

Maintenance, Inspection and Thorough Examination of Tower Cranes



Best Practice Guide



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CPA Best Practice Guide



Working in Partnership

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Foreword

Every year, the construction industry is responsible for causing deaths and serious injury. In recent times the industry has done much to improve its performance which I welcome, but there is always room for more improvement.

Our construction industry relies on the use of tower cranes to move materials on sometimes small, confined sites. Tower cranes are an essential part of the construction process and can help resolve some of the safety problems on site arising from space constraints.

Tower cranes are capable of lifting loads over people. The size and location of tower cranes provide the potential for death and serious injury to occur and indeed tragically, both site workers and members of the public off site have been killed in tower crane accidents. In addition to the terrible cost in human suffering, accidents have a financial cost. There is a very strong business case for improving safety performance.

The law relating on cranes is clear. There are requirements to ensure that cranes are installed, inspected, examined and maintained to ensure they do not present a risk. However, investigations into recent accidents have shown that enhanced standards of maintenance and thorough examination could have reduced the chance of death or injury.

This guidance has been prepared to provide clarity about the practical elements of maintenance, inspection and thorough examination. The guidance is simple but comprehensive and easy to adopt. It represents best practice.

I thank those who have been involved in its preparation and commend the guidance to anyone who owns supplies or controls the operation of tower cranes. Please read the publication and turn the advice into action.



Stephen Williams

HM Chief Inspector of Construction
Chair of the Health and Safety Commission's Construction Industry Advisory Committee (CONIAC).

1.0 Introduction and Summary

The consequences of any failure of a tower crane are likely to be extremely serious, with the potential for multiple fatalities. Tower cranes are also often the primary means of material handling on a construction site and any breakdown will have a serious effect on the construction programme. It is therefore extremely important that tower cranes are effectively maintained to ensure continued safe and efficient operation over time.

In addition to the maintenance process the thorough examination of tower cranes, after each erection, periodically and after exceptional circumstances is required to ensure that tower cranes are safe to take into use and to continue in use.

Both the maintenance and thorough examination of tower cranes are required by law and the purpose of this Best Practice Guide (BPG) is to set out, in clear and concise terms, both the requirements and Best Practice for meeting these requirements. The document is split into two sections – Maintenance and Thorough Examination, to emphasise that these are separate, although complimentary, activities. The document is aimed primarily at tower crane owners, and those managing and carrying out the maintenance and thorough examination of tower cranes. However the document will also be of benefit to other groups such as tower crane users.

Maintenance

There are a number of equipment maintenance management techniques that can be employed, including *“Breakdown Maintenance”* where maintenance is only carried out after faults or failures have occurred, and *“Planned Preventive Maintenance”* which involves routine inspection replacing parts and consumables or making necessary adjustments at preset intervals, so that risks do not occur as a result of the deterioration or failure of the equipment.

In the case of tower cranes the *“Breakdown”* approach is inappropriate, as any failure presents an immediate risk. The Best Practice Guidance is therefore the *“Planned Preventive Maintenance”* management technique.

Maintenance of tower cranes should be managed in the same way as any other business activity as, if not carried out effectively, it can have severe financial and safety implications for a business. An effective management structure is required to ensure that everyone involved in the maintenance activity is aware of their responsibilities, properly briefed on their duties and that systems are in place to enable effective feedback, including the monitoring of maintenance data.

Tower crane maintenance activities should be carried out, as a minimum, at the intervals specified in the tower crane manufacture’s maintenance manual. Varying circumstances on site may however require the frequency to be increased.

Once a tower crane has been erected on a site, the user of the crane has a duty to ensure that it is adequately maintained. The actual undertaking of the maintenance is often delegated to the crane owner by the user; the user however, retains the responsibility for ensuring that the maintenance is carried out.

Clear lines of responsibility for maintenance operations should be established from Board level downwards, ensuring that those appointed and responsible have sufficient knowledge and experience to carry out their duties in a way which will ensure that risks are properly controlled.

Each tower crane should have a documented preventive maintenance schedule which is targeted at the parts of the equipment where failure or deterioration could lead to health and safety risks and which specifies the frequency of inspection and

test of relevant parts, taking account of the manufacturer's instructions, the age of the crane and its in-use history.

Tower crane owners may not have access to expert professional engineering advice in-house. If this is the case arrangements should be made for securing such advice externally where this is necessary for the purposes of health and safety and clear guidelines should be established for when this advice should be sought.

For a preventive maintenance system to be fully effective it is essential that comprehensive records of daily checks, intermediate inspections, breakdown reports, maintenance work sheets (including details of parts replacement) and reports of thorough examination are kept. These should be filed in an individual machine history file which should be kept for the life of the crane.

An extremely important aspect of a planned preventive maintenance system is the continuous and systematic review of all maintenance records, inspection reports and reports of thorough examination to ensure that the maintenance is effective, defects are found and worn components are replaced well in advance of any possible failure. Should this review indicate that maintenance is not fully effective, the frequency may have to be increased and maintenance practices amended.

Maintenance should only be carried out by those who are competent and have adequate training and information to carry out the work required. A number of general maintenance training courses and qualifications are available for personnel carrying out and supervising maintenance operations. Training is offered by a number of training providers including the National Construction College, whilst qualifications are available through the NVQ/SVQ scheme.

All maintenance personnel should have received machine specific training, traceable to the tower crane manufacturer, before carrying out maintenance tasks on any tower crane.

Maintenance operations on tower cranes require adequate facilities and equipment to enable them to be carried out effectively, efficiently and safely. The size and sophistication of the facilities will depend on the degree of maintenance tasks to be carried out.

Thorough Examination

Thorough examination of lifting equipment is a fundamental requirement of the Lifting Operations and Lifting Equipment Regulations 1998 (LOLER). Regulation 9 of the *Lifting Operations and Lifting Equipment Regulations 1998 (LOLER)* requires employers to ensure that tower cranes are thoroughly examined at prescribed intervals. In the case of a hired-in tower crane the actual undertaking of thorough examinations is often delegated to the crane owner by the user. The user however, retains the legal responsibility for ensuring that thorough examinations are carried out.

The primary purpose of a thorough examination is to ensure that a tower crane or climbing frame 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 and is a statutory requirement.

Tower cranes operate in a high risk environment which includes lifting loads over people and with the operator in an elevated position. These factors must be taken into account by the competent person when determining the scope and nature of the thorough examination.

As with maintenance, the thorough examination of tower cranes should be managed effectively, irrespective of whether thorough examination is carried out in-house or by a third party. An effective management structure is required to ensure that everyone

involved in the thorough examination activity is aware of their responsibilities, properly briefed on their duties and that systems are in place to enable effective feedback, including the monitoring of thorough examination outcomes. If thorough examination is carried out by the organisation owning or supplying the tower crane steps must be taken to ensure that the competent persons carrying out the thorough examinations have, as LOLER requires *“the genuine authority and independence to ensure that examinations are properly carried out and that the necessary recommendations arising from them are made without fear or favour.”* This guidance describes a number of ways in which this requirement may be met.

Thorough Examination of tower cranes should only be carried out by those who are assessed as competent and have adequate training and information to carry out the task. Competent persons should be selected through a formally documented assessment process and any shortfalls in their knowledge or ability addressed through formal or on the job training. All assessment and training must be recorded in an individual training record, together with the ongoing Continuing Professional Development that should be undertaken by all Competent Persons.

Competent Persons carrying out Thorough Examinations of tower cranes should be provided with adequate information to enable them to carry out their duties effectively and safely. The Competent Person may specify supplementary tests to be carried out prior to or during the Thorough Examination. These may include such tests as:-

- Overload test following erection;
- RCI/RCL calibration and functional test;
- Hoist brake and luffing brake test;
- Pre-delivery inspections;
- Non Destructive Examination of individual components.

The results of the thorough examination must be reported in writing as required by LOLER. This includes the reporting of safety critical defects to the Enforcing Authority (Normally the Health and Safety Executive)

Availability of Tower Cranes for Maintenance and Thorough Examination

Tower cranes, when erected on a construction site, are often pivotal to the construction process and Site Managers may be reluctant to release a tower crane to the owner to allow maintenance or thorough examination to take place. It is essential that adequate downtime is built into the construction programme to allow effective maintenance and thorough examinations to be carried out and to ensure that personnel do not feel under pressure to skimp the work. The activities should always be carried out during the hours of daylight and the crane operator should be in attendance to operate the tower crane as required.

Other Issues

In addition to the issues summarised above the guidance also addresses - site issues, management review of records, spare parts, work at height, safe systems of work and checklists for checks and inspections.

This Guidance may be used by Principal Contractors when undertaking vendor assessment as required by the CDM Regulations.

2.0 Definitions

maintenance

The process of ensuring that a tower crane is kept in a safe state, in efficient working order and in good repair

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 be taken into 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.

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 their importance in relation to the safety and continued use of the lifting equipment

competent engineer

person who has such theoretical knowledge of the design of the lifting equipment as enables them to assess the design of the item in order to establish appropriate criteria for a thorough examination

functional testing

operation of each motion of the appliance without a load applied in order to determine whether the equipment performs as the manufacturer intended

performance testing

operation of each motion of the appliance with the rated load applied in order to determine whether the equipment performs to the manufacturer's specification

overload testing (static)

operation of the appliance with a load exceeding the rated load applied but without operating the full range of motions of the appliance in order to determine whether the appliance is stable, structurally sound and fit for the use for which it was designed

overload testing (dynamic)

operation of each motion of the appliance with a load that exceeds the rated load applied in order to determine whether the appliance is stable, structurally sound and fit for the use for which it was designed

non-destructive testing (NDT)

testing carried out on the structure of the appliance to establish the presence, location and extent of any defects that can affect the integrity of that structure

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).

in-service

condition where the crane is handling loads up to and including the rated capacities within permissible wind speeds and other conditions as specified by the manufacturer during normal operation following thorough examination

out-of service

condition where the crane is either not required for use or is out of use, without a load on the load lifting attachment and in conditions as specified by the manufacturer

NOTE: These conditions may include a higher wind speed than that permitted for the in-service conditions.

supplementary tests

appropriate tests and/or examinations called for by the competent person where concerns regarding the condition of equipment arise from the thorough examination or where additional or more arduous use may be taking place

3.0 Legal Requirements

3.1 Introduction

The law places duties on persons concerned with tower cranes, including those who supply, install and maintain tower cranes for use, those who undertake thorough examinations and those involved with the use of tower cranes for lifting operations. This Section outlines those legal duties and points the reader towards further relevant guidance material.

3.2 The Law Outlined

Legislation relating to the use of tower cranes at work includes the:

- Health & Safety at Work etc Act 1974
- Management of Health & Safety at Work Regulations 1999/SI3242
- Workplace (Health, Safety & Welfare) Regulations 1992/SI3004
- Provision & Use of Work Equipment Regulations 1998/SI2306
- Lifting Operations & Lifting Equipment Regulations 1998/SI2307
- Personal Protective Equipment at Work Regulations 1992/SI2966
- Work at Height Regulations 2005/SI735
- Supply of Machinery (Safety) Regulations 1992/SI3073 & 1994/SI2603
- The Construction (Design and Management) Regulations 2007/SI320

3.3 Health & Safety at Work etc Act 1974 (HSWA)

HSWA places a duty on employers to ensure the health and safety of employees and others who may be affected by their work activities. Similar duties are placed on the self-employed and persons in control of premises. Employees, managers and directors also have responsibilities. The HSWA also places a duty on tower crane owners and users, where their work activity involves tower cranes being used where they could affect the general public.

3.4 Management of Health & Safety at Work Regulations 1999 (MHSWR)

Under MHSWR, employers and self-employed people are required to assess risks to health and safety from their undertaking. This includes risks from the use, repair and examination of tower cranes on their premises, including the operation of the tower crane. The risk assessment should identify what measures are needed to comply with health and safety requirements and control risk. The duty holder should then put in place the organisation and arrangements to ensure that those measures are properly implemented.

3.5 The Workplace (Health, Safety & Welfare) Regulations 1992 (WPR)

WPR places duties on employers to ensure, as far as is reasonably practicable, that their work places are safe and without risks to health. The WPR cover matters such as ventilation, temperature, lighting, electromagnetic radiation and cleanliness of the workplace as well as certain basic welfare provisions.

3.6 The Provision & Use of Work Equipment Regulations 1998 (PUWER)

PUWER is concerned with such matters as safeguarding of dangerous parts of machinery, provision of appropriate controls, and maintenance of work equipment including tower cranes.

PUWER places duties on any person who has control to any extent of:

- work equipment;
- a person at work who uses, supervises or manages the use of work equipment; or
- the way in which work equipment is used at work (including maintenance).

PUWER applies to employers in respect of work equipment provided for, or used by, their employees, self-employed persons in respect of work equipment they use and other persons, e.g. visitors.

3.7 The Lifting Operations & Lifting Equipment Regulations 1998 (LOLER)

LOLER deals with the specific risks arising from the use of work equipment (including lifting accessories) to lift loads. It builds upon PUWER and applies to the same groups of people. LOLER also introduces particular requirements for lifting equipment which is used to lift people, and a requirement for the thorough examination and reporting of thorough examination of tower cranes.

3.8 Personal Protective Equipment at Work Regulations 1992 (PPE)

These Regulations impose health and safety requirements for the provision of, and use by, persons at work of personal protective equipment. The Regulations require employers to ensure suitable personal protective equipment is provided without charge, for their employees and also require self-employed persons to ensure suitable personal protective equipment is provided for them. Requirements are also imposed on employees and self-employed persons for the use, storage and maintenance of personal protective equipment. Employees are also required to report to their employer the loss of or any obvious defect in personal protective equipment.

3.9 Work at Height Regulations 2005 (WAH)

The Work at Height Regulations impose health and safety requirements for work at height. These include:-

- organisation and planning;
- hierarchy of control;
- competence and supervision;
- steps to be taken to avoid risk from work at height;
- selection of work equipment;
- inspection of work equipment.

The Regulations define work at height as:-

- (a) work in any place, including a place at or below ground level;
- (b) obtaining access to or egress from such place while at work, except by a staircase in a permanent workplace.

3.10 Supply of Machinery (Safety) Regulations 1992 & 1994

The Supply of Machinery (Safety) Regulations are the UK's implementation of European Union Directive 98/37/EC, the "Machinery Directive" which requires that all machinery (including lifting accessories) supplied into the European Union, meets the Essential Health and Safety Requirements detailed in Schedule 3 of the Regulations. Each machine must be accompanied at time of supply by an "EC Declaration of Conformity" declaring that the machinery fulfils all the relevant provisions of the Regulations.

3.11 The Construction (Design and Management) Regulations 2007 (CDM)

The Construction (Design and Management) Regulations place duties on duty holders including clients, designers and contractors in respect of the planning, management and monitoring of health, safety and welfare in construction projects and of the co-ordination of the performance of these duties by duty holders. These include a duty on every person working under the control of another to report anything that he is aware is likely to endanger health or safety. The Regulations impose additional duties on clients, designers and contractors where the project is notifiable, defined as likely to involve more than 30 days or 500 person days of construction work. These include the duty of the client to appoint a CDM coordinator and a principal contractor.

3.12 British, European and ISO Standards

Standards do not generally have the force of law: the application of a standard is almost always voluntary, although standards are very often used in support of legislation, and compliance with a standard is sometimes quoted in legislation as offering a route to discharging legal obligations. Good examples of this are the references to the BS 7121 series in the Guidance to LOLER.

British standards are generally restricted to Codes of Practice for safe use of equipment e.g. BS7121-5:2006 *Safe use of tower cranes*, whilst European (EN) standards cover requirements for basic principles (Type A), common product requirements (Type B) and specific product requirements (Type C) e.g. *EN14439:2006 Cranes-Safety-Tower cranes*.

International Standards (ISO) cover both the safe use and specification of tower cranes and components. They do not have any legal status but are often taken as good practice and are cited as normative references in some EN product standards.

4.0 Approaches to Maintenance

4.1 Maintenance System Elements

The introduction to this Best Practice Guide has emphasised the need to ensure that equipment is maintained, as required by PUWER, so that its performance does not deteriorate to the extent that it puts people at risk. Many people have a part to play in this from the tower crane operator carrying out daily and weekly checks, through the user reporting defects to the crane owner, to the maintenance personnel responding to breakdowns and carrying out routine maintenance on the crane. Adequate maintenance can only be achieved by establishing an effective maintenance management system which should include

- A statement of maintenance policy (e.g. Planned Preventive Maintenance, backed up by breakdown repairs and supplemented by Predictive Maintenance or in combination);
- Definition of roles and responsibilities of persons involved in the maintenance activities;
- Systems for the 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.

4.2 Types of Maintenance Management

There are three main types of maintenance management that may be applied to the maintenance of machines, including tower cranes: breakdown maintenance, preventive maintenance and predictive maintenance. Not all of these are appropriate for the effective maintenance of tower cranes, as explained below.

4.3 Breakdown Maintenance

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 tower cranes is that any failure could present an immediate and unacceptable risk. Additionally repair costs may well be very high when the machine does break down, often at the most inconvenient moment, with considerable downtime whilst repairs are carried out.

4.4 Planned Preventive Maintenance

All planned preventive maintenance systems are time driven. In other words, 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. The maintenance interval is based on experience of breakdowns or the mean-time to failure (MTTF) as illustrated in **Figure 1**. The MTTF or bathtub curve indicates that a newly installed machine has a higher probability of breakdown due to installation problems in the first few weeks of operation. Following this initial period, the probability of failure is relatively low for an extended period until wear and deterioration means that the probability of breakdown/failure increases sharply with elapsed time.

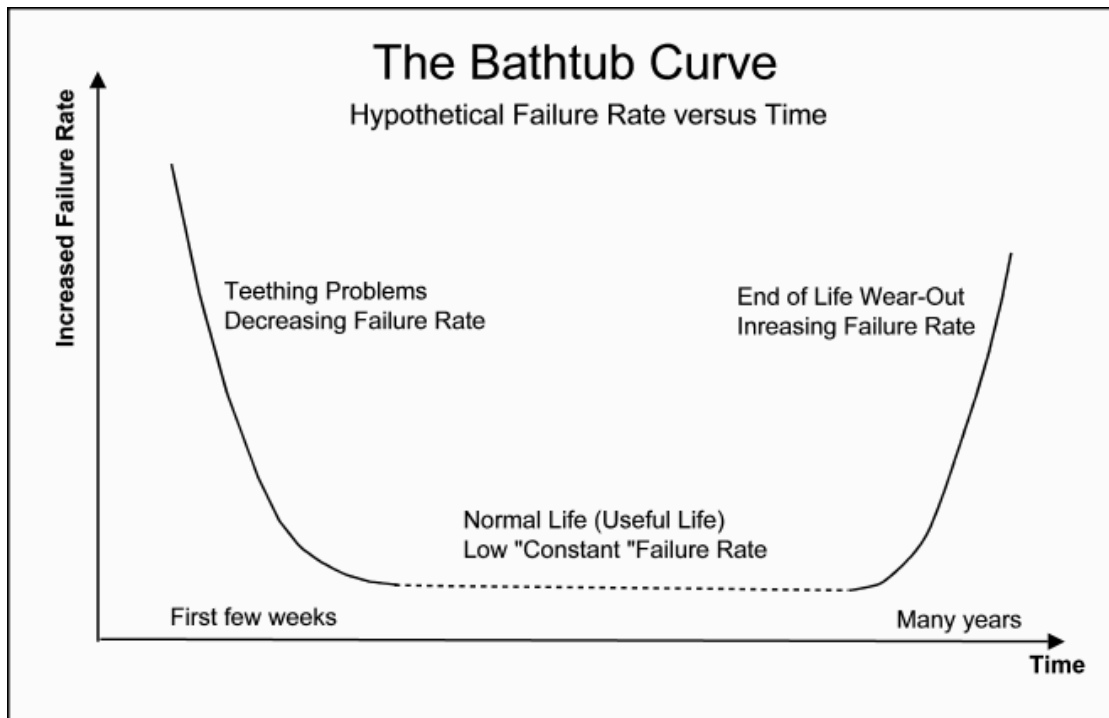


Figure 1. - The Bathtub Curve

The problem with this approach is that machines 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 machine may breakdown anyway and if they are too short maintenance costs may be unnecessarily high. Inappropriate or poor maintenance can also cause breakdowns.

