without signs of structural damage that could affect the safety of the crane, such as:

a) cracking;

b) permanent deformation;

c) paint flaking;

d) loosening of, or damage to, structural connections.

8.13 Reports of thorough examination

8.13.1 General

LOLER 1998 [2] requires that the competent person carrying out a thorough examination of a crane makes a report of that thorough examination in writing to the employer for whom the thorough examination is being carried out and to the crane owner. In most cases this will be the same person.

Under LOLER 1998 [2], the report is required to be authenticated by, or on behalf of, the competent person and is required to contain the information specified in LOLER 1998 [2] Schedule 1.

On completion of the thorough examination, the competent person should also make a verbal report to employer for whom the thorough examination is being carried out. This is particularly important where a defect is discovered which is, or could become, a danger to persons.

8.13.2 Categorization of defects

Where defects are found during the thorough examination of a crane the competent person should make a judgement on the severity of each defect and its potential to affect the safety of persons. Defects should be categorized as follows:

- defects that are, or could become, a danger to persons;
- defects affecting the safety of persons that have to be remedied within a specified period of time;
- observations/recommendations which might require planning for resolution and might be outside the strict scope of the thorough examination.

8.13.3 Level of detail in reports

Defects should be reported in a sufficient level of detail to enable the crane owner to identify the exact location and nature of the defects, and decide on a course of appropriate action to

rectify those defects. Reports should be clear to enable them to be readily understood by crane users. The use of abbreviations should be avoided.

8.13.4 Report completion timescale

Where defects are found during a thorough examination which are, or could become, a danger to persons, then the competent person should inform both the employer for whom the thorough examination is being carried out and the crane owner, so that the crane can either be prevented from being put into service or taken out of service until the defects have been satisfactorily rectified. Where necessary, an interim, hand written report should be left on site while the crane owner is contacted. In the case of an in-house competent person they will often have the authority to take the crane out of service immediately.

Where the competent person identifies defects which need to be made good within a specified time scale and could become a danger to persons, they should submit the report promptly to allow the crane owner to take the necessary action within the required period.

In normal circumstances, the competent person should complete the report of thorough examination and forward it within a maximum of 28 days.

8.13.5 Inclusion of cleared defects

On occasions the competent person carrying out the thorough examination might be accompanied by the crane owner's maintenance personnel and as defects are discovered they may be immediately rectified. In such cases it is still a requirement under LOLER 1998 [2] that these defects be reported, even if they have been cleared. Failure to report such defects is not only against the law, it would give a false picture of the condition of the crane and invalidate both the machine history and the review process.

8.13.6 Notification to the enforcing authority

Where, in the opinion of the competent person, the thorough examination identifies a serious defect in the crane which involves an existing or imminent risk of serious personal injury arising from failure of the crane, which could occur at the next use or a short time thereafter, the competent person should send a copy of the report to the local office of the relevant enforcing authority. In most cases this will be the local office of the Health and Safety Executive.

9 Pre-use checks, in-service inspections and thorough examination for cranes that have not been in use for an extended period of time

In cases 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 depends not only on the length of the period that the crane was out of use but also on the location of the crane during this period. A crane standing under cover or inside a workshop might require very little extra inspection. A crane that has been out of use in the open and therefore exposed to the weather and atmospheric pollution, etc. might require an extensive appraisal to determine whether it is safe to use. The programme of pre-use checks and in-service inspections should contain the following checks.

- any checks that are recommended in the manufacturer's instructions for the crane;
- checking all ropes for signs of corrosion/degradation and damage and ensuring that, where applicable, there is thorough lubrication;
- checking all control linkages for evidence of seizure or partial seizure and ensuring that there is correct lubrication;
- checking of all safety devices for correct functioning;
- checking hoses, seals or other rubber or plastics components for evidence of deterioration;
- checking for corrosion on the structure, means of access, control linkages etc;
- checking for structural integrity, for example cracks, dents, missing components;
- testing of every motion for several minutes without load, each motion individually at first then by combination of two or more motions simultaneously, as appropriate, and then repeating the test with a load.