4.5 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) to determine maintenance intervals, uses direct monitoring of the machine. This may include mechanical and electrical condition, environmental factors and other indicators such as frequency of use and load spectrum. These are used to determine the actual mean time to failure for the individual machine and achieve the best balance between low maintenance costs and unplanned failures.

4.6 Best Practice Maintenance Regime For Tower Cranes

In the case of tower cranes, reliance on the "Breakdown" approach is totally inadequate, as any failure presents an immediate safety risk, whilst at the current stage of tower crane technology a total "Predictive Maintenance" system would be difficult to implement. Current best practice is therefore "Planned Preventive Maintenance" backed up by repairs following breakdown. This involves replacing parts and consumables or making necessary adjustments, at preset intervals so that risks do not occur as a result of the deterioration or failure of the equipment. Some elements of Preventive Maintenance such as oil sampling and use of data logging records may well be able to be incorporated into the maintenance regime.

4.7 Investigation of Excessive Wear or Failure

Where maintenance activities identify excessive, unexpected or unusual wear, or failure of tower crane component, this must be fully investigated and a solution sought. This may well require engineering assessment, involve the manufacturer and must be fully documented. The documentation must be presented to the competent person at the time of the next thorough examination.

4.8 Management Structure

Maintenance of tower cranes should be managed in the same way as any other business activity as if not carried out effectively it can have severe financial and safety implications for a business. An effective management structure is required to ensure that everyone involved in the maintenance activity is aware of their responsibilities, properly briefed on their duties and that systems are in place to enable effective feedback, including the monitoring of maintenance data. A sample structure is shown in **Figure 2** below.

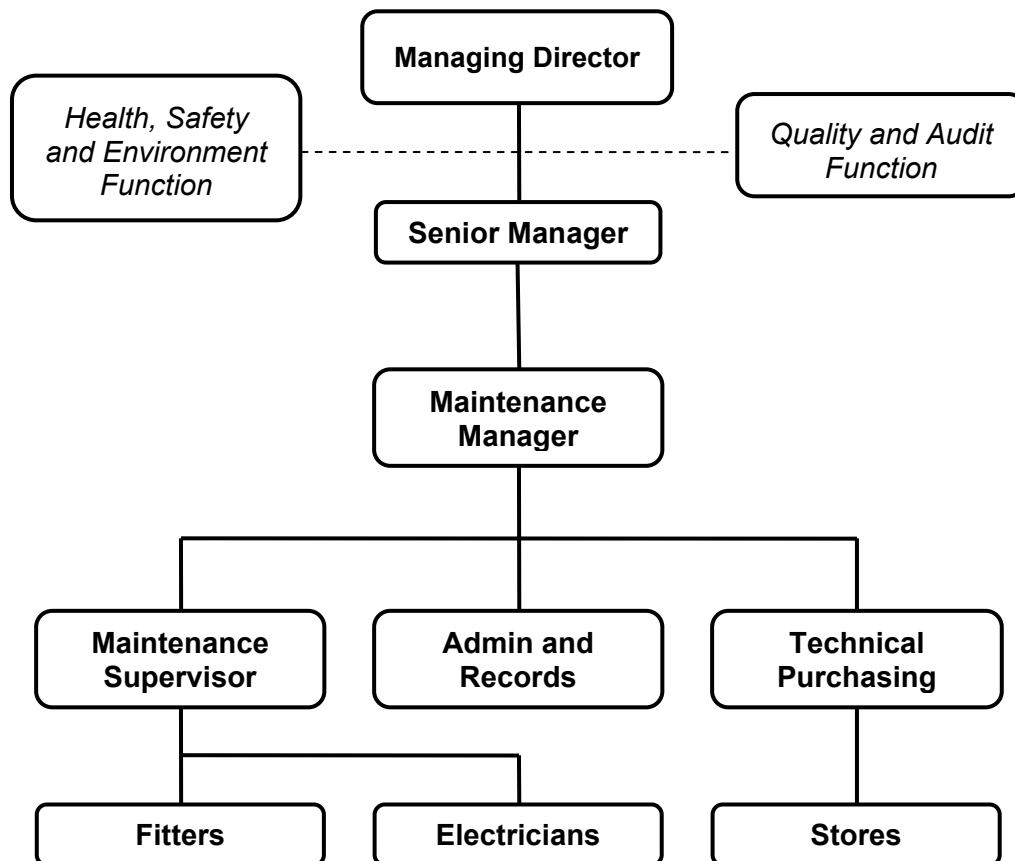


Figure 2. – Typical Maintenance Organisation

4.9 Auditing of Maintenance Systems

Once a maintenance system has been established it is important that it is regularly audited to ensure that the system is being adhered to and that it is functioning correctly. Auditing should be carried out by an auditor from outside the maintenance organisation with a sufficient degree of independence.

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

4.10 Tower Crane Users Responsibilities for Maintenance

The Health and Safety at Work etc. Act 1974 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 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 tower crane the actual undertaking of the maintenance is often delegated to the crane owner by the user. The user however, retains the legal responsibility for ensuring that the maintenance, including the rectification of defects, is carried out.

5.0 Maintenance Intervals

5.1 Introduction

It is essential that planned preventive maintenance is carried out at intervals which ensure that worn and damaged components are replaced before the tower crane becomes unsafe, breaks down or fails. Breakdown will cause downtime and a consequent loss of production for the user, whilst a component failure may well result in a partial or total collapse of the crane with potentially fatal consequences for persons in the vicinity of the crane.

5.2 Pre-delivery Maintenance and Inspection

Before a tower crane is delivered to site, prior to each erection or alteration, it is essential that it is inspected thoroughly to identify any worn or faulty components and that these are replaced. The results of the inspection should be recorded (See **Annex 11.9** and **Annex 13**). This record may be required by the competent person carrying out thorough examination of the crane.

It is considerably easier and less costly to replace components and carry out lubrication and adjustments in a depot, than when the crane has been erected on site. Work on an erected tower crane always involves work at height and presents difficulty in handling heavy components.

Pre-delivery maintenance provides a good opportunity for the completion of supplementary tests before the crane is erected. It is also strongly recommended that the tower crane's drive and control systems should be powered up and checked for correct functioning during pre-delivery maintenance.

The direct transfer of cranes between sites should be approached with extreme caution as it often leads to both delays in erection and time lost through the correction of faults. Best practice guidance is for direct transfers not to be undertaken and for cranes to be taken back to a depot for full pre-delivery maintenance before the next erection takes place.

Following delivery of the crane components to site the erection supervisor should verify that the pre-delivery inspection was completed at the depot prior to despatch and that the items have not been damaged in transit (See CPA Technical Information Note 014, Pre-Erection Component Checks). He should also verify that the correct components have been delivered in accordance with the build sheet and the manufacturer's manual.

5.3 In-service Maintenance Interval

Once a tower crane has been erected on site it should be maintained at regular intervals to avoid breakdown, failure or collapse. The frequency at which maintenance is carried out should be based on the recommendations contained in the manufacture's manual for the crane. This should however generally be taken as the maximum interval as various factors, including the following may require the maintenance interval to be reduced:-

- Usage – Double shifting, frequent lifting at or near the Rated Capacity, long hoist ropes and excessive slewing may accelerate wear of all components;
- Environment – Corrosive environments such as marine or industrial sites may accelerate corrosion of structural components, fasteners and wire ropes;

- Feedback – Feedback from maintenance records and Thorough Examination reports may indicate accelerated rates of wear and deterioration.

Once established the current maintenance interval should be recorded in the machine history file. Any variation from the manufacture's recommended intervals must be recorded and justified each time a change is made.

5.4 *Alteration or Dismantle Pre-Inspection*

Before an erected tower crane is altered or dismantled it should be inspected to ensure that there are no defects which could affect the safety of the alteration or dismantling operation. Any defects found during such an inspection should be recorded for inclusion in the machine history file. The details of these defects, together with any corrective actions must be presented to the competent person at the time of the next thorough examination.

5.5 *Second-hand Tower Cranes*

When purchasing second-hand tower cranes their condition should be thoroughly assessed as nothing can be taken for granted. Where possible this assessment should include a review of maintenance records and previous reports of thorough examination.

Once the crane's condition has been fully assessed any necessary repairs can be carried out and an appropriate in-service maintenance interval established (See **5.3**)

6.0 Maintenance Personnel - Attributes, Training and Assessment

6.1 Introduction

It is essential that the maintenance of tower 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.

6.2 Attributes

Maintenance personnel should be:

- Physically fit;
- Comfortable working at height;
- Have a responsible attitude;
- Able to communicate clearly with other personnel on site;
- Aware of their own limitations in knowledge and experience;
- Fully conversant with the machinery they are required to maintain and its hazards;
- 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;
- 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 working on construction sites and site specific safety requirements;
- Aware of their responsibilities under the Health and Safety at Work Act and supporting regulations;
- Trained and competent in the pre use inspection, correct wearing and limitations of their personal protective equipment.

6.3 Training

All tower crane maintenance personnel should be trained in a set of basic skills to enable them to work safely on site and participate effectively in the maintenance process. They should not be required to undertake tasks for which they have not been trained or 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 site specific safety;
- Slinging and signalling;
- Tool skills, including the selection and use of tools;
- Identification, selection and fitting of fasteners;

- Use, inspection and maintenance of fall protection equipment (working at height);
- Interpretation of technical information, use of manuals;
- Basic assessment of weather conditions;
- Product familiarity on all makes and models of crane on which maintenance is being carried out;
- Preparing equipment for use including isolation of power sources etc;
- Effective communication including the use and care of radio equipment;
- Carrying out basic adjustments;
- Identifying and rectifying basic faults in equipment;
- Assisting with examinations and testing.

These basic skills can be augmented by the following as required:-

- Wire rope inspection and termination;
- Use of specialist tools and equipment appropriate to the work being carried out (including torque wrenches, multipliers and hydraulic tensioning equipment);
- Setting limits, including RCI/RCL;
- Functional testing;
- Carrying out complex adjustments;
- Identifying and rectifying complex faults in equipment;
- Identifying proximity hazards;
- Welding and repair techniques.

6.4 Training Plan

An individual training plan should be drawn up for each person carrying out maintenance on tower cranes. This plan should take into account previous experience, qualifications and underpinning knowledge. Particular care should be taken where trainees fall into the category of Young Persons.

Achievement of this plan and continuing professional development should be monitored at frequent intervals as part of the management review process (See Section 10) and included in the quality system (e.g. ISO 9001) auditing process.

The plan could include elements from the Tower Crane Installation Training Programme, TWR 01 developed jointly by the Construction Plant-hire Association, the Construction Confederation, Construction Industry Training Board and the HSE.

6.5 Ongoing Development

Ongoing development is the conscious updating of technical knowledge and the improvement of a maintenance person's skill throughout their working life. This is a joint responsibility between the maintenance person and their employer.

The employer should maintain a training, experience and development record for each maintenance person. The Record should include details of how ongoing development is being achieved and should include for example:

- Initial training (See 6.8 Training Records);

- Specific training towards enhancements/additions to skills;
- Familiarisation/re-familiarisation, coaching and training;
- Changes in legislation and working practices;
- Updating of product knowledge;
- Attendance at seminars and any refresher training courses.

6.6 Manufacturer's Technical Product Training

Before carrying out maintenance on a specific make and model of tower crane, where a trained supervisor is not present, all maintenance personnel must receive technical training from the crane manufacturer. If direct training by the manufacturer is not available, training may be carried out in-house. In this case training must be carried out by a trainer who has received model specific technical training directly from the manufacturer. This ensures that the source of such training is only once removed from the manufacturer.

In the situation where the manufacturer no longer exists, a careful selection of alternative training providers will be required.

6.7 Qualifications and Assessment

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

National Vocational Qualifications (NVQ) are available for both tower crane erection (including maintenance) and construction plant maintenance.

NOTE: Training assessment tools are given in the *Tower Crane Installation Training Programme, TWR 01*.

6.8 Training Records

A comprehensive individual training record should be established for all maintenance personnel. 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.

7.0 Information for Maintenance

7.1 Introduction

The wide variation of designs and the increasing complexity of tower 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. Maintenance information comes in various forms and from several sources.

Tower crane owners must 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 will ensure frequent updating is taking place;
- Provision of electronic manuals using a system which will ensure frequent updating is taking place;
- A central technical information function which can be contacted for up to date information whenever maintenance is taking place.

NOTE: 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.

7.2 Manufacturer's Information

Information supplied by the tower crane manufacturer will be the main source of instructions and specifications when carrying out maintenance. The primary document will be the maintenance 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 maintenance is being carried out.

Manufacture's manuals are not always complete and in the case where a particular task is not covered, the manufacturer must be contacted for information **BEFORE** the task is undertaken.

7.3 In-House Technical Information

Some tower crane owners will 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 has been withdrawn.

7.4 Method Statements and Work Instructions

Much maintenance work on tower 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, such as hoist winch replacement on an erected crane, will have to be undertaken. Such tasks must be planned thoroughly and a job specific safe system of work put in place. This planning must 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 must 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.

7.5 Generic Information

Maintenance personnel may also need to refer to generic information such as standards and industry guidance. For example, for wire ropes there are BS ISO 4309: *Cranes – Wire Ropes – Care, maintenance, installation, examination and discard*, the CPA Tower Crane Interest Group's *Technical Information Note* series and wire rope manufacturer's literature (See Bibliography).

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

7.6 Machine History

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

7.7 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 should be up to date at the point of access. However the use of electronic display devices, such as laptop computers, during maintenance is not always easy or practical. Information may 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 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 may well affect safety. It is therefore essential that organisations carrying out maintenance on tower 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.

8.0 Inspection During Maintenance

8.1 Introduction

Inspection forms a very important part of the maintenance process and is required by the Health and Safety at Work Act (Regulation 2 (2) (a)); PUWER (Regulation 6) and LOLER (Regulation 9 (3) (b)).

The Guidance on Regulation 9 (3) (b) of LOLER says that:-

You should arrange for suitable inspections to be carried out where the lifting equipment is of a type where its safe operation is dependent on its condition in use and deterioration would lead to significant risks to the operator or other persons. In determining the suitability and scope of the inspection you should refer to available information such as the manufacturer's instructions. Examples of conditions which can be detected by inspection of the lifting equipment include:

- (a) rapid wear arising from use in an arduous environment, e.g. construction;*
- (b) failure through repeated operation, e.g. [of a hoist winch brake];*
- (c) malfunction, e.g. of a rated capacity indicator; and*
- (d) tampering with safety devices, e.g. [overriding a luffing limit].*

8.2 Inspection Intervals

In-Service inspections of tower cranes are normally of four types:-

Daily Pre-use Checks	Normally carried out by the tower crane operator who should have been trained and assessed to carry out this task. Any defects found should be reported to his supervisor and recorded.
Weekly Inspection	May be carried out by the operator if they have been assessed as trained and competent
In-Service Maintenance Inspection	Normally carried out by maintenance personnel as part of the maintenance process (See 5.3)
Intermediate Inspection	An additional inspection required to monitor deterioration of a frequently failing or suspect component

These checks and inspections should only be carried out by personnel who have been adequately trained and assessed as competent to carry out the required tasks. It is recommended that the results of all checks and inspections are recorded in writing to ensure that the requirements of LOLER and PUWER are met.

8.3 Reporting of Defects

Any defects found during checks and inspections must be recorded and reported to the crane owner. Where defects that could affect the safety of persons and require immediate rectification are found, the user of the crane must also be informed to ensure that the crane is taken out of service until the defect has been rectified.

8.4 Use of Checklists

The use of check lists is extremely useful when carrying out inspections, both as a reminder of the items to be checked and as a means of recording the results of the inspection. When inspections are being carried out as part of maintenance it is important that maintenance personnel do not succumb to the temptation not to record faults that are then rectified as part of the maintenance process. This masking of faults invalidates the machine history and hinders the review process (See Section 10). Examples of daily check and weekly inspection checklists are given at **Annex 7 & 8**. An example of a typical in-service maintenance checklist is given at **Annex 5**. These checklists should only be taken as a general guide and may well need additions for specific models of tower crane.

NOTE: Additional information on inspection during maintenance is given in:-

BS 7121- 2:2003 - *Code of practice for safe use of cranes — Part 2: Inspection, testing and examination*

8.5 Clearance of Defects

It is important that defects identified during checks and inspections are rectified before they can affect the safety of persons. It is helpful to categorise defects as follows:-

- defects affecting the safety of persons that are to be remedied immediately;
- defects that are to be remedied prior to the next maintenance activity;
- defects that are to be remedied prior to the next thorough examination.

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

NOTE: There is a need for sites to allocate time for routine inspection and maintenance. It is unreasonable for a site to expect this work to be undertaken overnight, in darkness, or always at weekends. Time needs to be built into normal working hours for this work. (See Section 10)

9.0 Maintenance Records

9.1 Introduction

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

- proof of adequate maintenance as part of the management system;
- establishing breakdown trends over time and informing the review of maintenance frequency;
- identification of component failure trends for feedback to the manufacturer;
- proof of adequate maintenance 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.

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 changes in types of input and output.

9.3 Machine History Files

Each tower 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 tower crane owner. These should include (where applicable):-

- EC Declaration of Conformity;
- Pre-delivery inspections;
- Service reports and worksheets;
- Breakdown reports and worksheets;
- Daily and weekly inspection reports;
- Records of component replacement;
- Records of major overhaul;
- Erection, alteration and dismantle records;
- 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.

In order to demonstrate compliance with the user's responsibility (PUWER Reg. 5) to ensure that maintenance is suitable and sufficient, a machine history file should also be kept on site by the user to record all maintenance activities carried out on the crane whilst it is erected on that site. This file should include (where applicable):-

- Service reports and worksheets;
- Breakdown reports and worksheets including records of defect rectification, component replacement and work completed following extraordinary events;
- Daily and weekly inspection reports;
- Erection, and alteration records including records of modifications and upgrades;
- Thorough Examination reports and records of supplementary tests.

The records in the site machine file will be less comprehensive than those in the owners file as they will only refer to the period during which the crane was on that particular site. It is however important to ensure that records from the site file are duplicated in the tower crane owners history file to ensure that the owners file contains a complete "cradle to grave" record of the particular crane.

As tower cranes are essentially modular structures made up of interchangeable components such as tower sections, jib sections, slew sections and various static and travelling bases, it is often difficult to identify what actually makes up an individual crane with an individual serial number. Common practice in the industry is to take a crane with a given serial number as being made up of the slew section, operator's cab, counter jib/machinery deck and jib. All other components are added to the "crane" as required, to make up a tower crane of a particular configuration for erection on a specific site. As the machine history file will only refer to those components that make up the "crane" there is a need for supplementary records for all other components. For each installation of the crane a record should be made indicating the identification and age of all the main components including jib sections, slew section, counter jib, tower sections and base components.

10.0 Management Review of Maintenance Records and Procedures

10.1 Introduction

A regular management review of tower crane maintenance records and procedures is essential for the safe and efficient operation of a tower crane fleet. It ensures that management can be confident that a robust maintenance system is in place and will rapidly highlight any shortcomings and the need for corrective action. The review should include:-

- A review to see that faults are being corrected and closed out appropriately and maintenance schedule is being completed to plan;
- A review to determine if the regime and frequencies are appropriate and to analyse trends.

10.2 Benefits

The benefits of regular management review of maintenance records are:-

- Confidence that the system is functioning correctly;
- Identification of extraordinary events and failures;
- Ensuring that there is proof of adequate maintenance to the Enforcing Authorities in the event of an incident;
- Establishing breakdown trends over time and informing the review of maintenance frequency;
- Identification of component failure trends for feedback to the manufacturer;
- Providing breakdown trends to the manufacturer to inform future designs;
- Highlighting on-site maintenance access problems for feedback to the manufacturer to improve future designs;
- Monitoring the performance of individual cranes over time to inform future purchases.

10.3 Review Frequency

The review should be carried out initially at least monthly. Once a suitable level of confidence in the systems has been established the review frequency may be reduced in the light of experience.

10.4 Review Methodology

The review should aim to identify exceptional events such as occurrences of heavy expenditure and reoccurring faults. It should also measure achievement of maintenance activities against target. An example of the use of such Key Performance Indicators is given in **Annex 9**.

10.5 Review Records

It is essential that written records of the management review are made, both as evidence that the reviews have been undertaken and to evaluate long term trends.

11.0 Site Issues For Maintenance

11.1 Introduction

Maintaining a tower crane on site presents a particular set of issues when compared with carrying out maintenance operations in a workshop or yard. These issues are best addressed at the planning stage before the crane is erected on site and taken into use. The effective maintenance of tower cranes on site will require the cooperation of the user and an example of a document informing them of the issues they should consider when maintenance is being undertaken, is given at **Annex 4**.

11.2 Maintenance Downtime

The main purpose for a tower crane being on site is to carry out lifting operations as part of the construction process. Site managers are understandably reluctant to stop the crane whilst maintenance is carried out. If maintenance downtime is not scheduled into the construction programme, maintenance is pushed to the back of the queue and ends up being carried out hurriedly in unsafe conditions such as poor light.

It is therefore essential that tower crane owners make clear to those hiring their cranes that maintenance is of paramount importance and that adequate maintenance downtime must be built into the site programme. Hirers must be informed at the planning stage of the frequency and length of time required for maintenance operations.

Construction projects in built up areas often have environmental restrictions imposed on them which severely limit working time at week ends and evenings. Such restrictions must be taken into account in maintenance planning.

Tower crane hirers should be informed that when maintenance of a tower crane is taking place the maintenance team have full control of the tower crane.

11.3 Communication

Those planning and carrying out maintenance on tower cranes on site must ensure that they have effective lines of communication with the site for both routine maintenance and attending to breakdowns. Maintenance personnel must always report their arrival on site, agree the programme of work to be carried out and report back once the tasks have been completed. This will avoid much frustration and misunderstanding on both sides.

11.4 Availability of Operators

Many maintenance operations such as fault finding and limit setting require the crane to be operated from the control cab whilst maintenance personnel are working on other parts of the crane. Arrangements should be made to ensure that an operator is available on such occasions and that a safe system of work is in place.

11.5 Availability of Power

Maintenance on tower cranes requires the crane to be operational and arrangements must be made to ensure that power is available.

11.6 Availability of Site Facilities

When maintenance is being carried both during and outside normal working hours, arrangements must be made to ensure that site management, safety and welfare facilities are available to maintenance personnel.

11.7 Access For Deliveries

Maintenance operations, particularly the rectification of breakdowns often require spare parts to be delivered to site. Care must be taken to ensure that there is adequate access for delivery and that adequate acceptance procedures are in place to ensure that the parts are available when required by maintenance personnel and are not lost on site.

11.8 Lifting Operations

Major maintenance operation such as the replacement of large components on an erected crane will require careful planning of the lifting operations involved. Lifting may be carried out by an oversailing crane on multi crane sites but on single crane sites a large mobile crane may need to be brought onto site with the consequent need for road closures and adequate access onto site. Consideration must also be given to the effect of component removal on the balance of the crane.

All this reinforces the point that major work on a tower crane is best carried out in a depot workshop and that effective crane preparation and pre-delivery inspection will much reduce the need for such operations on site.

11.9 Lone Working

Lone working should be avoided at all times by suitable liaison with the person in control of the site to ensure that site personnel are always in attendance.

The planning process for work at height on tower cranes should take into account the particular hazards of lone working and maintenance at height by lone workers should not be undertaken.

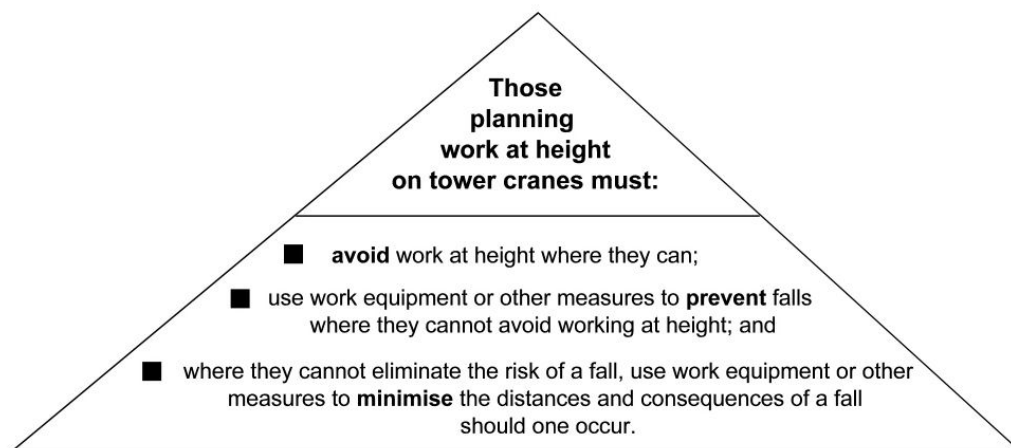
If lone working at ground level is unavoidable suitable measures should be put in place to minimise risks to the lone worker. This might include:-

- Call in arrangements;
- Notification to a remote supervisor of entry and exit to premises;
- Provision of alarm and tracking systems.

NOTE: Additional advice on lone working is given in HSE publication INDG 73 - *Working alone in safety*

11.10 Work at Height

Some maintenance activities on erected tower cranes will require competent persons to work at height outside edge protected areas on the tower crane structure. The Work at Height Regulations 2005 set out a hierarchy of fall protection measures to be taken when planning work at height. These are illustrated in the following diagram:-



This means that those planning work at height on tower cranes should:-

- Avoid work at height wherever possible and actively seek solutions to facilitate this;
- If this is not possible, use “collective” means of protection such as guardrails;
- If this is not possible, use “personal” means of prevention such as work restraint;
- If this is not possible, use a personal fall protection system such as a work positioning system or fall arrest system;
- Additionally provide training and instruction or take other measures to prevent any person falling a distance liable to cause personal injury.

Where a risk assessment indicates that a personal fall protection system is required a work positioning system should always be used in preference to a fall arrest system. Where the use of fall arrest personal fall protection systems are unavoidable there will be a risk of the wearer being left suspended following a fall and arrangements must be made to ensure that they can be rescued in a safe and timely manner (See **Annex 1**).

11.11 Isolation of Systems During Maintenance

To avoid the risk of trapping, crushing and shearing during the maintenance of mechanisms on tower cranes, all systems should be isolated before work starts. Where this is not possible due to the need to have power to a system for fault diagnosis etc., a safe system of work should be put in place to mitigate the risks of trapping. Such a safe system of work may well involve a “permit to work” and adequate communication between the crane operator and other members of the maintenance team. If safety systems have to be bridged or over-ridden during the fault finding, checks must be made to ensure that all safety systems are functioning correctly before the crane is returned to service.

11.12 Communication Equipment

Maintenance personnel should be provided with an adequate means of communication, often hand portable radios, to ensure that all members of the maintenance team can communicate effectively with each other, the tower crane operator and personnel on the ground.

NOTE: Additional advice on radio communications is given in the CPA Technical Information Note TIN 017 - *Radio Communication for Lifting Operations*

12.0 Spare Parts

12.1 Introduction

Maintenance operations on tower cranes can only be fully effective if the correct spare parts are available at the correct location in a timely manner. This can only be achieved if a robust spare parts management system is in place. Ineffective management of spare parts will result in both direct and indirect costs and may well affect the safety of the tower crane.

12.2 Availability and Sourcing

The two extremes of spare part sourcing are to stock every spare part that could ever be required in the crane owner's stores or to stock nothing, relying on the tower crane manufacturer's stock with courier delivery. In practice a combination of the two is often used, avoiding a costly inventory whilst ensuring that fast moving items are readily available.

A list of critical items with long lead times should be identified by consultation with the manufacturer. Strong consideration should be given to stocking such items to ensure minimum crane downtime.

12.3 Spare Part Specification

Spare parts should always be obtained from the crane manufacturer.

If this is not possible it is essential that they meet the original manufacturer's specification. Ensuring that this is the case is often a complex process involving a full engineering assessment of the component to be replaced.

12.4 Stock Control

Spare parts must be controlled using a robust stock control system. This will allow stock levels to be maintained at economic levels and ensure that valuable stock is not "misplaced". Too much stock will tie up capital unnecessarily, whilst too little will result in excessive downtime and repeat visits to site.

Stock levels should be periodically reviewed to ensure that levels are adjusted in the light of experience.

12.5 Storage

Spare parts must be stored in secure dry conditions to minimise deterioration and loss. Some form of racking is essential in order that each part number has a readily identifiable and unique location to ensure that parts can be easily located for issue and stock checks.

Spare parts can represent a considerable capital investment and should be treated as tangible business assets.

If spare parts are stocked in service vans for ready availability on site, this stock must be subject to regular audit to ensure that items are not misplaced and that they are in "as new" condition. Care should be taken to ensure that maintenance personnel do not accumulate a personal stock of part worn components (See **12.7**).

12.6 Identification

All spare parts should be indelibly marked with at least a part number to ensure that they are readily identifiable in storage, in the workshop and on site. Identification solely by comparison with the part being replaced is dangerous and could result in a component with the wrong material specification or dimension being fitted.

12.7 Component Reuse and Refurbishment

There is always a temptation to store part worn components for reuse. This is often a false economy as these components may contain hidden defects and may fail without warning. Refurbishment of worn components should only be undertaken if they can be returned to the manufacturer's original specification.

Worn or failed components that have been returned to the depot for investigation following replacement must be kept in a quarantined area until authorised for disposal. Disposal should ensure that the component is scrapped in a way that ensures it cannot be reused. All other replaced components should be scrapped on replacement.

12.8 Installation and Replacement of Spare Parts

Spare parts must always be installed in accordance with manufacturer's instructions as in the past problems such as gear box failure has occurred when replacement parts have not been installed correctly. Installation instruction should be provided by the manufacturer with the spare parts and must be made available to the personnel carrying out the installation.

13.0 Maintenance Facilities and Equipment

13.1 Introduction

Maintenance operations on tower cranes require adequate facilities and equipment to enable them to be carried out effectively, efficiently and safely. The size and sophistication of the facilities will depend on the degree of maintenance tasks to be carried out

13.2 Workshops

If maintenance and overhaul of mechanical and electrical components and assemblies is to be carried out successfully, an adequately sized workshop is essential. This should be weather tight with adequate heating, ventilation and lighting, and provided with power, work benches and adequate storage for tools and equipment.

13.3 Welfare Facilities

Suitable welfare facilities should be provided for the use of all employees and visitors. These should include:-

- Toilets;
- Washing facilities;
- Clothes storage and drying;
- Messing facilities;
- First Aid facilities and arrangements.

13.4 Washdown and Cleaning Area

A suitable area should be allocated to the washing down and cleaning of tower crane components. This should be a concrete area with suitable drainage which includes interceptors to ensure that solids and oils are not discharged into the main drainage system.

13.5 Shot Blasting

If shot blasting of tower crane components is to be undertaken at the maintenance facility adequate facilities must be provided to ensure that the requirements of noise, pollution control and COSHH regulations are not breached.

13.6 Spray painting

If spray painting of tower crane components is to be undertaken at the maintenance facility adequate facilities must be provided to ensure that the requirements of noise, pollution control and COSHH regulations are not breached. In certain circumstances spray painting operations will require licensing by the Local Authority who should be consulted before any spray painting equipment is installed at the maintenance facility.

13.7 Waste Disposal

Tower crane maintenance operations may well produce various types of hazardous waste including waste oils, paint and thinners. These should be stored in appropriate

containers and disposed of using a licensed waste contractor. Registration with the Environment Agency is also required.

13.8 *Hard Standing*

Maintenance facilities should be provided with adequate hard standing to enable tower crane components to be moved and handled safely.

13.9 *Test Area*

Maintenance facilities should be provided with a suitable test area to enable machinery assemblies and control systems to be powered up and tested for correct functioning before a crane is sent to site. It is essential that such a test area has a power supply of adequate capacity.

13.10 *Storage*

Suitable areas should be provided for the safe and secure storage of tower crane components. An area should be set aside where components received from site can be quarantined until they have been inspected and any defects rectified.

Care should be taken when storing tower crane components to ensure that all electrical equipment is adequately protected from the weather. Components should also be oriented so that water cannot pool or become trapped and lead to corrosion.

13.11 *Craneage*

Maintenance facilities will require adequate craneage to ensure that tower crane components can be handled safely both inside and outside the workshop. Internal craneage is often provided by the installation of an overhead travelling crane, whilst external craneage is frequently provided by the installation of a tower crane of suitable capacity. It should be borne in mind that the erection of a tower crane in industrial premises will generally require planning permission from the local planning authority.

13.12 *Loading and Unloading of Components*

The loading and unloading of components will involve work at height by the personnel carrying out these operations. Suitable risk assessments should be carried out to identify both the hazards and suitable control measures. Control measures may well include the provision of access gantries and loading bays with suitable edge protection.

NOTE: Further advice is given in the CPA Best Practice Guide on *Work at Height Whilst Loading and Unloading Transport*.

13.13 *Fastener Maintenance*

Fasteners such as bolts and pins are fundamental to the structural integrity of a tower crane. It is essential that all fasteners are stored and maintained correctly and the maintenance facility should be provided with suitable areas for these activities. It is particularly important that un-inspected fasteners, received from site, are stored separately from fasteners that have been serviced and are ready for re-issue.

13.14 Wire Ropes

Facilities should be provided for the storage, cutting, tensioning and lubrication of wire ropes. Wire ropes should be stored and transported on suitable drums, not as loose coils and must be stored undercover in a well ventilated area.

NOTE: Further advice on the installation, inspection and maintenance of wire ropes is given in:

- Clause **22** of BS 7121-1:2006, *Code of practice for safe use of cranes — Part 1: General*;
- Clause **12** of BS 7121-2:2003, *Code of practice for safe use of cranes — Part 2: Inspection, testing and examination*;
- CPA Technical Information Note TIN 004 - *Installing Wire Ropes on Winch Drums and Storage Reels*.

13.15 Test and Measuring Equipment

Sufficient test and measuring equipment must be available to enable all testing and measurement to be carried out accurately. Such tests and measurements might include:-

- Function testing;
- Overload testing;
- Electrical testing;
- Fault diagnosis;
- Non destructive testing;
- Dimensional measurement;
- Torque measurement;
- Bearing play measurement.

All test and measuring equipment should be marked with a unique identification number and entered on an asset register to ensure that the equipment can be monitored and tracked throughout its life. Equipment should be stored in a dry and secure location.

13.16 Calibration

All test and measuring equipment should be subjected to periodic calibration, marked with the calibration expiry date and records kept of the calibration. The calibration interval should be set taking into account manufacture's guidance together with the frequency and conditions of use.

13.17 Hand Tools

Maintenance personnel should be supplied with adequate hand tools to enable them to carry out maintenance tasks safely and efficiently. These tools should be checked and maintained at regular intervals to ensure that they continue to function safely.

13.18 Power Tools

Maintenance personnel should be supplied with adequate power tools to enable them to carry out maintenance tasks safely and efficiently. These tools should be checked and maintained at regular intervals to ensure that they continue to function safely. Electric power tools are required to be checked before each use by the user and more formally (PAT tested) at regular intervals to ensure that they remain safe.

Power tools used on construction sites should be PAT tested at a maximum of three monthly intervals, whilst those used in a workshop or permanent establishment should be tested every six to twelve months.

NOTE: Further advice on the maintenance and testing of electrical power tools is given in HS(G) 107 - *Maintaining portable and transportable electrical equipment*.

13.19 Welding Facilities

Structural repairs to tower cranes will require the use of welding techniques. Welding should only be carried out by trained competent personnel working to welding procedures approved by the tower crane manufacturer or following a full engineering assessment by a competent engineer. Welding should be carried out undercover wherever possible and arrangements should be made to protect welders and other personnel from arc flashes and welding fumes.

Welding equipment should be regularly checked, maintained and calibrated as appropriate. Consumables should be stored in a secure dry area.

Weld repairs should be subjected to full visual, and where appropriate NDT inspection.

NOTE: Further information is given in:-

- BS EN 287-1:2004 - *Qualification test of welders. Fusion welding. Steels*;
- BS EN 970:1997 - *Non-destructive examination of fusion welds. Visual examination*;
- BS EN ISO 15607:2003 – *Specification and qualification of welding procedures for metallic materials. General rules*;
- British Institute of Non-destructive Testing at <http://www.bindt.org>.

13.20 Hydraulic Presses and Torque Gear

The maintenance and assembly of some tower cranes requires the use of hydraulic presses and hydraulic torque gear. These items should be checked and maintained as with other power tools but will also require calibration checks at regular intervals to ensure that bolts are not over or under tightened.

13.21 Machining Facilities

Connections between tower sections may well suffer wear and deformation over time, leading to excessive clearances between pins and holes, which in turn will increase the load on the structure. Pin holes can be restored to their original dimensions by techniques such as building up the lost material by welding and then machining to a finished size. If such methods are employed they **must** be approved by the tower crane manufacturer.

13.22 Job Control

It is essential that all refurbishment and repair of tower cranes is carried out by competent personnel who are fully briefed and supplied with adequate information, equipment and facilities. Jobs should be monitored to measure progress against target and to ensure that late delivery of spare parts, lack of resources etc. is not holding up the job.

13.23 Repair Records

It is essential that all work carried out as part of maintenance is recorded in the machine history file (See **9.3**).

13.24 Maintenance Vehicles

Maintenance Personnel who are required to work on site should be provided with suitable vehicles for transport of themselves, tools, equipment and spare parts. Vehicles should have adequate carrying capacity and be fitted with racking to ensure that tools, equipment and parts can be stored securely during travelling. Overall security of the vehicle should also be considered as the contents may well have a high value.

It should be remembered that although maintenance vehicles under 3500kg GVW are exempt from the EU Drivers Hours and Tachograph rules, anyone driving a company vehicle is “at work” and the requirements of the Working Time Regulations for rest breaks etc. apply.

14.0 Approaches to Thorough Examination

14.1 Introduction

The primary purpose of thorough examination is to ensure that a tower crane or climbing frame 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 and is a statutory requirement.

Tower cranes operate in a high risk environment which includes lifting loads over people and with the operator in an elevated position. These factors must be taken into account by the competent person when determining the scope and nature of the thorough examination.

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. The competent person may require supplementary tests as part of thorough examination. See BS 7121-2 and BS 7121-5.

NOTE: The legal requirements covering thorough examination are set out in HSE publication L113 - *Approved Code of Practice and Guidance to LOLER*. It is essential that anyone undertaking thorough examinations of tower cranes or the management of the thorough examination of tower cranes obtains and familiarises themselves with this document.

14.2 Types of Thorough Examination

There are three situations where thorough examination is required by Regulation 9 of LOLER:-

- After each installation of the tower crane or climbing frame and before putting into service, LOLER Regulation 9(2)(a)&(b);
- Periodically whilst in service, LOLER Regulation 9(3)(a)(i)&(ii);
- After exceptional circumstances have occurred, LOLER Regulation 9(3)(a)(iv).

14.3 Initial Post Installation Thorough Examination

Once a tower crane has been erected on a new location (site) it must be thoroughly examined by a competent person, before being taken into service, to ensure that it has the adequate strength and stability for its intended use and that any defects present have been identified and are rectified.

This initial thorough examination will require a high degree of scrutiny of the configuration and all relevant documentation to ensure that the tower crane has been installed correctly and is safe to use.

If the configuration of the tower crane is changed while it is still at a given location, e.g. a change in height or jib length, the crane will require further thorough examination before it is returned to service.

14.4 Thorough Examination of Self Erecting Tower Cranes

The requirement for thorough examination of self erecting tower cranes will depend on the extent of assembly from components carried out during the deployment of the crane on site. In the case where a self erecting tower crane arrives at site, is positioned on a prepared base, connected to a power supply, deployed by unfolding using its own winches and where no additional components are put into the structure; then no thorough examination following erection will be required as the crane will not

have materially altered since its last periodic examination. A parallel may be drawn here with mobile cranes.