10 Supplementary tests in support of thorough examination and for other purposes

10.1 General

The purpose of the supplementary tests is to support the thorough examination, being carried out immediately prior to the thorough examination and, in some cases, also at other times as set out in **10.2** to **10.20**, in order to determine whether the crane is safe for use. These supplementary tests may be specified by the competent person and can cover a wide range of techniques, not just overload testing. Tests directly supporting a thorough examination should be undertaken, completed by the date specified by the competent person and the results documented, in order to enable the subsequent thorough examination to be completed. The exception to this is overload testing where a thorough examination should be undertaken before the overload test as well as afterwards (see **10.11**). Failure to complete these supplementary tests could prevent the completion of the subsequent thorough examination. In some circumstances the competent person may wish to witness the supplementary tests.

The results of any tests not witnessed by the competent person should be forwarded to the competent person for review without delay.

Supplementary tests on cranes may include the following. (Some detailed recommendations, including the content of reports, are given in **10.2** to **10.20**, respectively):

NOTE This list is not exhaustive.

- anemometer functional test and calibration check;
- spark arrestor test;
- electrical system inspection and test;
- electrical/electronic control system test program run;
- function testing;
- hoist brake operational test;
- hoist/luffing winch assessment;
- hook blocks inspection;
- hydraulic system tests;
- overload testing;
- maintenance log/reports check;
- non-destructive testing of individual components;
- performance testing of the crane;
- RCI/RCL calibration checks and functional tests;
- sheaves check;
- slew brake test of operational efficiency;
- slew ring clearance measurement and condition assessment;
- stowage of the crane's superstructure for transport, functional test.

10.2 Anemometer functional test and calibration check

The following should be checked or tested and recorded in the report:

- location and function of the wind speed sensor;
- function and calibration of the indicating system;
- function and setting of any warning indicators or alarms.

The make, serial number and calibration details of the hand held anemometer, or other test device, used to check the calibration of the anemometer mounted on the crane, should be recorded in the test report.

The appointed person responsible for the in-service lifting operations should specify the setting values for any anemometer warning indicators or alarms.

10.3 Spark arrester test

Spark arresters should be tested by running the engine in a safe environment and examining the exhaust discharge in darkness for any sparks.

WARNING. If the engine is being run in an enclosed space it is essential that adequate precautions are taken to avoid the effects of exhaust fumes, in particular carbon monoxide poisoning.

10.4 Electrical system inspection and test

Inspection and testing of the electrical system for safety, correct functioning, integrity and conformity to BS 7671 should be carried out by a competent electrician. The report should contain:

- the name, qualifications and employing organization of the person completing the inspection and tests;
- results of the inspection and tests;
- whether the test results show that the electrical system conforms BS 7671;
- the date the inspection and tests were completed.

10.5 Electrical/electronic control system test program run

Many cranes are fitted with sophisticated microprocessor based control systems with inbuilt diagnostic capability, including detailed test programs. The competent person may require these test programs to be run and the results made available for his inspection.

Data downloads from control systems should only be completed by fully trained staff.

NOTE Attention is drawn to the Data Protection Act 1998 [10].

10.6 Function testing

Function testing should be carried out without a load applied.

The object of function testing is to determine whether the crane performs as the manufacturer intended. This should include the operation of all controls (including any remote controls) to determine whether the equipment operates correctly and smoothly, and is free from wear and other damage.

Function testing should be carried out on all functions of the crane, including brakes and safety devices where it might be necessary to include the lifting of a suitable load once these devices have been tested without a load applied.

10.7 Hoist brake operational test

This test should be carried out to check the operational efficiency of the hoist brake. In addition to the test supporting a thorough examination, this test should also be completed following a major overhaul of the braking system, replacement of brake shoes or pads, or in the event that the brake has failed to arrest or hold a load.

The operational test should include:

- dynamic testing to check that the brake can bring to rest a moving load being lifted or lowered at the normal maximum operational speed;
- dynamic testing to check that the brake can bring to rest a moving load being lifted or lowered at the normal maximum operational speed following operation of the emergency stop;
- static testing to check that the brake can hold a static load without slippage.

10.8 Hoist/luffing winch assessment

Hoist and luffing winches are frequently designed on the basis of a theoretical service life taking into account a number of factors including the power unit group, load spectrum and collective service factor. This theoretical service life is not the same as the real (actual) service life. In addition to the assessment supporting a thorough examination, at least every year an assessment of the proportion of the theoretical service life left should be made to determine when the next major overhaul of each winch needs to be carried out. This assessment should be carried out using the information supplied by the crane manufacturer,

together with the effective operating hours for the winch and an assessment of the load spectrum for the winch over the period.

10.9 Hook blocks inspection

The inspection of hook blocks should assess the general condition of the assembly and in particular the condition of bearings and fasteners. The mouth of the load hook should be checked for deformation by measuring between the marked datum points and comparing the value obtained with the original dimensions marked on the hook data plate. The increase should not exceed the value specified by the manufacturer (normally 10%).

In addition to the inspection supporting a thorough examination, the threads on the hook retaining nut and the shank of the hook should be checked at regular intervals as part of the in-service inspection (typically at daily or weekly intervals) for signs of fretting and wear.

10.10 Hydraulic system tests

The competent person may request tests and reports on various aspects of the crane's hydraulic system including:

- hydraulic oil sampling and analysis for contaminants to aid assessment of component wear;
- cylinder lock valve holding capability;
- accumulator integrity;
- confirmation that filters have been periodically replaced in accordance with the manufacturer's instructions;
- pressure testing of components.

10.11 Overload testing

*NOTE This subclause covers overload testing to be carried out to supplement thorough examination, and also overload testing for other purposes. It is important to note, however, that irrespective of the purpose of the overload testing, a thorough examination has to be carried out before and after this testing (see **10.1** and **10.11.1**).*

10.11.1 General

Before and after any overload testing the crane should be thoroughly examined. See **8.11** and **8.12**. The objective of overload testing is to determine whether the crane is stable, structurally sound and fit for the use for which it was designed. The test programme drawn up by the competent person should include every load-bearing part. The competent person should determine whether the original or, if appropriate, the previous test certificate is satisfactory, and subsequent testing should be based on this with any necessary modifications to suit the requirements of the particular crane.

The instructions and other relevant information provided by the manufacturer or other appropriate specialist should be followed prior to the application of overloads to the crane.

To prevent undue repetition, the test programme should be conducted so that each load-bearing part is given one overload, for example to test a wire rope hoist mechanism and brakes it is only necessary to subject the mechanism to the overload on maximum line pull.

NOTE It is essential that the competent person consults the crane manufacturer (or if they are no longer in existence another design authority) to ensure that the selected test programme is adequate.

During testing with overloads all operations should be carried out with extreme care and every permissible crane motion carried out singly at the lowest possible speed.

Overloads should be kept as close to the ground as possible, generally between 100 mm and 200 mm. Preferably, overloads should not be raised above 200 mm to allow them to pass over obstructions. Where such limitations exist, the competent person should consider an alternative test to prove the crane in the restricted area. When no alternative test is

possible and the competent person is not satisfied that all of the crane duties have been adequately tested, use of the crane should be restricted to the tested duties and both the certificate of test and report of thorough examination endorsed accordingly.

To ensure that the load is applied at the correct position, any dimensions should be checked using separate measuring equipment; the crane instrumentation should not be used for this purpose. All measuring equipment should be accurate to ±1% of the measured value and be undamaged and properly maintained.

The mass of the lifting accessories should be included as part of the test load.