On the other hand a self erecting tower crane where after delivery to site and positioning on a prepared base, the deployment of the crane structure requires the assembly of additional components will require a thorough examination after erection as is the case with a top slew tower crane.

In either case checks should be carried out on site after installation to ensure that all crane motions and limits are functioning correctly.

Further guidance on the thorough examination of self erecting tower cranes is given in **Annex 6**.

14.5 Periodic Thorough Examination

Once a tower crane has been taken into service on a new site it must be thoroughly examined periodically to ensure that it is safe to continue in use. LOLER specifies that the maximum intervals between thorough examinations are six months for tower cranes that lift people and twelve months for tower cranes that lift goods only.

It is however good practice to set the maximum interval for all tower cranes on construction sites at six months for the following reasons:-

- Tower cranes frequently work above or near people, both personnel on site and members of the public outside the site;
- Most tower cranes will be used for lifting of persons, including rescue, even if it is not initially planned;
- The intensity of use and the environment in which they are installed.

This decision may be made by the competent person or the tower crane owner.

14.6 Thorough Examination Interval

The recommended maximum interval of six months may be reduced at the discretion of the competent person, taking into account environmental factors or the general age and condition of the crane etc. To assist the competent person in assessing the interval he should view 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.

14.7 Thorough Examination After Exceptional Circumstances

If the tower crane is subjected to exceptional circumstances it should be removed from service and subjected to a thorough examination to ensure that it is safe to be returned to service. Exceptional circumstances may include an overload, jib clash, use for particularly arduous duties, a failure of a structural component or being subjected to weather in excess of design parameters.

14.8 Thorough Examination of Tower Crane Climbing Frames

Climbing frames should be thoroughly examined upon each assembly on a crane and also periodically if left installed for a period of six months or more on a particular crane. An example of a typical procedure for climbing frame thorough examinations and checks is given in Annex D of BS 7121-5:2006.

14.9 Examination Schemes

As an alternative to the maximum intervals of twelve and six months for periodic thorough examination LOLER allows a competent person to draw up an “examination scheme” for an item of lifting equipment such as a tower crane. This scheme must take account of the condition of the equipment, 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. As a result of this detailed analysis of the equipment’s condition and use the competent person will specify the intervals at which periodic thorough examinations must be carried out. These intervals may be shorter or longer than the six or twelve month intervals and will reflect the anticipated rate of deterioration and likelihood and consequences of failure.

Examination schemes are a useful approach where lifting equipment is used in well defined circumstances and a consistent environment, such as a manufacturing plant. Lifting equipment such as tower cranes used in the construction industry, however, are used in ever changing circumstances, using different components for each installation, arduous duties, lifting over people and involving multiple operators. In addition examination schemes require significant time to draw up, validate and administer.

Best Practice guidance suggests that the examination scheme approach is totally unsuitable and periodic thorough examinations should be used for all tower cranes.

14.10 Tower Crane Users Responsibilities for Thorough Examination

Regulation 9 of the *Lifting Operations and Lifting Equipment Regulations 1998 (LOLER)* requires employers to ensure that tower cranes are thoroughly examined at prescribed intervals (See **14.2**). In the case of a hired-in tower crane the actual undertaking of thorough examinations is often delegated to the crane owner by the user. The user however, retains the legal responsibility for ensuring that thorough examinations are carried out.

15.0 Management of Thorough Examination

15.1 Introduction

LOLER permits thorough examination to be carried out by competent persons from both third party in-service inspection organizations and “in-house” examiners. Competent persons are required to have *“such appropriate practical and theoretical knowledge and experience of the lifting equipment to be thoroughly examined as will enable them to detect defects or weaknesses and to assess their importance in relation to the safety and continued use of the lifting equipment.”* It is also *“essential that the competent person is sufficiently independent and impartial to allow objective decisions to be made.”*

15.2 Use of a Third Party Inspection Body

Most third party inspection bodies that carry out thorough examinations of tower cranes will be members of the Safety Assessment Federation and hold accreditation to ISO 17020.

In order to satisfy such accreditation requirements the following must be included:

- Verification of an organisation’s independence for the function of inspection;
- Identification and stipulation of the limiting scope of activity for the organisation (i.e. defining the inspection competencies of the organisation);
- Sufficiently documented processes and procedures (Procedural, Quality and Health & Safety) supporting the thorough examinations undertaken;
- Evidence that documentation has been periodically reviewed and relevant information provided to the competent person;
- The auditing of these processes and procedures on a periodic basis, by a recognised accreditation body;
- The performance assessment, by the accreditation body, of the organisation’s in-house audit schedule and that non-conformity action has been suitably completed;
- The auditing, by the accreditation body, of the competent person’s training records;
- The auditing, by the accreditation body, of the thorough examinations carried out by competent persons;
- The auditing, by the accreditation body, of the reporting process to ensure that enforcing authority reports are issued as appropriate without fear or favour and within required timescales. This will also include report format compliance with legislative requirements.

The benefit of a third party inspection body is that the competent person will, by definition, be independent from all aspects of the installation and maintenance of the tower crane. They may, however, not have the detailed product knowledge that an in-house competent person might possess but they will have been comprehensively trained and assessed in thorough examination techniques and will know when to ask for product specific information. They will look at a crane from a different perspective than someone regularly involved in the maintenance of that type or model of crane.

Use of a third party body will require management input from the crane owner and user in terms of making the tower crane available, providing details of crane configuration, maintenance carried out, preparation of the crane for thorough examination, supplementary tests and management of thorough examination reports.

Both parties must also be prepared to take a crane out of service if the third party competent person carrying out a thorough examination identifies defects which immediately affect the safety of persons.

It is essential that the tower crane owner and the competent person, or his employer, agree and periodically review, the programme and information requirements for thorough examinations, including the specific supplementary test reports that will be provided prior to each thorough examination following erection and each subsequent in-service thorough examination. This is especially important when a new external provider has been appointed.

NOTE: The United Kingdom Accreditation Service (UKAS) is the sole UK body authorised by The Department for Business, Enterprise & Regulatory Reform (BERR) to carry out accreditation to ISO 17020

15.3 Carrying Out Thorough Examination In-house

As noted above, LOLER permits the use of in-house competent persons. Their employer must, however, ensure that they *“have the genuine authority and independence to ensure that examinations are properly carried out and that the necessary recommendations arising from them are made without fear or favour.”* This can only be demonstrated by means of a clearly defined autonomous management structure with built in checks and balances to ensure that the necessary degree of independence is achieved. One means of demonstrating this is accreditation to ISO 17020.

15.4 In-house Thorough Examination Management Structure

If thorough examination of tower cranes is being undertaken in-house an effective management structure should be put in place to ensure that everyone involved in the activity is aware of their responsibilities, properly briefed on their duties and that systems are in place to demonstrate independence and enable effective feedback including the monitoring of thorough examination. A sample structure is shown in **Fig. 3**.

A number of measures can be taken which will help establish the independence of the competent persons:-

- A fully documented, detailed and independently audited quality system such as ISO 9001;
- The thorough examination function reporting straight to the Managing Director or equivalent;
- An undertaking that the competent person will never examine their own installation or maintenance work;
- A statement that in the case of any conflict, the Managing Director will always back the competent person;
- The competent person has the authority to stop the operation of any tower crane owned or operated by the company;
- The competent person has the authority to send reports of examination where there is an imminent danger of serious personal injury to the enforcing authority (HSE or Local Authority);
- The competent persons are not paid by results.

From this, it is clear that thorough examinations, following erection, carried out by any member of the erection team (including the supervisor) would not have the

required degree of independence. Members of the erection team may however, undertake supplementary inspections, tests and reports requested by the competent person.

It is also clear that in-service thorough examinations, where a member of the maintenance team examines his own work would not have the required degree of independence. Members of the maintenance team may undertake supplementary inspections, tests and reports requested by the competent person.

15.5 Auditing of In-house Thorough Examination Management Systems

Once an in-house thorough examination system has been established it is important that it is regularly audited to ensure that the system is being adhered to and that it is functioning correctly. Auditing should be carried out by an auditor from outside the thorough examination department with a sufficient degree of independence.

If a business has a formal quality management system such as an ISO 9001 accredited system the thorough examination activity should be integrated into that system and the scheduled audits.

Strong consideration should also be given to obtaining UKAS accreditation to ISO 17020 as an in-service inspection body.

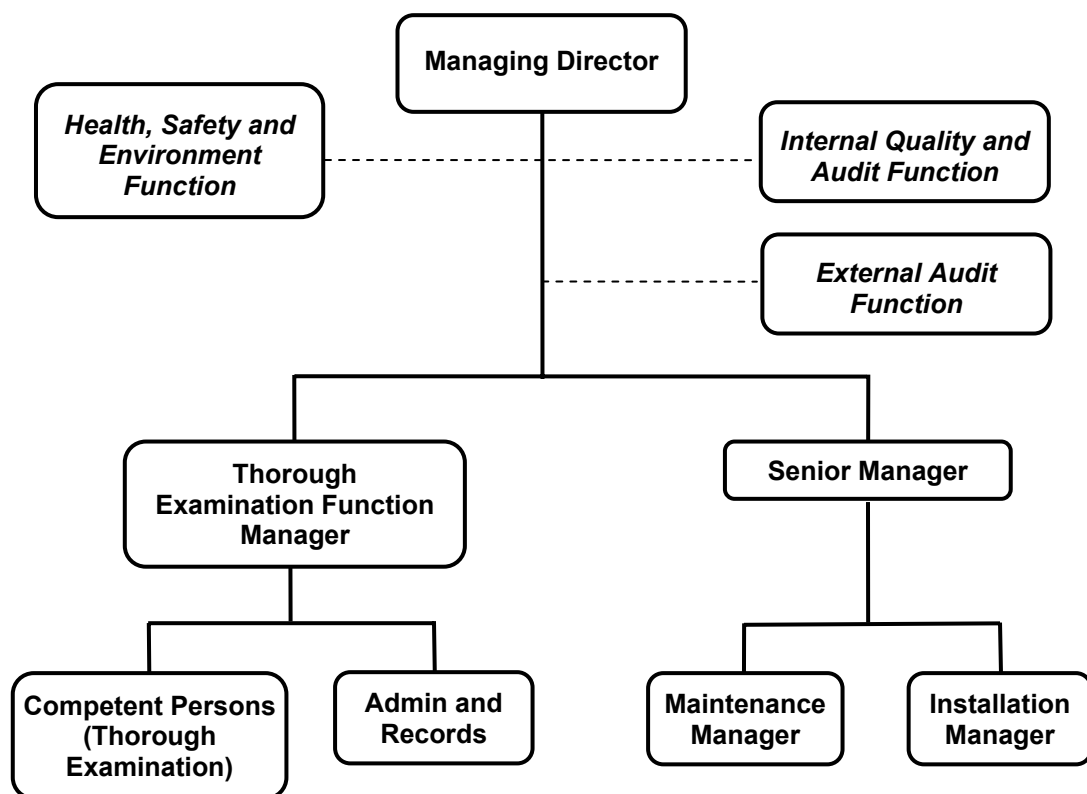


Figure 3. – Typical In-house Thorough Examination Organisation Structure

16.0 Competent Persons – Attributes, Training and Assessment

16.1 Introduction

It is essential that the thorough examination of tower cranes is always carried out by competent persons who have been assessed as competent and have adequate training, information and independence to carry out the work required.

16.2 Attributes

Competent persons carrying out the thorough examination of tower cranes should have the following attributes:

Personal Attributes

- Be physically fit;
- Be comfortable working at height;
- Have a responsible attitude;
- Be able to communicate clearly with other personnel on site;
- Be familiar with working on construction sites and site specific safety requirements;
- Be aware of their responsibilities under the Health and Safety at Work Act and supporting regulations;
- Be trained in the use, pre-use checks and maintenance of their personal protective equipment and capable of using it correctly.

Knowledge Base

- Have an understanding of the legislative requirements for thorough examination;
- Have an understanding of the tower crane design Standards and codes of practice for the selection and use of tower cranes, together with the applicable inspection/examination criteria;
- Have an understanding of the safety rules and associated codes of practice that are applicable to tower cranes;
- Have an understanding of the inspection and maintenance requirements of tower cranes;
- Have knowledge of appropriate test procedures which may be employed and the interpretation and limitations of those techniques;
- Have an understanding of drawings and manufacturing literature relevant to the tower cranes to be inspected or examined;
- Have knowledge of the materials and techniques used in the manufacture and assembly of the tower cranes;
- Be aware of their own limitations.

Practical Skills

- Be capable of detecting defects or weaknesses in tower cranes which could compromise the safety of the tower crane;

- Have sufficient knowledge and experience to assess the importance of defects or weaknesses in the tower crane and identifying what actions need to be taken in order to rectify them. In particular they should be able to:-
 - verify that the tower crane is operating as intended;
 - specify the appropriate time-scales within which identified defects or weaknesses need to be rectified;
 - establish that defects identified in the previous report of thorough examination have received attention;
 - assess the correct function of all safety devices;
 - check that warning notices are correctly fixed and legible; and where necessary specify any limitations on the use of the tower crane;
 - witness any testing required as part of thorough examination;
 - report on the findings of the thorough examination.

16.3 Qualifications and Experience

Competent persons should have both appropriate recognised academic qualifications and a relevant level of practical experience in a related engineering field.

The following are examples of those with the cumulative attributes necessary to support competence:

- Engineering Technician as defined by the Engineering Council or equivalent (e.g. appropriate ONC with relevant experience) having a minimum of 5 years experience within a relevant discipline of which at least one year shall have been spent working within an engineering discipline related to lifting equipment;
- Person trained in a relevant engineering discipline with a recognised and documented engineering apprenticeship (in lieu of an academic qualification) with a minimum of 5 years experience within a relevant discipline of which at least one year shall have been spent working within an engineering discipline related to lifting equipment;
- Level 3 (Tower Crane Erection) or Level 4 (Engineer Surveyor National Vocational Qualifications (NVQ) are available for competent persons carrying out thorough examination of tower cranes.

Employers must determine competence of each individual person, both existing employees and new entrants, based on the attributes listed above together with academic qualifications. A shortfall on attainment level does not preclude employment in this role but such shortfalls must be addressed before the person is allowed to carry out unsupervised thorough examinations of tower cranes.

16.4 Competent Person Selection

Competent persons should be selected through a formally documented assessment process.

The purpose of the assessment, which must include a sufficiently robust technical interview and other elements, is to determine whether or not the interviewee has the general aptitude and appropriate level of relevant underpinning knowledge and understanding to perform the intended duties of a competent person when combined with the training provided by the employer.

16.5 Training Plan

An individual training plan should be drawn up for each person who is to carry out the thorough examination of tower cranes. Achievement of this plan and continuing professional development should be monitored at frequent intervals as part of the management review process (See Section 19) and included in the quality system (e.g. ISO 9000) auditing process.

16.6 Training Courses

Training courses covering both the management and practice of thorough examinations are available from the National Construction College at www.citb-constructionskills.co.uk/traininglearning/nationalconstructioncollege

16.7 Technical Product Awareness

Before carrying the thorough examination of a specific make and model of tower crane all personnel should receive technical information from the crane manufacturer or the employer. This may be carried out in-house by a trainer who has received model specific technical training directly from the manufacturer.

16.8 Assessment

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

16.9 Continuing Professional Development

Continuing Professional Development (CPD) is the conscious updating of professional knowledge and the improvement of a competent person's Competency throughout their working life. This is a joint responsibility between the competent person and their employer.

The competent person's employer should maintain a training, experience and development record for each competent person. The Record should include details of how CPD is being achieved and should include for example:

- Initial training towards achievement of competency;
- Specific training towards enhancements/additions to competency;
- Familiarisation/re-familiarisation, coaching and training;
- Any alterations and/or withdrawals of competency;
- Enhancements to qualifications;
- Membership of professional bodies/institutions;
- Attendance at seminars and any refresher training courses;
- Visits to manufacturers and trade shows.

16.10 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 took place;
- Where the training took place;
- The scope of the training including types and models of tower crane;
- The duration of the training;
- The outcome of the training;
- Who delivered the training;
- When refresher training is required.

17.0 Information for Thorough Examination

17.1 Introduction

The wide variation of designs and the increasing complexity of tower crane technology make it essential that all competent persons carrying out thorough examination are supplied with adequate information to enable them to carry out their duties effectively and safely. Information comes in various forms and from several sources.

17.2 Tower Crane Build Specifications

A build specification for the individual tower crane to be thoroughly examined must be made available to the person carrying out the initial thorough examination following erection. This should be in the form of a schematic drawing or table indicating the location of each major component or sub assembly. The information should be sufficiently detailed to enable the competent person to confirm that the specified components have been assembled correctly.

17.3 Manufacturer's Information

Information supplied by the tower crane manufacturer or another competent source will be the main source of instructions and specifications when carrying out thorough examination. The primary document will be the maintenance 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 the thorough examination is being carried out.

Manufacturer's manuals are not always complete and in the case where particular information is not covered, the crane owner or manufacturer must be contacted for information **BEFORE** the thorough examination is undertaken.

17.4 In-House Technical Information

Some tower crane owners will 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 thorough examination personnel but care should be taken to ensure that circulation is controlled to ensure that information is current and that outdated data has been withdrawn.

17.5 Method Statements and Work Instructions

Most thorough examination work on tower cranes is of a routine nature and can be covered by generic risk assessments, method statements and work instructions. On occasions however, the crane and/or site will present specific hazards and a job specific safe system of work will have to be put in place.

The system of work will be described in a job specific method statement on which all persons assisting the competent person must be fully briefed. This briefing should be recorded.

17.6 Scope of Thorough Examination

It is important that a scope of thorough examination is drawn up before a thorough examination is undertaken on a tower crane. This should cover at least the following:-

- What is to be looked at;
- How often;
- Details of any supplementary reports and tests;
- Anticipated duration.

The scope will be determined by hazard analysis, risk assessment and manufacturer's information. An example of a scope of thorough examination is given in **Annex 3**.

17.7 Generic Information

Competent persons may also need to refer to generic information such as standards and industry guidance. Examples of these are BS ISO 4309:2004, *Cranes. Wire ropes. Care, maintenance, installation, examination and discard*, and the CPA Tower Crane Interest Group's *Technical Information Note* series.

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

NOTE: The monthly "examination" interval for wire ropes on tower cranes specified in BS ISO 4309:2004 should be regarded as an intermediate inspection and not part of a thorough examination.

NOTE: Additional information on the examination of wire ropes on tower cranes is given in **Annex 12**.

17.8 Machine History

The history of the repairs and maintenance carried out on a tower crane is essential to a competent person carrying out a thorough examination. Details of any structural repairs, welding and any non-routine maintenance must be presented to the competent person at the time of the next thorough examination.

17.9 Supplementary Reports and Tests

The purpose of the supplementary tests is to support the thorough examination in order to establish the equipment's suitability for continued safe use. These supplementary tests may be specified by the competent person and can cover a wide range of techniques, not just overload testing. They will need to be undertaken, completed by the date specified and documented, in order to enable the subsequent thorough examination to be completed. Failure to complete the supplementary tests may preclude the completion of the subsequent thorough examination. In some circumstances the competent person may wish to witness the 'supplementary tests'. In particular they should witness the following:

- Functional test and confirmation of calibration of RCI/RCL;
- Hoist brake and luffing brake test and examination.

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

Other supplementary tests and corresponding reports on tower cranes may include: -

- Load test following erection;
- RCI/RCL calibration and functional test;
- Anemometer calibration and functional test;

- Non Destructive Examination of individual components;
- Slew ring condition and clearances;
- Mast pin clearance;
- Pre-loads on high tensile bolts;
- Anti-collision/zoning system installation;
- Pre-delivery inspections;
- Mast verticality report;
- Foundation design specification;
- Foundation “as built” report;
- Tie installation report;
- Crane configuration drawing/report;
- **Hoist Brake and Luffing Brake Test and Examination**
- Earth continuity test;
- Report of inspection and test of electrical control equipment;
- Report of inspection and test of lightning protection.

Additional information on supplementary tests is given in **Annex 11**.

In practice the tower crane owner and the competent person may wish to agree and periodically review, the specific supplementary test reports that will be provided prior to each thorough examination following erection and each subsequent in-service thorough examination. These should at least include functional test and confirmation of calibration of RCI/RCL, hoist brake and luffing brake test, load test following erection and crane configuration drawing/report. Additional supplementary tests will be requested by the competent person as circumstances demand.

17.10 Previous Reports of Thorough Examination and Supplementary Tests

Where a tower crane has been previously examined, the reports of the most recent thorough examination and any supplementary tests carried out should be made available to the competent person before they carry out the current thorough examination. Best practice guidance is that all reports of thorough examination are kept for the life of the tower crane.

17.11 Information on Clearance of Defects

Where a previous thorough examination report has identified defects requiring rectification, evidence of clearance of those defects should be made available to the competent person before they carry out the current thorough examination.

17.12 Information Formats

Paper information, such as that found in 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 information should be up to date at the point of access. However the use of electronic devices during thorough examination is not always easy or practical. Information may 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 current and relevant.

Facilities should be available on site to print any document required by the competent person. Any print out should be marked “uncontrolled”.

17.13 *Management of Information*

Information should be managed effectively if it is to be of maximum benefit to those involved in the thorough examination process. Outdated information can at best waste time and at worst may well affect safety. It is therefore essential that organisations carrying out thorough examination of tower cranes ensure that they have robust systems and procedures to ensure that personnel are supplied with adequate information that is both up to date and accurate.

18.0 Reports of Thorough Examination

18.1 Introduction

LOLER requires that the competent person carrying out a thorough examination of a tower crane makes a report of that thorough examination in writing to the user of the crane and to the person from whom the crane has been hired. The report must be authenticated by the competent person, or on his behalf, and must contain the information specified in Schedule 1 to LOLER.

18.2 Categorisation of Defects

Where defects are found during the thorough examination of a tower crane the competent person will make a judgement on the severity of the defect and its potential to affect the safety of persons. To assist this process defects are divided into three categories:-

- Defects affecting the safety of persons that are to be remedied immediately;
- Defects affecting the safety of persons that are to be remedied within a specified period of time;
- Observations/recommendations which may require planning for resolution and may be outside the strict scope of the thorough examination.

18.3 Required Level of Detail

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 and readily understood by crane users. The use of abbreviations should be avoided.

18.4 Distribution of Reports

Generally tower crane thorough examinations are carried out on behalf of, or by, the tower crane owner. The thorough examination report is therefore sent to the crane owner who should then immediately send a copy to the tower crane user as the user has a duty to ensure that the crane is safe to use.

18.5 Report Completion Timescale

Where defects are found during a thorough examination which are or could become a danger to persons then the competent person must inform both the user and the owner, so that the crane can either be prevented from being put into service or is taken out of service until the defects have been satisfactorily rectified. This is often accomplished by leaving an interim, hand written, report on site and making contact with the crane owner. 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 tower 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.

18.6 *Inclusion of Cleared Defects*

On occasions the competent person carrying out the thorough examination will be accompanied by the tower crane owner's maintenance personnel and as defects are discovered they may be immediately rectified. In this case all defects **MUST** be reported even if they have been cleared. Failure to report defects is contrary to the requirements of LOLER, will give a false picture of the condition of the crane and invalidate both the machine history and the review process.

18.7 *Notification to the Enforcing Authority*

Where, in the opinion of the competent person, the thorough examination identifies a serious defect in the tower crane which involves an existing or imminent risk of serious personal injury arising from failure of the crane which may occur at the next use or a short time thereafter, the competent person must 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.

19.0 Management Review of Thorough Examination Records

19.1 Introduction

A regular management review of tower crane thorough examination records is essential for the safe and efficient operation of a tower crane fleet. It ensures that management can be confident that robust maintenance and thorough examination systems are in place and will rapidly highlight any shortcomings and the need for corrective action. It may be beneficial to include competent persons or the employer or third party competent persons in this process.

19.2 Benefits

The benefits of regular management review of thorough examination records are:-

- Confidence that the system is functioning correctly;
- Identification of extraordinary defects, events and failures;
- Ensuring that there is evidence of adequate maintenance and thorough examination to the Enforcing Authorities in the event of an incident and a subsequent investigation;
- Establishing trends over time and informing the review of the examination frequency;
- Feedback to the maintenance activity;
- Identification of component failure trends for feedback to the manufacturer;
- Highlighting on-site thorough examination access problems for feedback to the manufacturer to improve future designs;
- Monitoring the performance of individual cranes over time to inform future purchases;
- Ensuring that defects are rectified in a timely manner.

19.3 Review Frequency

The review should be carried out initially at least monthly. Once a suitable level of confidence in the systems has been established the review frequency may be reduced in the light of experience.

19.4 Review Methodology

The review should aim to identify exceptional events such as occurrences of heavy expenditure and reoccurring faults. It should also measure achievement of maintenance activities against target. An example of the use of such Key Performance Indicators is given in **Annex 10**.

19.5 Review Records

It is essential that written records of the management review are made, both as evidence that the reviews have been undertaken and to evaluate long term trends.

20.0 Site Issues for Thorough Examination

20.1 Introduction

Carrying out a thorough examination of a tower crane on site presents a particular set of issues when compared with carrying out a thorough examination of a mobile crane in a workshop or yard. These issues are best addressed at the planning stage before the crane is erected on site and taken into use. The effective thorough examination of tower cranes on site will require the cooperation of the user and an example of a document informing users of the issues they should consider when a thorough examination is being undertaken is given at **Annex 4**.

20.2 Downtime During Thorough Examination

The main purpose for a tower crane being on site is to carry out lifting operations as part of the construction process. Site managers are understandably reluctant to stop the crane whilst a thorough examination is carried out. If thorough examination downtime is not scheduled into the construction programme it is pushed to the back of the queue and ends up being carried out hurriedly in unsafe conditions such as poor light.

It is therefore essential that tower crane owners make clear to those hiring their cranes that thorough examination is a legal requirement and that adequate downtime must be built into the site programme. Hirers must be informed at the planning stage of the frequency of thorough examination and probable time required.

Construction projects in built up areas often have environmental restrictions imposed on them which severely limit working time and such restrictions must be taken into account when planning thorough examinations.

20.3 Lines of Communication

Those planning and carrying out the thorough examination of tower cranes on site must ensure that they have effective lines of communication with the site for initial, periodic and exceptional thorough examinations including preparation. This will avoid much frustration and misunderstanding on both sides.

20.4 Availability of Operators

Thorough examination will require the crane to be operated from the control cab whilst the competent person is examining other parts of the crane. Arrangements must be made to ensure that an operator is available on such occasions.

20.5 Availability of Power

Thorough examination requires the crane to be operational and arrangements must be made to ensure that power is available.

20.6 Availability of Site Facilities

When thorough examination is being carried out outside normal working hours arrangements must be made to ensure that site management, safety and welfare facilities are available to the competent person and any personnel assisting them.

20.7 Access For Deliveries

Test weights and other equipment often need to be delivered to site. Care must be taken to ensure that there is adequate access for delivery and that adequate acceptance procedures are in place to ensure that they are available when required by the competent persons.

20.8 Load Testing

Any load testing of tower cranes will require careful planning of the lifting operations involved. The consequence of a collapse during testing must be evaluated and a suitable exclusion zone put in place which may well involve the need for road closures.

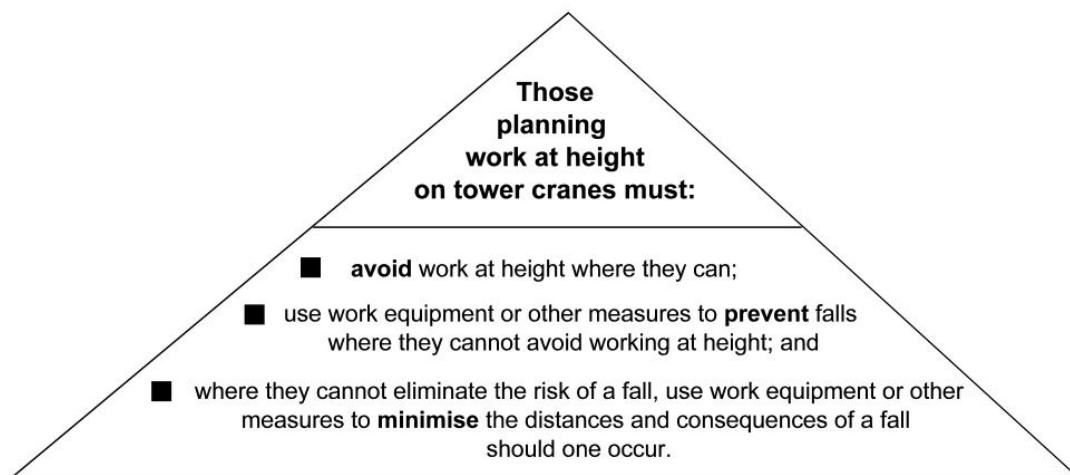
20.9 Lone Working

Lone working should be avoided at all times by suitable liaison with the person in control of the site to ensure that site personnel are always in attendance.

The planning process for work at height on tower cranes should take into account the particular hazards of lone working and thorough examination at height by lone workers should not be undertaken.

20.10 Work at Height

Some thorough examination activities on erected tower cranes may require competent persons to work at height outside edge protected areas on the tower crane structure. The Work at Height Regulations 2005 set out a hierarchy of fall protection measures to be taken when planning work at height.



This means that those planning work at height on tower cranes should:-

- Avoid work at height wherever possible and actively seek solutions to facilitate this;
- If this is not possible, use “collective” means of protection such as guardrails;
- If this is not possible, use “personal” means of prevention such as work restraint;
- If this is not possible, use a personal fall protection system such as a work positioning system or fall arrest system;

- Additionally provide training and instruction or take other measures to prevent any person falling a distance liable to cause personal injury.

Where a risk assessment indicates that a personal fall protection system is required a work positioning system should always be used in preference to a fall arrest system. Where the use of fall arrest personal fall protection systems are unavoidable there will be a risk of the wearer being left suspended following a fall and arrangements must be made to ensure that they can be rescued in a safe and timely manner (See **Annex 1**).

20.11 Isolation of Systems During Thorough Examination

To avoid the risk of trapping, crushing, shearing or electrocution during the thorough examination of mechanisms on tower cranes, all systems should be provided with a means of isolation. Where power is required to a system during examination, a safe system of work should be put in place to mitigate the risks of trapping. Such a safe system of work may well involve a “permit to work” and adequate communication between the crane operator and other members of the thorough examination team.

20.12 Access for Examination of Bases, Ties and Grillages

The site should provide safe access routes to allow the competent person to examine bases, ties and grillages. Where necessary, bases should be well drained or kept dry by pumping.

NOTE: Access will also be required for the operator to check these items as part of his daily checks.

20.13 Communication Equipment

Personnel carrying out thorough examinations should be provided with an adequate means of communication, often hand held portable radios, to ensure that all members of the thorough examination team can communicate effectively with each other, the tower crane operator and personnel on the ground.

NOTE: Additional advice on radio communications is given in the CPA Technical Information Note TIN 017 - *Radio Communication for Lifting Operations*.

Annex 1 – Work at Height

A1.1.0 Introduction

Working at height is an inevitable part of the maintenance and thorough examination of tower cranes and should be carried out by trained personnel, following careful planning which includes adequate assessment of the risks involved. This planning should include provision for the rescue of persons.

Health and Safety legislation requires that safe systems of work are in place for all work activities and the particular references for the requirement to provide safe access, egress and a means of safe rescue are:-

- Health and Safety at Work etc. Act 1974. - Sections 2 & 3
- Work at Height Regulations 2005
- Provision and Use of Work Equipment Regulations (PUWER) 1998 – Regulation 17
- Lifting Operations and Lifting Equipment Regulations (LOLER) 1998 – Regulation 3
- Management of Health and Safety at Work Regulations 1999 – Regulation 3
- Construction Design and Management Regulations 2007

A1.2.0 Responsibility for Planning of Work at Height and Provision of Rescue Resources

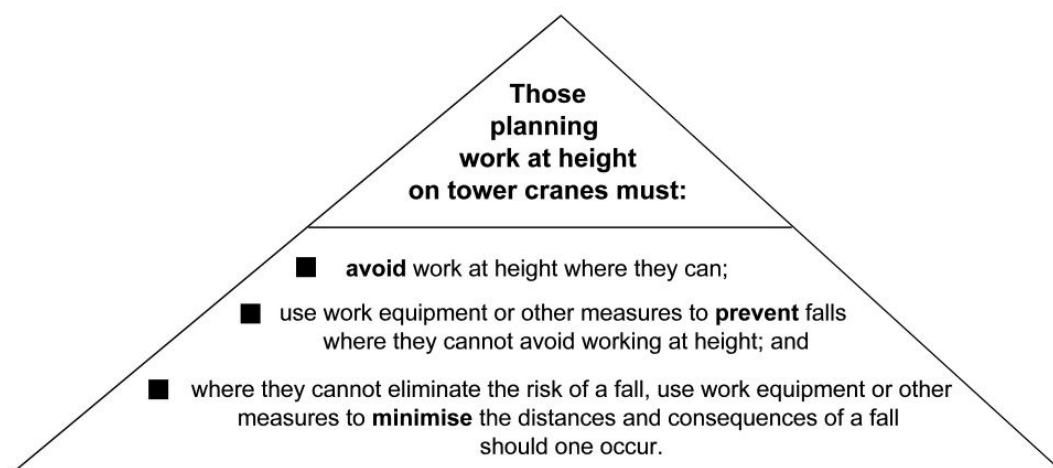
It is clear that the primary duty for ensuring that work at height on a tower crane is effectively planned and that there are adequate resources for carrying out rescue of persons from height, rests with the organization in control of the premises on which any tower crane is sited. In the case of a construction site this will be the Principal Contractor as defined by the Construction (Design and Management) Regulations 2007.

In practice it is likely that:-

- Arrangements for work at height during maintenance and thorough examination will be made by the tower crane supplier;
- Arrangements for rescue during maintenance and thorough examination will be made by the tower crane supplier.

A1.3.0 Guidance for Work at Height

The Work at Height Regulations 2005 set out a hierarchy of fall protection measures to be taken when planning work at height.



This means that those planning work at height on tower cranes should:-

- Avoid work at height wherever possible and actively seek solutions to facilitate this;
- If this is not possible, use “collective” means of protection such as guardrails;
- If this is not possible, use “personal” means of prevention such as work restraint;
- If this is not possible, use a personal fall protection system such as a work positioning system or fall arrest system;
- Additionally provide training and instruction or take other measures to prevent any person falling a distance liable to cause personal injury.

A1.3.1 **Elimination of work at height**

As a primary aim, all tasks associated with work at height during maintenance or thorough examination of tower cranes should be reviewed to see if they can be fully or partially completed off site or at ground level.

An example of this is the carrying out of pre-delivery maintenance (See 5.2) which will reduce the need for replacement of worn or faulty components when a tower crane is erected.

Where work at height cannot be eliminated the following hierarchy should be employed:-

A1.3.2 **Collective measures**

The tower, slew section and counter jibs of most tower cranes will be provided with suitable edge protection which will allow maintenance and thorough examination to be carried out without any additional measures to prevent or mitigate the effect of falls from height. Trolley baskets can also provide a collective means of fall protection when there is a need to travel along, and to the end of, the jib.

Care should be taken when carrying out maintenance that the maintenance work does not remove edge protection and put maintenance personnel at risk of falling. There will also be occasions where the maintenance task or thorough examination will require personnel to move outside the edge protection in these areas in which case personal fall protection equipment will be required.

A1.3.3 Personal Fall Protection

As it is often difficult to provide collective fall protection when accessing hoist structures a significant amount of work will be carried out using personal fall protection equipment. This will normally fall into one of three types:-

- Work restraint systems
- Work positioning systems
- Fall arrest systems

A1.3.3.1 Work restraint systems



Work restraint systems will prevent personnel from reaching an unprotected edge and falling. As by definition they restrain the wearer by restricting movement and may be of limited value when working on tower cranes.

A1.3.3.2 Work positioning systems



Work positioning systems can provide full or partial support to personnel and prevent them from falling whilst carrying out tasks in one location. They allow the wearer to work safely outside the confines of guard rails with both hands. Work positioning systems used on tower cranes should always be combined with a fall arrest system to provide protection at the location where the work positioning system will be used. The fall arrest system will provide protection whilst the wearer is moving to, and from the location where the work positioning system will be used.

A1.3.3.3 Fall arrest systems



Fall arrest systems will reduce the consequences of a fall where the wearer is working outside a protected edge, such as the confines of any guardrails. A two lanyard system will allow movement around a structure. When fall arrest systems are used, a vital part of the planning process is consideration of arrangements for the rescue of persons suspended in the fall arrest system after a fall.

Suspension trauma can occur even if a person has only been suspended at height for a short period of time, particularly if they are motionless.

Rescue arrangements for the recovery of maintenance or thorough examination personnel will require the presence of a second trained person on site at all time whilst fall arrest systems are being used. This means that lone working during maintenance or thorough examination can only be undertaken where there is no risk of falling and the consequent need for rescue.

A1.3.3.4 Anchor points

All personal fall protection systems require connection to an anchor point. It is essential that all anchor points have an adequate margin of strength and stability to withstand the dynamic and static forces that could be applied to them in service. Anchor points for fall arrest systems will require a greater capacity than those for work restraint or work positioning systems. Manufacturers should be consulted on the designation of suitable & sufficient anchor points.

Single person anchor points for fall arrest systems should be designed to resist a minimum static force of 12kN. This includes a safety factor of two to allow for the dynamic and static forces that could be applied to them in service. If two or more users are to be connected to the same anchor the minimum static strength of the anchor should be increased to 14kN for two person use and 16kN for three person use.

Specifications for the installation and testing of anchors are given in BS 7883:2005 - *Code of practice for application and use of anchor devices conforming to BS EN 795*.

With all types of personal fall protection equipment it is essential that the following points are considered during planning for work at height:-

- Correct equipment for the application is selected;
- Personnel are trained and assessed as competent in the correct adjustment, use, care and recorded checking of fall protection equipment;
- Suitable anchor points on the structure are identified;
- Arrangements are made for the inspection and maintenance of the equipment.

Detailed guidance on the selection of personal fall protection systems is given in:-

- *BS 8437:2005 - Code of practice for selection, use and maintenance of personal fall protection systems and equipment for use in the workplace.*
- *BS EN 795:1997 - Protection against falls from a height — Anchor devices — Requirements and testing.*

A1.4.0 Rescue from suspension in a fall arrest harness

A suitable rescue system such as the Spanset “Gotcha” system may be used in this situation. This system is contained in a bag, taken up the tower crane by the maintenance team and kept there whenever fall arrest systems are in use. In the event of a person falling and being suspended in the fall arrest system his colleagues will attach a block and tackle to the crane structure and clip one end of the fibre rescue rope to the casualty’s harness ring using the telescoping pole provided. The casualty can then be raised back up to the crane structure or lowered to the ground (after the casualty’s harness lanyard has been severed).

The Gotcha system is always operated by members of the maintenance team who have been trained by the system manufacturer or by in-house trainers trained and authorised by the manufacturer. In planning for rescue from height, reliance should not be placed on the use of the Emergency Services without first consulting those services

Suspension in a harness for a period of time (often as little as ten minutes) without moving may give rise to “suspension trauma” which leads to pooling of blood in the veins of the lower limbs. This can cause disturbance to the circulatory system leading to damage of the vital organs. When rescuing a suspended person care must be taken to avoid moving them into a horizontal position as this can cause a massive flow of venous blood to the heart, which cannot cope, and this can cause potentially fatal cardiac abnormalities.

Additional information on suspension trauma is given in Annex D of *BS 8437:2005 - Code of practice for selection, use and maintenance of personal fall protection systems and equipment for use in the workplace.*

Additional information on access and work at height on tower cranes is given in the following TINs in the CPA Technical Information Note series:

- TIN 001 Access to Tower Cranes After Commissioning
- TIN 003 Tower Crane Access Procedures
- TIN 006 Tower Crane Access Ladders
- TIN 008 Tower Crane Edge Protection
- TIN 009 Security of Access to the Crane Base
- TIN 013 Rescue of Personnel From Height on Tower Cranes
- TIN 015 Risk Assessment – General Access to Tower Cranes (including for maintenance)
- TIN 016 Fall Protection Equipment For Tower Crane Operators

Annex 2 - Example of a Typical Safe System of Work for Thorough Examination Activities

A 2.1.0 Introduction

This safe system of work considers the hazards and risks when undertaking the examination of tower cranes. As a necessity of examination, the plant will have to be manoeuvred to prove satisfactory function and operation. This creates added risks such as falling from plant, being trapped, crushed or struck by plant movement. The safe system is to raise awareness of the hazards and therefore reduce the risks involved so far as is reasonably practicable.