During the test the performance of the crane should be monitored by the competent person.

10.11.2 Overload testing of cranes which have been altered or repaired

In addition to overload testing in support of a thorough examination, in the event of any alteration or repair which could affect the strength of the crane, overload testing should be carried out, ensuring that all parts affected by the repair are subjected to the test loads in accordance with the original crane specification.

NOTE It is essential that the competent person consults the crane manufacturer (or if they are no longer in existence another design authority) to ensure that the selected test programme is adequate.

10.11.3 Overload testing as part of periodic checks and inspections

In addition to the overload testing in support of a thorough examination, the competent person may wish to specify overload testing at other times to assess the continued integrity of the crane, taking into account its age, usage, condition and operating environment.

10.11.4 Overload test site conditions

Careful consideration should be given to the condition of the site where any overload tests are to be conducted. The recommendations provided in the operating instructions for the crane relate to operations within the rated capacity, and more stringent recommendations apply when loads are being applied for the purpose of overload testing.

The ground should be well consolidated and capable of withstanding the loads applied to it. There should be no hidden dangers such as cable ducts, drains, pipes, back-filled areas, cellars or other subterranean weaknesses (see BS 7121-1:2006, **12.2**). Cranes should not be tested in the vicinity of overhead power lines (see BS 7121-1:2006, **12.3.2**).

The ground should be level within the limits specified in the crane operating instructions.

The site should be of sufficient area and have unrestricted overhead clearance to allow the unobstructed movement of the crane and load throughout its test movement, for example slewing, derricking and travelling.

Tests should not be conducted over high risk areas, for example a public highway, railway, occupied buildings or in the flight path of airports (see BS 7121-1:2006, **12.3.3**). If, owing to the requirements of usage, this is unavoidable, arrangements should be made with the appropriate authorities.

Overload testing is intended to assess the stability of a crane together with the integrity of its structure and mechanisms, so it is possible that the crane might not withstand the loading. All personnel not essential for carrying out the test should be kept away from the test area. The test area should be roped off and notices posted prohibiting unauthorized entry. The test area should be clear of plant and structures which could interfere with the test.

10.11.5 Weather conditions

10.11.5.1 General

Test sites should not be located in areas which are exposed to extreme weather conditions because certain weather conditions such as electric storms, strong wind, heavy rains, ice,

snow or excessive sea state can impose loads on a crane or adversely affect the safety of crane operations.

It is essential that tests are not undertaken when the crane or load cannot easily be seen because of limitations on visibility (including inadequate lighting) or when they are heavily coated with ice or snow.

A test load should not be applied to a crane by pulling against an anchor point instead of using test weights. Pulling against anchor points can introduce side loading to the crane and the test load cannot be hoisted and applied to all parts of the gear train.

*NOTE BS 7121-1:2006, Clause **18** for further guidance regarding weather conditions for load testing.*

10.11.5.2 Wind speeds and sea state

The limiting wind speed for overload testing of a crane is lower than the limiting wind speed for normal operation as given in the operating instructions for the crane. Similarly, in the case of a crane on a water-borne craft, the limiting sea state, or degree of vessel movement, for overload testing is lower than that for normal operation as given in the operating instructions for the crane. In both cases, advice should be sought from a design authority before overload testing is carried out.

NOTE 1 Gusting wind conditions can have an additional adverse effect on the safe handling of the load and the safety of the crane.

NOTE 2 Information regarding the Beaufort scale of wind force is given in Annex A.

NOTE 3 Information regarding sea state codes is given in Annex B.

10.11.6 Test weights

Test weights should be used which have been proven to be accurate within ±1% of their nominal value by one of the following methods:

a) proven on a weighbridge which has been calibrated within the previous 12 months; or

b) by suspension from a weighing device which has been calibrated within the previous 12 months.

NOTE It is important that the weighing device is capable of weighing the test load to within ±1.0%.