A 2.2.0 Scope

The guidance covers work associated with the examination of all types of tower crane and lifting accessory.

A 2.3.0 Legislation and other publications

A 2.3.1 Legislation

The following is a summary of relevant legislation, including:

- a. Health and Safety at Work Act 1974.
- b. The Supply of Machinery (Safety) Regulations 1992 (as amended 1994).
- c. Provision and Use of Work Equipment Regulations 1998 (PUWER 98).
- d. Lifting Operations and Lifting Equipment Regulations 1998 (LOLER).
- e. Management of Health and Safety at Work Regulations 1999.
- f. Work at Height Regulations 2005 (as amended 2007).

This list is not exhaustive and reference may need to be made to other Legislation as applicable.

A 2.3.2 Other relevant guidance includes:

- a. Safe use of Cranes: BS 7121 Pts 1, 2 & 5.
- b. Safe use of ladders, step ladders & trestles, HS(G) 31.
- c. In-house procedures and instructions.
- d. Personal Protective Equipment.

This list is not exhaustive and reference may need to be made to other documents.

A 2.4.0 Hazards

A 2.4.1 Anticipating the Consequences of Actions

Many accidents occur because of a lack of planning and/or consideration of what could happen as a result of actions on site.

A 2.4.2 Known Hazards

Examples of how injury can occur when undertaking the examination of tower cranes include:

- a. Trapping / Crushing;

- b. Falling;
- c. Being struck;
- d. Electrical shock.

A 2.4.3 *Hazard details*

A2.4.3.1 Trapping and crushing points

There are many trapping points to consider when undertaking the examination of tower cranes. Trapping hazards are present at following areas:

- a. Slewing of tower cranes: Trapping can occur between slew ring and its attachments (ladders, underside of jibs, counterweight attachments etc.). At slew ring drive systems;
- b. Luffing/derricking of cranes: At rope drums and diverter sheaves (hands or clothing being caught between ropes and rope drums and diverter sheaves); in machinery housings or apex assemblies. At jib pivot and articulating points. Moving counter balance systems;
- c. Hoisting/lowering of ropes: At rope drums and rope diverter sheaves, and pulley systems. Rotating machinery, i.e. brake drums, shafts, couplings, winches etc. Trolley ropes on tower cranes;
- d. Between cranes and site buildings or ground in the event of cranes overturning during examination.

A2.4.3.2 Falling

Generally falls can occur at any time when undertaking the examination of tower cranes. By virtue of their construction climbing and access to areas above ground are a necessity. The risk from falling is present when:

- a. Climbing jibs, masts, machine structures; slipping from ladders and plant structure;
- b. Using ladders and other means of access;
- c. Slipping on oil/grease on plant structure and ground, unstable or uneven ground conditions;
- d. Tripping over obstacles on items of plant being examined, and items at ground level on site;
- e. Deteriorating weather conditions, i.e. ice, rain and wind present.

A2.4.3.3 Being struck

- a. By moving parts of the crane undergoing examination i.e. jib structures, slew arrangements;
- b. By load hooks and suspended loads on cranes;
- c. By other plant, and mobile systems in operation at site;
- d. By chain slings and lifting beams and frames suspended from cranes;
- e. By failure of the crane under examination i.e. loads being dropped, failure of crane structures;

- f. From projections on machinery and buildings.

A2.4.3.4 Other hazards include

- a. Risk of electrical shock from live equipment and poorly maintained systems. The tower crane being examined, striking overhead electric power lines;
- b. Fumes and dust from site work. Dust from overhead areas due to disturbance during examination;
- c. Catch points - clothing or rings being caught on protrusions;
- d. Noise - from plant being examined and adjacent work processes;
- e. Vibration - from plant being examined.

A 2.5.0 Safe working on tower cranes - general

Prior to examination of tower crane:-

A 2.5.1 *Access & Egress*

The competent person shall make his presence known to a responsible person at the location. At the end of his visit the competent person shall advise that person that he is leaving the site.

A 2.5.2 *Unoccupied Premises*

Under no circumstance shall the competent person work alone at unoccupied premises or carry out any examination at premises where no member of the client's staff (or other responsible person) is present.

A 2.5.3 *Appropriate Clothing*

Competent persons shall wear suitable protective clothing and equipment, e.g. safety helmet, boiler suit, gloves, suitable safety boots or shoes, and safety harness. All shall be maintained in good condition and properly worn.

A 2.5.4 *Personal Protection & Safety Equipment*

Other personal protection and safety equipment shall be worn according to the site conditions and clients site safe systems of work, e.g. eye protection hearing protection, high visibility clothing, personal buoyancy equipment, and respiratory protective equipment.

A 2.5.5 *Inspection Plan*

Competent persons shall plan the sequence of their examination prior to commencement. This is essential when undertaking the examination of crane systems with regard to health and safety.

Planning should include the following:

- a. A suitable and satisfactory emergency release/rescue procedure must be in place and capable of being initiated, if required prior to commencement of examination.
- b. Briefing of the responsible person on site and crane operator as to the sequence of examination.
- c. Banksman (where used) and crane operator must fully understand the examination procedure and the system of hand signals to be used where

applicable. All personnel must understand the emergency signals and procedures.

- d. Examinations of cranes should be away from regular site traffic and site routes. This will reduce the risk from being struck by, and striking, other site traffic and site personnel.
- e. Position of crane being examined to be well away from edges of excavations, and overhead electric power lines.
- g. Ensure adequate clearance, and sufficient operating space, between plant being examined and adjacent fixtures to prevent trapping and crushing hazard.

A 2.5.6 *Isolation*

Where tower cranes need to be isolated for inspection purposes the competent person shall ensure power is isolated from the crane. This should consist of switching off power where required, locking off isolators with padlocks, and displaying warning notices at the isolation points.

A 2.5.7 *Operation of Tower Cranes*

Operation of tower cranes shall be carried out by the normal crane operator or another competent operator who has been familiarised with the crane in question, except where it is necessary for the competent person to do so as part of his examination.

A2.5.7.1 Unrestricted View

The tower crane operator must have a clear view of operations. Where this is not possible a banksman must be used.

A2.5.7.2 Surveyor Restrictions

Competent persons should not drive or operate motions of the crane for any other purpose than the minimum amount strictly necessary to carry out the examination.

Where it is necessary for the competent person to operate the crane himself he shall:

- a. obtains prior permission of a responsible person at the location;
- b. takes all reasonable care during the operation of the crane;
- c. satisfies himself that all reasonable safety precautions have been taken;
- d. ensure that the crane is left in a safe condition at the end of the examination.

A2.5.7.3 Client Responsibility

Under no circumstance shall a competent person operate any crane if he has the slightest doubt as to his own ability to do so or the authority of the person giving him permission to do so. In all such cases the competent person shall request the client provides a competent operator.

A 2.5.8 *Notification of Appropriate Authorities*

If a crane is to slew over a public highway, river or railway the competent person shall ensure client has notified the appropriate authority.

A 2.5.9 *Environmental Conditions*

Careful attention should be given to cranes operating in situations where they are likely to be affected by the weather. Certain weather conditions such as strong wind, heavy rains, ice or snow can impose loads on a crane and adversely affect the safety of crane operations. Never undertake examinations when the crane or load cannot be easily seen due to limitations on visibility or when coated with ice or snow. Crane should not be operated in wind speeds in excess of those specified in the operating instructions for the crane.

A 2.5.10 *Outriggers*

Plant fitted with outriggers is not fully stable until the outriggers are set in accordance with the manufacturers instructions. When used always ensure outriggers are fully extended to their full extension position.

A 2.6.0 During examinations

A 2.6.1 *Safe Access*

Always use a safe means of access to reach parts of the crane requiring inspection above ground level. i.e. properly secured ladders, access platforms and/or safety lines. When working above ground level a safety harness should be worn by the competent person when there is an identifiable risk of falling.

A 2.6.2 *Climbing Precautions*

Keep a good foot and handhold when climbing plant structures. Watch for obstacles, protrusions, oil and grease deposits, ice and water which may cause a tripping or slipping hazard.

A 2.6.3 *Other Hazards*

Competent persons should not position themselves close to open excavations, pits or waters edge during course of examination without taking appropriate safety precautions.

A 2.6.4 *Moving the Crane and its Parts*

When the crane is being moved during an examination, the competent person should position himself clear of all moving parts and have a clear view of the operator. Where this is not possible either a banksman should be used to relay the competent person's signals to the operator or hand portable radios should be used.

A 2.6.5 *Other Plant*

Be aware of other plant moving on site and adjacent to the plant being examined.

A 2.6.6 *Rope Inspections*

Always wear gloves when inspecting hoist ropes etc. If it is necessary to examine ropes when they are moving ensure they are moving at slow speed and away from in-running nips and hoist and winch drums. Running ropes should not be passed through the hands. It is vital that the competent person has instant communication with the crane operator.

A 2.6.7 *Suspended Loads*

Never stand beneath suspended loads or parts of plant which could descend.

A 2.6.8 *Buoyancy Aids*

Buoyancy aids/life jackets must be worn when undertaking examinations adjacent to waters edge.

A 2.6.9 *Trapping*

A competent person should always position himself where he will not be trapped between adjacent fixed structures and plant being examined.

A 2.6.10 *Crushing*

Keep hands, arms, feet and head clear of any potential trapping or crushing points. i.e. plant pivot and articulating points, sliding and telescoping components, open rotating parts.

A 2.6.11 *Pendant Controls*

When working at height on a crane, ensure that any pendant controls are not within reach of anyone who could inadvertently operate the crane during examination.

A 2.7.0 Permit to work

Some clients operate a "Permit to Work" system when work is required on certain plant. The permit to work system is an extension to the safe system of work when written authorisation is required before a particular job can be started.

A 2.8.0 Summary

The preceding sections outline the main considerations to achieve a safe system of work when undertaking examinations of lifting plant. Physical layout and operational facilities vary considerably depending on client's premises and the tower crane being examined; therefore the safe system of work must be adapted to take into account the particular characteristics and situation of the tower crane being examined and the working environment in which it is operating.

Annex 3 – Example of a Scope of Thorough Examination for Tower Cranes

Prerequisites for the Thorough Examination of Tower Cranes		
1	Description:	Tower Crane
2	Regulations:	Health & Safety @ Work Act 1974 Provision & Use of Work Equipment 1998 Lifting Operations & Lifting Equipment Regulations 1998 Work At Height Regulations 2005 (as amended)
3	Documentation:	Health & Safety @ Work Act 1974 PUWER/LOLER Regulations/ACOP's BS 7121 Parts 1,2 & 5 Working at Height Regulations 2005 H&S Technical Documents
4	Tools:	Torch Internal Calliper Feeler Gauges Engineers Tape Rule Rope Gauge Adjustable Spanner Screwdriver Vernier Calliper Padlock & Chain Hammer
5	Requirements:	Plant Location Plant Description Plant Identification Safe Working Load RCI/RCL and other functional Tests Permit to Work Last Report of Thorough Examination
6	Personal Protective Equipment	Safety Harness – Twin Lanyard Restraint Safety Boots Safety Helmet with chin strap Safety Gloves Safety Glasses Weatherproof clothing High visibility jacket

Scope of Thorough Examination		
Area	Element	Feature
Electrical	Mains Isolator Cables & Glands Motors	Function Condition & Marking Security of Connection, Condition Function & Condition
Controls	Electrical Switches Pneumatic/Hydraulic Travel Limits Lowering Limit Hoisting Limit Overload Devices RCI/RCL Free Slew Tower Position Microswitch	Function, Condition, Marking & Testing
Structure	<p><u>Tower</u> Structure & Telescopic Slide Blocks Locking Mechanism & Linkage Mountings Ropes, Terminations & Pins Slewing Mechanism & Slewing Ring Hydraulic Cylinders Hydraulic Tank Base Ballast Tower Guarding/Fencing Luffing Tower</p> <p><u>Base & Outriggers</u> Structure Chassis/Fixing Angles/Cruciform Base Ballast Hydraulic Stabiliser Jacks</p> <p><u>Jib & Jib Extension</u> Structure Ropes Extension Locks Trolley/Trolley Locks Pulleys/Sheaves SWL Plates Counter Jib/Ballast</p>	<p>Wear, Damage, Alignment, Distortion Security of Connections, Condition Assessment of Construction, Corrosion, Cracking & Rejection Criteria</p> <p>Wear, Damage, Alignment, Distortion Security of Connections, Condition Assessment of Construction, Corrosion & Cracking. Counter Ballast Correct Number.</p> <p>Distortion, Damage, Cracking & Corrosion. Function & Condition Wear, Damage, Alignment, Lubrication Assessment of Construction.</p>

Area	Element	Feature
Hoisting & Luffing Drive Mechanism	Pulleys/Sheaves Drums Micro-switches Ropes Hooks Rope Blocks Hoist Brake	Wear, Damage, Alignment, Lubrication, Condition, Lay, Wear, Damage, Function & Condition
Motors, Drives, Couplings & Gearboxes	Tower Hoisting Motor Jib Hoisting Motor Brake Mechanisms Clutches Slewing Brake	Function & Condition, Wear, Damage, Leakage, Security, Corrosion
Rope Chains & Sheaves	Suspension Ropes/Chains Anchorages Terminations Pulleys/Diverter Sheaves Pins, Bearings	Wear, Damage, Lubrication, Cracking Assessment of Construction, Condition Security, Rejection Criteria
Safety Devices and Signs	Warning Signs Information Signs Operator Instructions Lifting Capacities Indicator Tests Emergency Stop Klaxon Anemometer	Security, Damage, Function & Condition, Settings & Lights
Remote Control	Controls/Switches Pendant Lead Lights Emergency Stop	Function & Condition, Smoothness & Wear
Operators Cabin	Controls/Switches Emergency Stops Lights Wipers/Washers SWL Configuration Board	Function & Condition, Smoothness & Wear
Full Plant	Functional & Operational Tests	Operate Through Full Range

Annex 4 – Sample Document Covering Maintenance and Thorough Examination Issues for Tower Crane Users

The effective maintenance and thorough examination of tower cranes erected on construction site depends of a significant degree of cooperation between the tower crane supplier/owner and the Principal Contractor. Tower crane users (Principal Contractors) are frequently unaware of the part they have to play and the intention of this document is to provide tower crane suppliers/owners with a means of making users aware of their responsibilities and the need for effective cooperation.

A4.1.0 Introduction

An important part of the safe use of tower cranes on construction sites is ensuring that tower cranes are effectively maintained and subject to thorough examination at the appropriate intervals. This is normally undertaken by the tower crane owner and it is essential that tower crane users fully appreciate the need to allocate sufficient time in the construction programme to allow these tasks to be carried out effectively.

This document identifies the maintenance and thorough examination issues that must be agreed between the tower crane owner and user before a tower crane is erected on site.

A4.2.0 Responsibility for Maintenance and Thorough Examination

Both the *Provision and Use of Work Equipment Regulations 1998* (PUWER) and the *Lifting Operations and Lifting Equipment Regulations 1998* (LOLER) are very clear that the responsibility for ensuring that the maintenance and thorough examination of tower cranes is carried out, lies with the user of the tower crane. In the case of a hired-in tower crane the actual undertaking of maintenance or thorough examination is often delegated to the crane owner by the user. The user however, retains the legal responsibility for ensuring that both maintenance, including the rectification of defects, and thorough examinations are carried out.

A4.3.0 Downtime During Maintenance and Thorough Examination

The main purpose for a tower crane being on site is to carry out lifting operations as part of the construction process. Site managers are understandably reluctant to stop the crane whilst maintenance or thorough examination is carried out. If maintenance or thorough examination downtime is not scheduled into the construction programme it is pushed to the back of the queue and ends up being carried out hurriedly in unsafe conditions such as poor light.

It is therefore essential that tower crane users understand that both maintenance and thorough examination are a legal requirement and that adequate downtime must be built into the site programme. Tower crane owners should inform those hiring their cranes of the frequency and expected time required for maintenance and thorough examination at the planning stage, well before the crane arrives on site.

Construction projects in built up areas often have environmental restrictions imposed on them which severely limit working time at week ends and such restrictions must be taken into account when planning maintenance and thorough examinations.

A4.4.0 Lines of Communication

It is essential that effective lines of communication are established between the user and those planning and carrying out both maintenance and thorough examination of tower cranes. This will avoid much frustration and misunderstanding on both sides.

A4.5.0 Availability of Operators

Maintenance and thorough examination will require the crane to be operated from the control cab whilst maintenance personnel are carrying out their tasks or the competent person is examining other parts of the crane. Arrangements must be made to ensure that an operator is available on such occasions.

A4.6.0 Availability of Power

Maintenance and thorough examination requires the crane to be operational and arrangements must be made to ensure that power is available.

A4.7.0 Availability of Site Facilities

When maintenance or thorough examination is being carried out outside normal working hours, arrangements must be made to ensure that site management, safety and welfare facilities are available to maintenance personnel, the competent person and any personnel assisting them.

A4.8.0 Access For Deliveries

Maintenance operations, particularly the rectification of breakdowns often require spare parts to be delivered to site. Care must be taken to ensure that there is adequate access for delivery and that adequate acceptance procedures are in place to ensure that the parts are available when required by maintenance personnel and are not lost on site.

A4.9.0 Load Testing

Any load testing of tower cranes will require careful planning of the lifting operations involved. The consequence of a collapse during testing must be evaluated and a suitable exclusion zone put in place which may well involve the need for road closures.

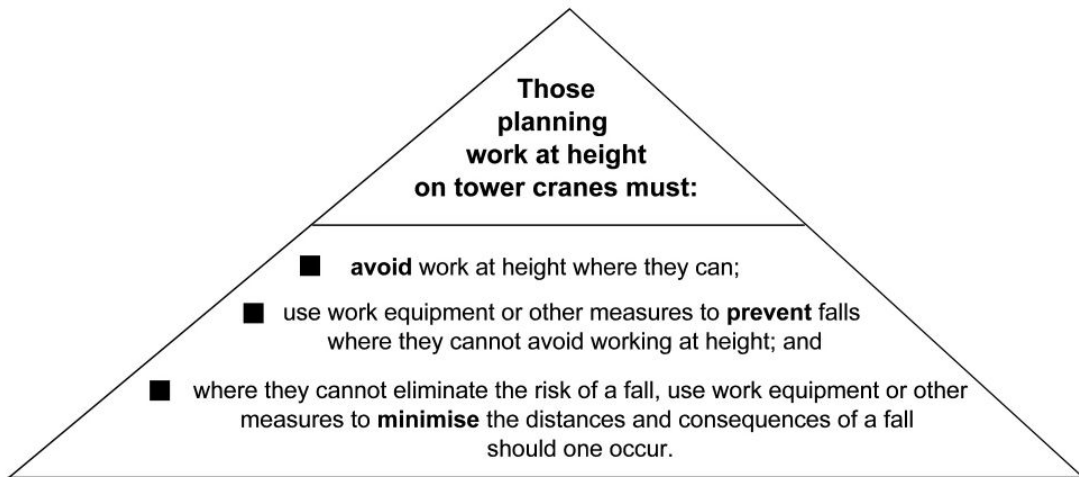
A4.10.0 Lone Working

Lone working should be avoided at all times by suitable liaison with the person in control of the site to ensure that site personnel are always in attendance.

The planning process for work at height on tower cranes should take into account the particular hazards of lone working and thorough examination at height by lone workers should not be undertaken.

A4.11.0 Work at Height

Some maintenance and thorough examination activities on erected tower cranes may require maintenance personnel or competent persons to work at height outside edge protected areas on the tower crane structure. The Work at Height Regulations 2005 set out a hierarchy of fall protection measures to be taken when planning work at height.



This means that those planning work at height on tower cranes should:-

- Avoid work at height wherever possible and actively seek solutions to facilitate this;
- If this is not possible, use “collective” means of protection such as guardrails;
- If this is not possible, use “personal” means of prevention such as work restraint;
- If this is not possible, use a personal fall protection system such as a work positioning system or fall arrest system;
- Additionally provide training and instruction or take other measures to prevent any person falling a distance liable to cause personal injury.

Where a risk assessment indicates that a personal fall protection system is required a work positioning system should always be used in preference to a fall arrest system. Where the use of fall arrest personal fall protection systems are unavoidable there will be a risk of the wearer being left suspended following a fall and arrangements must be made to ensure that they can be rescued in a safe and timely manner.

A4.12.0 Isolation of Systems During Maintenance and Thorough Examination

To avoid the risk of trapping, crushing, shearing or electrocution during the maintenance or thorough examination of mechanisms on tower cranes, all systems should be provided with a means of isolation. Where a system requires power maintenance or thorough examination, a safe system of work should be put in place to mitigate the risks of trapping. Such a safe system of work may well involve a “permit to work” and adequate communication between the crane operator and other members of the maintenance or through examination team.

A4.13.0 Access for Examination of Bases, Ties and Grillages

The site should provide safe access routes to allow the competent person to examine bases, ties and grillages. Where necessary bases should be well drained or kept dry by pumping.

NOTE: Access will also be required for the operator to check these items as part of his daily checks.

A4.14.0 Communication Equipment

Personnel carrying out maintenance or thorough examinations should be provided with an adequate means of communication, often hand held portable radios, to ensure that all members of the thorough examination team can communicate effectively with each other, the tower crane operator and personnel on the ground.

NOTE: Additional advice on radio communications is given in the CPA Technical Information Note TIN 017 - *Radio Communication for Lifting Operations*.

A4.15.0 Additional Information

The Construction Plant-hire Association produces a series of Technical Information Notes (TINs) on the safe use, maintenance and thorough examination of tower cranes. These are available to download free of charge on the CPA web site at www.cpa.uk.net in the Tower Crane Special Interest Group section.

Provision & Use of Work Equipment Regulations 1998/SI2306

L22 *Safe use of work equipment*, HSE Books.

Lifting Operations & Lifting Equipment Regulations 1998/SI2307

L113 *Safe use of lifting equipment*, HSE Books.

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

BS 7121-2:2003, *Code of practice for safe use of cranes — Part 2: Inspection, testing and examination*

BS 7121-5:2006, *Code of practice for safe use of cranes — Part 5: Tower cranes*

Annex 5 – Typical In-service Maintenance Checklist

Intermediate inspection report			Record of operations carried out								noted condition		noted operation		Repair necessary before putting into service										
Date of inspection:		Crane model:	Serial number:		option not present on crane	checking	cleaning	lubrication	verification / measurement	adjustment / update	repair	replacement	noted condition		noted operation		Repair necessary before putting into service								
/ / 200													satisfactory	unsatisfactory	satisfactory	unsatisfactory	yes	no							
Number of inspection report:		Inspection type:											Intermediate inspection												
Name of technician in charge:		Company:		Signature:																					
Ref.	List of recommended operations																								
Check the general condition of structures, fastenings and machinery																									
01	Check the condition and secure fixing of ballast blocks and counterweight																								
02	Check the condition of structural elements																								
03	Check the presence and condition of fastenings - particularly pins of frames and masts																								
04	Check the lubrication of articulated connections in operation																								
05	Check the condition and assembly of access equipment - platforms, trap doors, ladders, hoop guards, guardrails, etc.																								
06	Check the fixing of accessories - advertising signs, wind plates, jib indicating plates, etc.																								
07	Check the condition and fixing of machinery																								
Test the crane in operation with the crane driver																									
08	Check the operation of all machinery																								
09	Check the condition and operation of alarms - warning lights, horn, flash lamp, etc.																								
10	Check the condition and operation of indicators - load, moment, distribution, anemometer, etc.																								
11	Check the adjustment and operation of motion limiters - limit switches, slow speed, etc.																								
12	Check the condition and operation of cab accessories - windscreen wiper, heater, seat, lighting, etc.																								
Check the brakes																									
13	Check lining wear and gap of machinery brakes (excluding traveling machine)																								
14	Check the presence and condition of manual release mechanisms																								

VBRD061129

Observations :

Intermediate inspection report							Record of operations carried out							noted condition		noted operation		Repair necessary before putting into service																	
General counter reading		Summary of lubrication operations carried out						option not present on crane	checking	cleaning	lubrication	verification / measurement	adjustment / update	repair	replacement	satisfactory	unsatisfactory	satisfactory	unsatisfactory	yes	no														
hours		List of elements concerned				C	G															TO	DO	Qty (l)											
Lifting counter reading																																			
hours																																			
Distribution counter reading																																			
hours																																			
		Cleaning, Greasing, Top up Oil, Drain Oil																																	
Ref.	List of recommended operations																																		
15	Check the operation of the weathervaning mechanism																																		
Check the machinery																																			
16	Check the condition and operation of the roller path																																		
17	Check the greasing of the ring and its external teeth																																		
18	Check the oil level of the reduction gears																																		
19	Check the oil level of the hydraulic units and circuits for leaks																																		
20	Check the condition and operation of belt transmissions																																		
21	Check the belt tension of the orientation encoder																																		
Check the control gear																																			
22	Check the condition of the cabling and electrical components - particularly the vertical column																																		
23	(in cold season) Check the adjustment and operation of the heating of electrical cabinets																																		
24	Check the condition and operation of the isolating switch and/or general circuit breaker																																		
25	Check the condition and operation of contactors and control switches																																		
26	Check the internal cleanliness of electrical cabinets - check the condition of any vents and filters																																		

VBRD061129

Observations :

Intermediate inspection report				Record of operations carried out							noted condition		noted operation		Repair necessary before putting into service									
List of replaced parts				option not present on crane	checking	cleaning	lubrication	verification / measurement	adjustment / update	repair	replacement	noted condition		noted operation		Repair necessary before putting into service								
Ref.	Name	Code	Quantity									satisfactory	unsatisfactory	satisfactory	unsatisfactory	yes	no							
Ref.	List of recommended operations																							

Check the safety devices

27	Check the condition of safety gear - moment, motion and load limiting devices, etc.																
----	---	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Check metal cables, lines of cables, crab and pulley block

28	Check the condition of the distribution trolley - structure, straining screw, saber, wheels, fall protection, etc.																
29	Check the condition of cable lines - pulleys, bearings, cable guides, etc.																
30	Check the condition and operation of the sliding pulley mechanism																
31	Check the greasing of the sliding pulley mechanism																
32	Check the winding of cables on drums																
33	Check the condition of cables and their attachments - swivel, rope anchor box, bulldog grip, etc.																
34	Check the condition and operation of the pulley block - hook, safety catch, SMDM locking, thrust ball bearing, etc.																

Check the documentation and markings

35	Check that documentation is present - instruction manual, certificates of conformity, maintenance log, etc.																
36	Check that warning signs are present - on the foot and in cab / on the jib (radio controls)...																

Optional traveling machine

37	Check the condition of the wheel rims and treads of the traveling machine																
38	Check the condition of the collector and the friction mechanism of the winder																
39	Check the condition of the safety mechanisms relating to the traveling machine - forks, stops, ramps etc.																

Observations :

VBRD061129

Annex 6 - Supplementary information for Thorough Examination of Self Erecting Tower Cranes (SETC)

A6.1 Thorough Examination of SETCs

The requirement for thorough examination of self erecting tower cranes will depend on the extent of assembly from components carried out during the deployment of the crane on site. In the case where a self erecting tower crane arrives at site, is positioned on a prepared base, connected to a power supply, deployed by unfolding using its own winches and where no additional components are put into the structure; then no thorough examination following erection will be required as the crane will not have materially altered since its last periodic examination. A parallel may be drawn here with mobile cranes.

On the other hand a self erecting tower crane where after delivery to site and positioning on a prepared base, the deployment of the crane structure requires the assembly of additional components will require a thorough examination after erection as is the case with a top slew tower crane.

In either case checks should be carried out on site after installation to ensure that all crane motions and limits are functioning correctly.

A6.2 First Thorough Examination

Such an examination will fall under the requirements of the Lifting Operations and Lifting Equipment Regulations 1998, regulation 9(1). The necessity for undertaking such an examination will depend on the current status of the EC Declaration of Conformity for the equipment and its previous operational history as outlined by the regulation.

Where it is deemed necessary to undertake such a first thorough examination then the following information should be readily available for scrutiny:

- Declaration of Conformity for the equipment;
- Load Test and Thorough Examination Certificate. This should clearly identify the overload and stability test magnitudes applied to the equipment;
- A valid and current calibration certificate for the Rated Capacity Indicator;

NOTE: The Supply of Machinery (Safety) Regulations requires that all lifting equipment with a Rated Capacity of not less than 1000kg or an overturning moment of not less than 40,000 Nm must be fitted an RCI/L.

- Operation and Maintenance Manual;
- Test certification for the limiting switches and devices.

NOTE: Where available certification should be made available to the competent person; however, the Declaration of Conformity is normally seen as validating the testing of such switches and devices

A6.3 Thorough Examination After Installation

The periodic thorough examination comes under the requirements of the Lifting Operations and Lifting Equipment Regulations 1998, regulation 9(2). The need for such an examination will depend on the extent of assembly from components carried out during the deployment of the crane on site. In the case where a self erecting tower crane arrives at site, is positioned on a prepared base, connected to a power supply, deployed by unfolding using its own winches and where no additional components are put into the structure; then no thorough examination following erection will be required as the crane will not have materially altered since its last periodic examination. A parallel may be drawn here with mobile cranes.

On the other hand a self erecting tower crane where after delivery to site and positioning on a prepared base, the deployment of the crane structure requires the assembly of additional components will require a thorough examination after erection as is the case with a top slew tower crane.

At the time of the thorough examination following installation, the following information should be made available for scrutiny by the competent person:

- Declaration of Conformity for the equipment.
- Periodic maintenance records.
- Records outlining repairs and renewals carried since last examination.
- Operation and Maintenance Manual.
- A copy of the last Report of Thorough Examination
- Documentation confirming the adequacy of the ground conditions for the crane configuration and load capacity.

NOTE: This is primarily the responsibility of the duty holder to have the ground capability confirmed for the loading conditions applied. Hence, the availability of such documentation would enhance the thorough examination and allow for independent scrutiny).

The thorough examination following installation may give rise to concerns regarding integrity. The competent person may then call for verification records, as deemed necessary, which would include:

- Load Test and Thorough Examination Certificate. This should clearly identify the overload and stability test magnitudes applied to the equipment.
- A valid and current calibration certificate for the Rated Capacity Indicator/Limiter.

NOTE: The Supply of Machinery (Safety) Regulations requires that all lifting equipment with a Rated Capacity of not less than 1000kg or an overturning moment of not less than 40,000 Nm must be fitted an RCI/L.

- Test certification for the limiting switches and devices.

NOTE: Where available certification should be made available to the competent person; however, the Declaration of Conformity is normally seen as validating the testing of such switches and devices.

A6.4 Periodic Thorough Examination

The periodic thorough examination comes under the requirements of the Lifting Operations and Lifting Equipment Regulations 1998, regulation 9(3).

At the time of the periodic thorough examination then the following information should be made available for scrutiny by the competent person:

- Declaration of Conformity for the equipment.
- Periodic maintenance records.
- Records outlining repairs and renewals carried since last examination.
- Operation and Maintenance Manual.
- A copy of the last Report of Thorough Examination
- Documentation confirming the adequacy of the ground conditions for the crane configuration and load capacity.

NOTE: This is primarily the responsibility of the duty holder to have the ground capability confirmed for the loading conditions applied. Hence, the availability of such documentation would enhance the thorough examination and allow for independent scrutiny).

The periodic thorough examination may give rise to concerns regarding integrity. The competent person may then call for verification records, as deemed necessary, which would include:

- Load Test and Thorough Examination Certificate. This should clearly identify the overload and stability test magnitudes applied to the equipment.
- A valid and current calibration certificate for the Rated Capacity Indicator/Limiter.

NOTE: The Supply of Machinery (Safety) Regulations requires that all lifting equipment with a Rated Capacity of not less than 1000kg or an overturning moment of not less than 40,000 Nm must be fitted an RCI/L.

- Test certification for the limiting switches and devices.

NOTE: Where available certification should be made available to the competent person; however, the Declaration of Conformity is normally seen as validating the testing of such switches and devices.

Annex 8 - Weekly Inspections

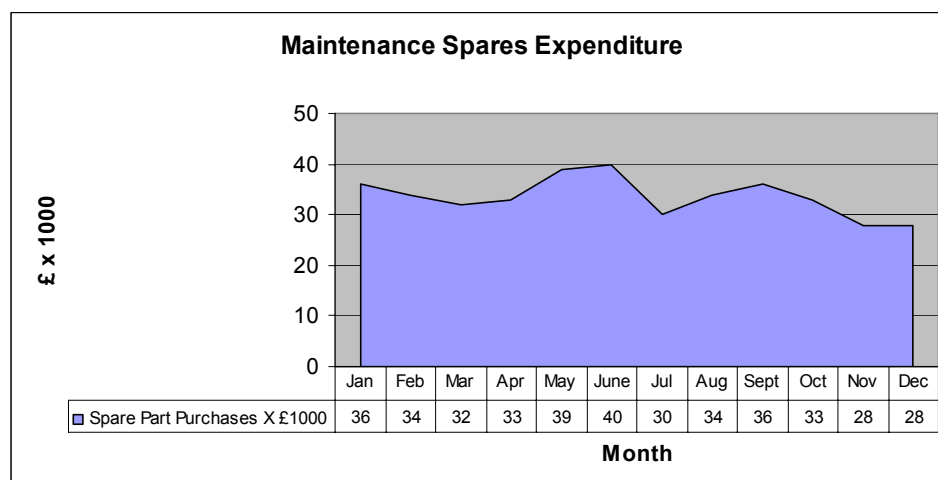
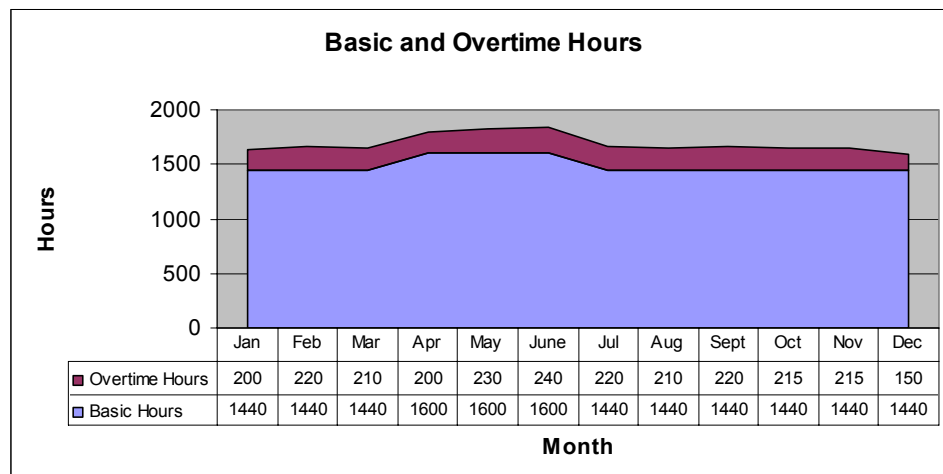
Weekly inspections must be made in addition to the daily checks listed in Annex 7 and should include everything on the following list. There may be additional checks required by the tower crane owner based on advice given to them by the manufacturer of the crane. The results of these checks should be recorded in an appropriate form.

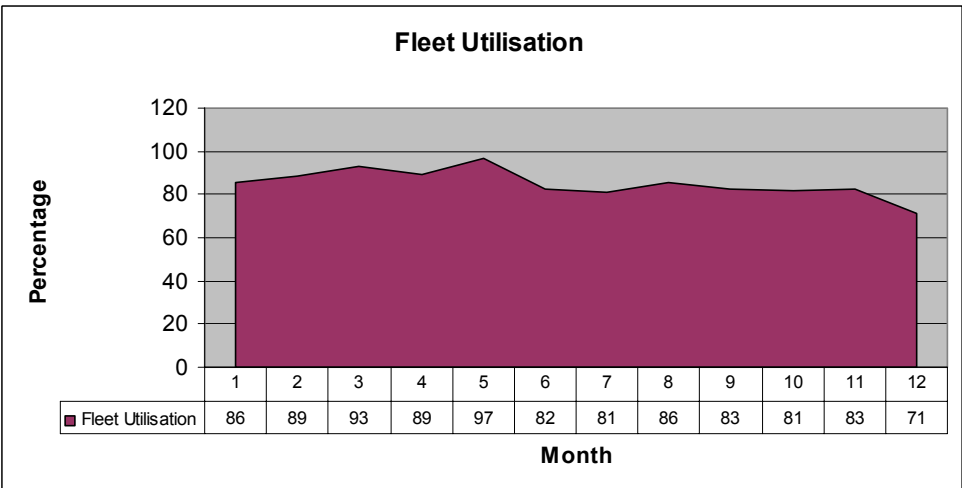
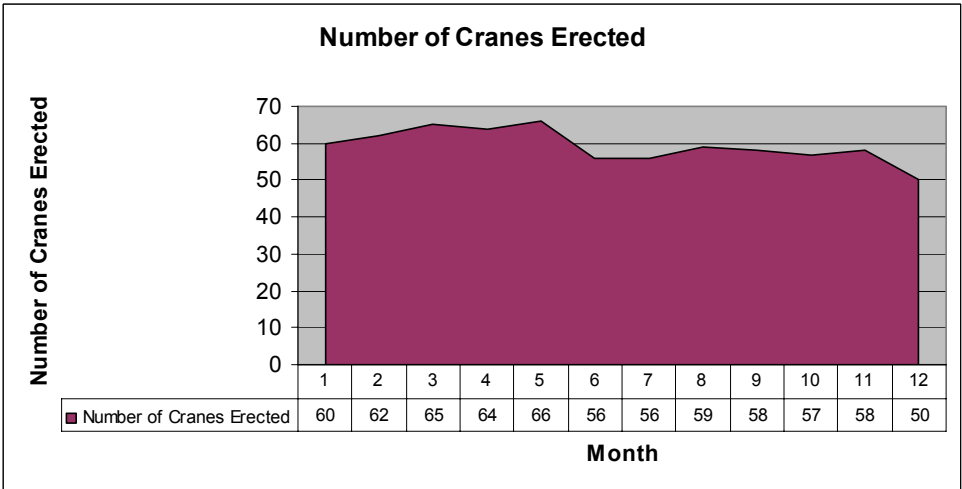
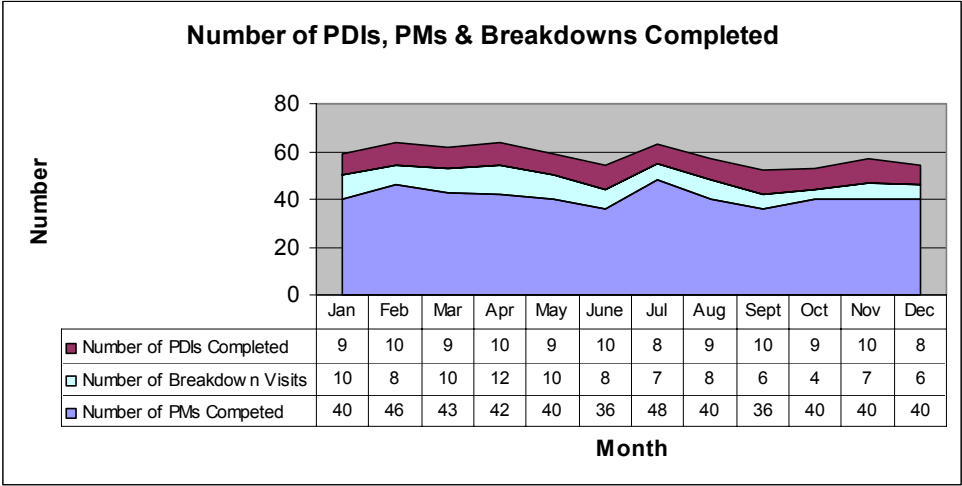
1. Counter jib components
2. Counter jib access
3. Counter jib ballast security
4. Illuminated sign condition and security
5. Oil leaks on motors and gearboxes
6. Control enclosure condition and security
7. Slew ring teeth and lubrication
8. Hoist rope condition
9. Hydraulic fluid levels
10. Rope lubrication