10.12 Maintenance log/reports check

The competent person may request a copy of the maintenance log/reports for the crane. This information may be provided as individual records or in summary form.

10.13 Non-destructive testing of individual components

Non-destructive testing may be requested by the competent person to supplement any visual examination. The report should include:

- date the tests were completed;
- name, qualifications and position of the person completing the tests;
- serial number or identifying mark of the components tested;
- details of the test method(s) employed and reference to the relevant standard(s) where test method(s) specified in standard(s) were used;
- calibration details of any test equipment used;
- results of the test(s).

Before the crane is subjected to non-destructive testing it should be cleaned to remove dirt, debris and grease so that any defects can be clearly identified.

10.14 Performance testing of the crane

Performance testing of the crane should be carried out after function testing (see **10.6**) and with a load applied which is equivalent to the rated capacity of the crane.

The object of performance testing is to determine whether the crane performs to the manufacturer's specification. This should include the operation of all controls (including any remote controls) to determine whether the crane operates correctly and smoothly at the rated speeds, and is free from wear and other damage.

Performance testing should be carried out on all functions of the crane including brakes and safety devices.

10.15 Rated capacity indicator (RCI) and rated capacity limiter (RCL) calibration checks and functional tests

In addition to testing in support of thorough examination (see **10.1**), a calibration check should also be carried out when any major repair or modification has been carried out on the RCI or RCL. At each successive calibration check, a different configuration of the crane should be chosen so that eventually all configurations are systematically covered.

The calibration of the RCI or RCL should be checked by the suspension of calibrated weights on the crane in accordance with BS 7262. During the calibration check of the RCI or RCL it is essential that the crane is not loaded beyond 110% of its rated capacity. The radius/angle at which the test load corresponds to 110% of the rated capacity should be marked and the test load should not be taken beyond that point.

The RCI or RCL should be subjected to a functional test and should give the following warnings within the tolerance limits stated:

a) Warning of approach to rated capacity

The RCI or RCL should give a clear and continuous warning of approach to the rated capacity. The warning should commence at a load of not less than 90% of the rated capacity and not more than 97.5%. The approach to rated capacity warning should continue to function until the load as a percentage of rated capacity falls to below the value at which the warning was initiated.

b) Warning of overload

The RCI or RCL should give a clear and continuous warning of overload. The warning should commence at a load of not less than 102.5% of the rated capacity and not more than 110%. The overload warning should continue to function until the load as a percentage of the rated capacity falls to below the value at which the warning was initiated.

10.16 Sheaves check

Sheaves should be checked as part of testing in support of thorough examination, and frequently between thorough examinations, determine whether they rotate freely and whether any play in the bearings is within the manufacturer's limits. The radius at the bottom of the sheave groove should be checked with a set of sheave gauges to determine whether it is within the manufacturer's limits. These limits are normally no smaller than the nominal rope diameter +5% and no greater than the nominal rope diameter +15%.

10.17 Slew brake test of operational efficiency

The slew brake should be tested for operational efficiency. In addition to testing in support of a thorough examination, this test should also be completed following major overhaul of the braking system, replacement of brake shoes or pads, or in the event that the brake has failed to arrest or hold a load. The operational test should include dynamic testing to check whether the brake can bring to rest a moving load being slewed at the normal maximum operational speed.

When testing the slew brake, the slew gearbox and pinion should also be inspected and a sample taken of the gearbox oil for analysis.

10.18 Slew ring clearance measurement and condition assessment

Slew ring bearing clearance measurements should be made in accordance with the manufacturer's instructions. These are most effectively made in a workshop. In addition to measurement in support of thorough examination (see **10.1**), the frequency of measurement should be in line with the manufacturer's recommendations, and at an increased frequency if the crane has been subjected to arduous service conditions or at the request of the competent person completing thorough examination.

The condition and function of greasing systems, grease lines, nipples and lip seals should be ascertained.

An indication of slew ring bearing clearance may also be obtained on a jib crane without disassembly. In this case measurements should be taken using a dial test indicator (DTI) mounted on the centreline of the bearing track. The DTI should be zeroed with no load on the hook (back moment condition). A load should then be lifted at such a radius that a forward moment condition is created and the bearing moves to the other extent of its play. The process should then be repeated with the crane slewed through 45° increments.

The slew ring should also be checked dynamically and noted for noise and smooth operation, condition of teeth and pinion gear (mesh and backlash).

Measurement of slew ring bearing play on an assembled crane will not give a result that is as accurate as axial loading in workshop conditions, but can be expected to give a good indication of excessive wear and the need for any corrective action.

The report should include:

- date the examination was completed;
- unique serial number or identifying mark of the slew ring;
- measurements taken and relative geometric index position;
- manufacturer's specifications;
- previous recorded values;
- assessment as to the condition of the bearing faces and rolling elements;
- the function of the grease nipples and lubrication systems.

It is good practice to measure the slew bearing clearance on new acquired cranes before first use to provide a reference value against which all subsequent measurements can be assessed.

10.19 Stowage of crane superstructure for transport, functional test

A functional test and examination should be carried out to determine whether the superstructure of the crane can be stowed for transport in accordance with the manufacturer's instructions. Specific checks should be made to determine whether:

- the boom rests correctly in the transport position;
- the slew locking system can be applied and is effective;
- counterweights attached to either the slewing structure or the chassis are secure;
- the fly jib, where fitted, is secure.

11 Data logging and condition monitoring systems

Data logging and condition monitoring systems are available for some types of cranes and these can provide a valuable aid to the competent person.. There are several software packages available which address the various levels of complexity at which condition monitoring can be undertaken. Systems range from simple storage of results and the generation of "trends" from those records, to the most sophisticated which can process data and generate reports and warnings to assist the competent person with decision making.

The following are some examples of the information that data loggers can record:

- time, date and duration of each lift;
- configuration of each lift;
- outrigger position;
- details of average and maximum load;
- radius, angle and boom length;
- number of lifts carried out;
- number of times rated capacity is exceeded and this figure as a percentage of total number of lifts;
- the number of times that manufacturer's set limits are exceeded
- limit overriding;
- reeving changes;
- operating mode;
- road travel or on-site working;
- distances travelled;
- start and stop times in real time;
- operator identification;
- over speeding;
- harsh braking;
- idling time.

12 Additional recommendations for cranes for lifting persons and for personnel carriers (suspended baskets)

12.1 General

LOLER 1998 [2] require that cranes that are used to lift persons, and the personnel carrier, are thoroughly examined either at least every 6 months (see **8.4**) or in accordance with a written examination scheme drawn up by the competent person (see **8.9.1**). The thorough examination should include checks of the features listed in **12.2** and **12.3** and the report should state that the crane and personnel carrier have been thoroughly examined for the purpose of lifting persons, together with the unique identification number of the personnel carrier.

12.2 The crane

To be suitable for lifting persons, the crane should be equipped with the following features. Checks should be made for the presence and correct functioning of these features before the crane is used to lift persons:

- The crane should have an RCI/RCL with an appropriate duty for lifting personnel (i.e. half the rated capacity for lifting other loads).
- The crane should be equipped with a motion control system that brings the crane to rest automatically when the controls are released.
- The crane should be equipped with an appropriate anemometer or other device to monitor in-service wind speeds.

NOTE A crane should not be used to lift persons in wind speeds in excess of 7 m/s.

- If the crane is equipped with a winch it should have power lowering. Cranes with free-fall ability should not be used to lower and raise persons unless the free-fall facility has been locked out.
- The load bearing hydraulic cylinders should be fitted with load hold valves (over-centre valves) to stop movement in case of hose rupture or pipe fracture. Cranes only equipped with simple check or hose rupture valves should not be used for the lifting of persons.
- A functional check should be carried out to determine whether the crane control system is able to provide a smooth movement of the personnel carrier. The control system should be such that the carrier can move gently, and the working speed should not exceed 0.5 m/s in all motions;
- Means should be provided such that if the power supply or control system fails, the personnel carrier can be positioned so as to enable access/egress without risk.
- The diameter of the wire rope used for hoisting and lowering the personnel carrier should be measured. The wire rope should have a diameter of at least 8 mm.

12.3 The personnel carrier (suspended basket)

To be suitable for lifting persons, the personnel carrier should be equipped with the following features. Checks should be made for the presence and correct functioning of these features before the personnel carrier is used to lift persons. An example of a personnel carrier pre-use check form is given in Annex C.

- Storage accommodation for equipment, including any emergency egress equipment (for example safety harness, lanyard), should be provided in the carrier.
- The carrier should be marked with the number of persons that can be carried and the maximum load that can be carried.
- Any doors in the carrier should not open outwards and means should be provided for any doors to be securely fastened.
- The carrier should have handrails to provide security for persons, mounted in positions that do not trap hands.
- The sides of the carrier should be of a construction to prevent persons or materials falling from the carrier.
- Any attachment points for safety devices such as harnesses should be secure and undamaged. They should be checked before the carrier is used.
- The carrier should be free from damage, corrosion, cracks and other imperfections.
- Any mechanism provided to ensure that the floor of the carrier remains horizontal should be free from damage, leaks, corrosion and wear.

NOTE Design and construction requirements for suspended baskets for lifting persons are given in BS EN 14502-1:2010.

13 Personal fall protection equipment

It is essential that all equipment used for personal fall protection has a pre-use check (visual and tactile inspection) before each use. The check should be carried out in accordance with the manufacturer's instructions. Damaged equipment should be taken out of service immediately. The checks should include any tensioned horizontal safety lines.

In addition to pre-use checks, BS 8437 recommends that equipment should be subjected to detailed inspections by a competent person before first use and at intervals not exceeding 6 months, and after circumstances liable to jeopardize safety have occurred. Damaged equipment should be taken out of service immediately.

BS 8437 also recommends that interim inspections of personal fall protection equipment are carried out over and above the pre-use checks and the detailed inspections, at intervals determined by the risk assessment carried out at the beginning of the job. In determining what is a suitable interval, factors such as whether items are subject to high levels of wear and tear or contamination should be considered.

The results of both the detailed inspections and the interim inspections should be recorded.

Equipment should be kept clean and dry and should be properly stored. Wet equipment should be thoroughly dried before storage. Equipment should not be altered or repaired, unless this has been authorized by the manufacturer.

The frequency of detailed inspection should be reviewed by a competent person to take account of storage conditions and any damage found at pre-use and detailed inspections.

NOTE Additional guidance is given in BS 8437.

14 Assessment of wire rope condition and discard criteria

When carrying out examination of wire ropes as part of the thorough examination of a crane, the competent person should examine the rope in accordance with BS ISO 4309:2010, Clause **5** and Clause **6**.

BS ISO 4309:2010 stresses the importance of examining critical areas of the rope such as:

- the termination points of both moving and stationary ropes;
- that part of the rope which passes through the block or over sheaves;
- in the case of cranes performing a repetitive operation, any part of the rope which lies over sheave(s) while the crane is in a loaded condition;
- that part of the rope which lies over a compensating sheave;
- any part of the rope which might be subject to abrasion by external features.

The continued safe use of wire ropes depends on regular assessment of the condition of the ropes and the equipment with which they are used, in addition to examination as part of the thorough examination.

Some cranes operate in conditions where the wire ropes and the equipment with which they are used are particularly liable to damage, e.g. in a corrosive atmosphere or where there are abrasive particles. In such circumstances, assessment of the condition of the rope and the equipment should be carefully carried out and the rope removed from service when the damage might affect its safe operation.

Records should be kept of the examination and replacement of wire ropes. These should consist of the reports of thorough examination for the crane and certificates of test for the wire ropes at time of supply.

When carrying out inspections and examinations to assess the fitness of the wire rope for further service, both general deterioration and localized deterioration or damage should be

considered. Therefore the whole length of the rope should be examined, paying particular attention to the rope adjacent to the terminations, lengths that have been running or stationary over drums, sheaves and deflection pulleys and any other areas likely to sustain damage.

Annex A (informative)
Beaufort scale

Table A.1 gives information regarding wind conditions the Beaufort scale.

Table A.1 – Beaufort scale of wind conditions

Beaufort number	**Description of wind**	**Specifications for use on land**	**Wind speed** mph	**Wind speed** m/s
0	Calm	Calm; smoke rises vertically	0 to 1	0 to 0.2
1	Light air	Direction of wind shown by smoke	1 to 3	0.3 to 1.5
2	Light breeze	Wind felt on face; leaves rustle; ordinary vanes moved by wind	4 to 7	1.6 to 3.3
3	Gentle breeze	Leaves and small twigs in constant motion; wind extends light flag	8 to 12	3.4 to 5.4
4	Moderate breeze	Raises dust and loose paper; small branches are moved	13 to 18	5.5 to 7.9
5	Fresh breeze	Small trees in leaf begin to sway; crested wavelets form on inland waterways	19 to 24	8.0 to 10.7
6	Strong breeze	Large branches in motion; whistling heard in telephone wires; umbrellas used with difficulty	25 to 31	10.8 to 13.8
7	Near gale	Whole trees in motion; inconvenience felt when walking against wind	32 to 38	13.9 to 17.1
8	Gale	Breaks twigs off trees; generally impedes progress	39 to 46	17.2 to 20.7
9	Strong gale	Slight structural damage occurs (chimney pots and slates removed)	47 to 54	20.8 to 24.4

Annex B (informative)
Sea state code

Table B.1 gives information regarding the condition of the sea and the associated sea state codes.

Table B.1 – Sea conditions and sea state codes

Code	Description of sea	Significant wave height m
0	Calm (glassy)	0
1	Calm (rippled)	0 to 0.10
2	Smooth (wavelets)	0.10 to 0.50
3	Slight	0.50 to 1.25
4	Moderate	1.25 to 2.50
5	Rough	2.50 to 4.00
6	Very rough	4.00 to 6.00
7	High	6.00 to 9.00
8	Very high	9.00 to 14.00
9	Phenomenal	over 14.00

Annex C (informative)
Example of personnel carrier pre-use check form

An example of a personnel carrier pre-use check form is given in Figure C.1.

Figure C.1 – Example of personnel carrier pre-use check form

PERSONNEL CARRIER — PRE-USE CHECK		
Inspector:	**Date:**	
Platform ID:		
	Satisfactory	**Unsatisfactory**
Platform (all information legible)		
Suspension system		
Structure		
Load supporting welds/bolts		
Load supporting members		
Barrier from toe board to intermediate rail		
Hand rail		
Fall protection device		
Anchorage points		
Gate locking mechanisms		
Platform flooring		
Suspension attachment points		
Attachment mechanisms		
Pins/eyes		
Wire rope/chain		
Master links and shackles		
Special purpose items (e.g. overhead protection, platform controls)		
1.		
2.		
3.		
4.		
General comments:		
Weather conditions and lighting:		
Appointed person/crane supervisor:		
Signature:		

Bibliography

Standards publications

For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

BS 8437, *Code of practice for selection, use and maintenance of personal fall protection systems and equipment for use in the workplace*

BS EN 14502-1:2010, *Cranes – Equipment for lifting persons – Suspended baskets*

BS EN ISO 9001, *Quality management systems - Requirements*

BS EN ISO/IEC 17020, *General criteria for the operation of the various types of bodies performing inspection*

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