Annex 9 – Example of the Use of Key Performance Indicators for Maintenance

Basic Data

KPI	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sept	Oct	Nov	Dec
No. of Cranes Erected	60	62	65	64	66	56	56	59	58	57	58	50
No. of Cranes in the fleet	70	70	70	72	68	68	69	69	70	70	70	70
Spare Part Purchases X £1k	36	34	32	33	39	40	30	34	36	33	28	28
No. of Tradesmen	9	9	9	10	10	10	9	9	9	9	9	9
Basic Hours	1440	1440	1440	1600	1600	1600	1440	1440	1440	1440	1440	1440
Overtime Hours	200	220	210	200	230	240	220	210	220	215	215	150
Total Hours	1640	1660	1650	1800	1830	1840	1660	1650	1660	1655	1655	1590
PMs Completed	40	46	43	42	40	36	48	40	36	40	40	40
PDIs Completed	9	10	9	10	9	10	8	9	10	9	10	8
No. of Breakdown Visits	10	8	10	12	10	8	7	8	6	4	7	6
Fleet Utilisation	86	89	93	89	97	82	81	86	83	81	83	71

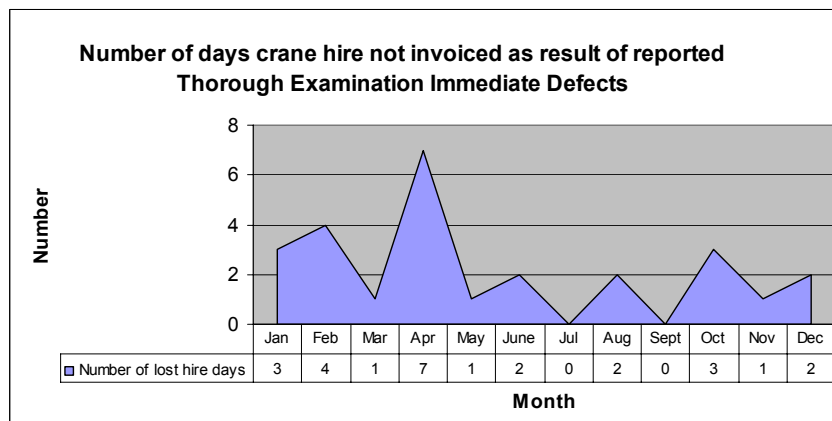
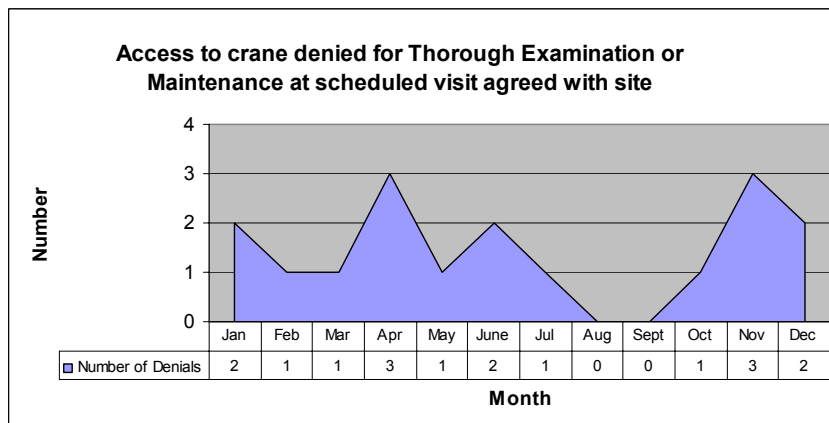
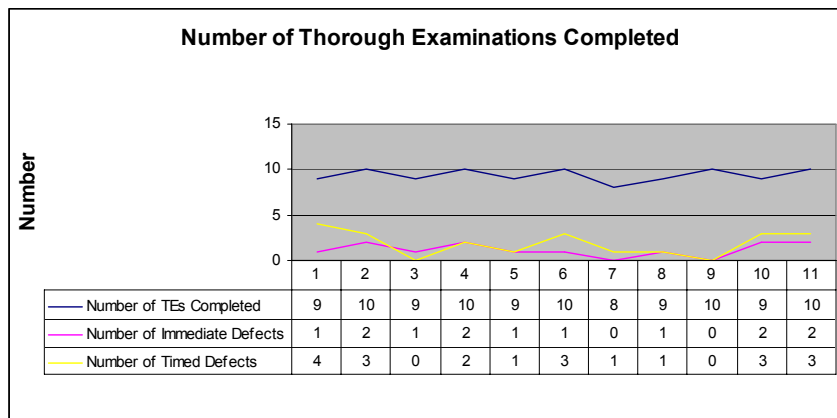




Annex 10 – Example of the Use of Key Performance Indicators for Thorough Examination

Basic Data

KPI	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sept	Oct	Nov	Dec
No. of TEs Completed	9	10	9	10	9	10	8	9	10	9	10	8
No. of Immediate Defects	1	2	1	2	1	1	0	1	0	2	2	2
No. of Timed Defects	4	3	0	2	1	3	1	1	0	3	3	3
% Immediate Defects	11	20	11	20	11	10	0	11	0	22	20	25
% Timed Defects	44	30	0	20	11	30	13	11	0	33	30	38
No. of hire days lost due to Immediate Defects	3	4	1	7	1	2	0	2	0	3	1	2
Access denied to crane for TE or Maintenance	2	1	1	3	1	2	1	0	0	1	3	2



Annex 11 - Supplementary Reports and Tests Supporting Thorough Examination

A11.1 Report of Load Test Following Erection

This test would normally be completed shortly after erection of the crane at a new location to confirm the structural integrity of the crane following erection and to detect any weaknesses. The magnitude of the test load should be as specified by the crane manufacturer.

The report should include:-

- Date the test and subsequent examination was completed;
- The configuration of the crane at time of test;
- The unique serial number or identifying mark of the crane;
- Test weights and radii tested;
- Details of any defects or deformation observed.

A11.2 RCI/RCL Calibration and Functional Test Report

This is a report of the results of a functional and calibration check on the rated capacity system. The report should include confirmation of correct function of:-

- Visual displays and read outs;
- Warning lights advising of the approach to, and reaching of, an overload condition (hoist and moment systems);
- Audible alarms internal and external to the cab;
- Prevention of dangerous crane movements when an overload condition has been reached;
- Override keys (i.e. spring loaded);
- Self test on first power up.

Calibration of the unit would normally include:-

- Zero load calibration;
- Calibration completed with a test load of a known value close to the maximum lifting capacity of the crane;
- Radius calibration at minimum and maximum radius;
- Pre-Overload and Overload warning.

A11.3 Anemometer Calibration and Functional Test Report

This is a report recording the results of a functional and calibration check of an anemometer. The report should include confirmation of:-

- Suitable location and function of the wind speed sensor;
- Function and calibration check 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 verify the calibration of anemometer mounted on the crane.

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

A11.4 Test Report of NDT of Individual Components

Non-destructive testing may be requested by the competent person to supplement any visual examination. Where requested, such information should be made available to the competent person. 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 examined;
- Details of the test method employed and reference to appropriate standards;
- Calibration details of any test equipment used;
- Results of the examination.

A11.5 Slew Ring Clearances and Condition Report

This is a report detailing the clearances measured at the slew ring bearing. Slew ring bearing clearance measurements are most effectively made in a workshop environment. The frequency of examination should be in line with the manufacturer's recommendations, 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.

During the test an axial load is typically applied to the ring using hydraulic jacks or an overhead crane and the clearances/movement of the bearing measured with dial indicator gauges. The measurements should be taken at various positions around the ring with the bearing indexed during the test to a minimum of four geometric positions. The report should specify the maximum clearance allowed by the manufacturer for the specific slew ring type and model. It is recommended that results of previous examinations be recorded on the same report in order that an assessment can be made as to the rate that clearances are increasing.

A basic assessment as to the condition of bearing faces and rolling elements can often be made by rotating the bearing whilst under a vertical axial load. The slew ring should where possible be rotated by hand rather than via the slew ring motor. Any tight spots, grumbling or clicking of the bearing should be noted and investigated by stripping down of the bearing assembly for close visual 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 an erected tower crane. 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 hood (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 can then be repeated with the crane slewed through 45° increments.

Measurement of slew ring bearing play on an erected crane will not give result that is as accurate as axial loading in workshop conditions, but will 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;
- Manufacturers specifications;
- Previous recorded values;
- Assessment as to the condition of the bearing faces and rolling elements;
- Confirmation as to the function of the grease nipple and systems.

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

A11.6 Mast Pin Clearance

Clearance on mast pins, collars and bushes can be measured with the crane erected. It is often beneficial to schedule this check to be completed prior to the crane being dismantled at the end of a hire period. The crane counter balance weight should be slewed, with no load on the hook, over each mast joint in turn. The movement of the joint can then be measured using a dial indicator gauge placed across the joint as the counterbalance passes over the joint.

As an alternative; mast sections, collars and individual pins can be examined prior to erection to confirm that they are within the wear tolerances specified by the manufacturer. Measurements can be taken with suitable measuring equipment such as Vernier callipers, external and internal micrometers or purpose made Go No-Go gauges. The disadvantage of measuring individual components is that the tolerance build up of the final assembly is often difficult to assess.

Any mast sections or pins that are found to be outside manufacturer's specified tolerances should be segregated and removed from service to await disposal or repair.

Reports for each inspected mast section should detail:-

- The date the examination was completed;
- The mast section unique serial number or identifying mark;
- Test method employed;
- Measured clearances or dimensions;
- The tolerances / measurements specified by the manufacturer.

A11.7 Pre-loads on High Tensile Bolts

The competent person may request a report recording that high tensile bolts have been preloaded to the manufacturer's specification. Before undertaking this work on an erected crane the maintenance manual should be consulted to ensure that the crane jib position (if fitted) and balance condition are as the manufacturer has specified. If this information is not available then the crane manufacturer should be consulted before any work is undertaken. Application of pre-load on high tensile fasteners may be achieved by the use of torque or hydraulic stretching devices. Ring testing or hammer testing should not be relied upon as a means of verifying the preload on high tensile fasteners. Best practice guidance is that the pre-load of slew ring fasteners is verified and recorded during pre-delivery inspection and maintenance.

The report should include the following information:-

- Date the work was completed;
- The name of the person completing the work;

- Details of the equipment used including the serial numbers or identifying marks;
- Calibration details for the equipment used;
- Settings used on the torque or stretching device.

A11.8 Anti-collision/zoning System Installation Report

Anti-collision and zoning systems are often installed by specialist sub-contractors, following installation of a crane on a site with either multiple cranes, over-sailing or zoning restrictions. The report should include the following information:-

- Date the equipment was commissioned;
- Make, model and serial number of the equipment;
- A site plan showing inter-arcing jibs, over-sailing or other restrictions;
- Confirmation of the settings programmed into the device;
- Details of the other cranes with which the device is communicating;
- Confirmation of correct function of the device;
- Details of the person completing the work.

A11.9 Pre-delivery Inspection Reports

The competent person may request sight of the pre-delivery inspection reports completed by the hire company prior to despatch to site. These reports should be sufficiently detailed for the competent person to confirm that all components of the crane have been inspected and the extents of the inspections. Records should be provided of any remedial work completed following the inspection.

Further information on pre-delivery inspection reports is given in:-

- CPA Technical Information Note TIN 014 *Pre-Erection Component Checks*

A11.10 Mast Verticality Report

A report on mast verticality may be requested at the discretion the competent person. This is likely to be requested on installations where the crane has been tied to the building structure or has been, or shortly will be, involved in climbing operations.

Where the mast verticality is found to be outside of the crane manufacturers tolerance, adjustments may be required to support ties or foundations. In this case the report should detail the verticality before and after adjustment. Where the mast verticality can not be brought within manufacturers tolerances further investigation will be necessary to identify and rectify the problem.

Mast verticality should be checked with the crane top, above the slew ring, in balance as the mast can deflect in an unbalanced condition.

The report should include the following information:-

- Date the test was completed;
- Height of the crane, number and position of any ties;
- Details of the equipment and method employed;
- Balanced hook radius and balance weight employed;
- Results of the examination at each point measured together with the manufacturers tolerances;
- Details of the person completing the work.

A11.11 Foundation Design Specification

This report is prepared by the designer of the foundation listing the design criteria, calculations and design outcome of the foundation method selected. The information may be in the form of a drawing with key data shown in tabulated form. The designer should state the design standards employed in preparing the design.

The report should include:-

- The name, qualifications and employing organisation of the person completing the design;
- Values for maximum design vertical loads, horizontal loads, applied overturning moments and rotational torques;
- Maximum out of service wind speeds considered;
- Drawing and specifications of final design.

A11.12 Foundation “as-built” Report

This report confirms that the foundations have been constructed in accordance with the foundation design. The report should be prepared by the organisation that has constructed/installed the foundation. The appointed person responsible for the planning and supervision of the crane erection should countersign the report.

All Foundations	<ul style="list-style-type: none">• Report confirming the foundation is in accordance with the foundation designer’s drawings.• Measurements confirming dimensional accuracy and level
Cast-in Items	<ul style="list-style-type: none">• Level, plumb and to tolerance
Reinforced Concrete	<ul style="list-style-type: none">• Record of concrete mix and placement date, cube tests where carried out, to ensure concrete is of the correct grade and sufficient maturity
Piles	<ul style="list-style-type: none">• Results of pile tests• Confirmation that the design has sufficient reinforcement bond length into pile cap and that the pile to take tension where applicable.
Steelwork	<ul style="list-style-type: none">• Steel dimensionally correct and to the correct grade• Bolts to the correct grade and tightened to specified torque• Weld quality (NDT results if required)
Rails	<ul style="list-style-type: none">• Bedding properly compacted• Sleepers of sound quality and rail clips securely fastened• Rail centres and levels to correct tolerances• Limit ramps and end stops correctly positioned and firmly fixed• Rails earthed

A11.13 Tie Loadings

A report prepared by appointed person that planned and supervised the erection of the tower crane. The report should include:-

- Tie loadings;
- Confirmation from the building designer (Structural Engineer) that tie loadings to be imposed on the building can be absorbed by the building structure;
- Confirmation that the tie design, type and fixing method is sufficient for the anticipated tie loadings;
- Results of any pull out tests completed on any tie anchors;
- Confirmation that the ties have been correctly assembled positioned and adjusted.

A11.14 Crane Erection Configuration Drawing/report

A drawing or tabulated report should be provided for each tower crane erection, providing sufficient detail for the competent person completing the thorough examination to identify that the correct components have been installed. This drawing should be in addition to any drawing contained in the manufacturer's manual, as often these drawings are difficult to follow for different configurations. The drawing should include details such as:-

- Manufacturers serial numbers;
- Unique marks;
- Model type references, sizes and capacities;
- Basic dimensional information to aid identification;
- Hook block reeving;
- Hoist rope length;
- Under hook height;
- Tower build;
- Jib length;
- Counter balance details;
- Cruciform base weights where specified.

A11.15 Hoist Brake and Luffing Brake Test and Examination

This is a test of the operational efficiency of the hoist and luffing brakes. This test may 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 confirm that the brake can bring to rest a moving load being lifted or lowered at the normal maximum operational speed;
- Dynamic testing to confirm 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 confirm that the brake can hold without slippage a static load.

The dynamic testing should be completed with and without the benefit of any eddy current or regenerative braking systems. This is necessary as often these systems can mask an underlying problem with the braking system. It is also a useful method of verifying the efficiency and settings of these systems.

A11.16 Maintenance Records

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.

A11.17 Earth Continuity Test

A test completed by a competent electrician to confirm the earth continuity of the electrical installation. The report should contain:-

- The name, qualifications and employing organisation of the person completing the test;
- Results of the test;
- Comparison of the test results with standard requirements (BS 7671);
- Identification and calibration details of the test equipment used;
- The date the test was completed.

A11.18 Report of Inspection and Test of Electrical Control Equipment

A report of an inspection, following installation, to confirm the safety, function and integrity of the electrical installation, completed by a competent electrician. The report should contain:-

- The name, qualifications and employing organisation of the person completing the inspection and tests;
- Results of the inspection and tests;
- Comparison of the test results with standard requirements (BS 7671);
- The date the inspection and tests were completed.

NOTE: Certain elements of this inspection and test may be undertaken prior to erection of the crane, as often this work can be better completed in a workshop or yard environment. The equipment should however be re-examined following erection to confirm parts have not been damaged or installed incorrectly.

A11.19 Report of Lightning Protection

This report of an inspection, following installation, to confirm the safety, function and integrity of the lightning protection system, should be completed by a competent electrician. The report should contain:-

- The name, qualifications and employing organisation of the person completing the test;
- Results of the inspection and tests;
- Comparison of the test results with standard requirements (BS EN 62305);
- The date the inspection was completed;
- Identification and calibration details of the test equipment used.

Annex 12 - Thorough Examination of Wire Ropes

The examination of wire ropes as part of the thorough examination of a tower crane should be based on the principles and requirements set out in BS ISO 4309:2004, *Cranes. Wire ropes. Care, maintenance, installation, examination and discard*

This document 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 may be subject to abrasion by external features.

When examining the hoist ropes on a tower crane it is often quite difficult to examine some parts of the rope, particularly those parts of the hoist rope that are continually passing over trolley and hook block sheaves, unless a trolley basket is fitted to a saddle jib crane. On luffing jib tower cranes there are similar problems with both the luffing and hoist ropes where all parts of the rope on an erected crane are not always accessible to the competent person. Consideration should be given to both the length of time that the crane will be erected on a particular site and the age of the rope. It may well be appropriate to fit a new rope before erection to reduce the risk of rope failure.

During the planning of thorough examinations the following points should be taken into consideration

1. Where it is not possible to carry out an effective examination of all parts of a hoist or luffing rope on an erected tower crane, that part of the rope that cannot be accessed should be examined by the competent person on the ground **before** the winch is installed on the crane. This will provide confirmation that the rope is in good condition at the time of erection. At the same time the state of lubrication of the rope should be assessed so that any necessary remedial action can be taken before the winch is installed on the crane. Fitment of a new rope will negate the requirement for this examination.
2. Where it is not possible to examine all parts of a hoist or luffing rope on an erected crane the competent person must specify, following pre-erection examination on the ground, the maximum period for which the rope may remain in service before full examination or replacement. In the case of a new rope fitted to the crane at time of erection the period must not exceed 12 months.
3. The competent person must be provided with the hoist or luffing rope specification and history of usage before carrying out the thorough examination.
4. If a hoist or luffing rope is found to be excessively greased - and hence not able to be properly examined, the rope must be cleaned prior to examination.
5. All signs of external corrosion should be followed up by detailed measurement of rope diameter in those parts of the rope where the corrosion is observed to assess any reduction of rope diameter which may indicate deterioration of the rope core.
6. The competent person should assess the state of rope lubrication and detail any requirements for additional lubrication on his report.

The results of any examination of wire ropes should be recorded.

Annex 13 – Examples of Pre-delivery Maintenance and Inspection Record Forms

Tower Crane Workshop Maintenance and Inspection Record (Mechanical)					
Make:		Plant No.		Date:	
Model:		Fitter's Name:		Signature:	
Component	Task	Completed		Comments	
		Yes	No		
<i>Hoist Gearbox</i>	Check oil				
	Change oil				
	Check gearbox				
	Check mounting				
<i>Trolley Gearbox</i>	Check oil				
	Change oil				
	Check gearbox				
	Check mounting				
<i>Slew Gearbox</i>	Check oil				
	Change oil				
	Check gearbox				
	Check mounting				
<i>Travel Gearboxes</i>	Check oil				
	Change oil				
	Check gearbox				
	Check mounting				
<i>Travel Bogies</i>	Check wheels				
	Check bearings				
	Check locks				
<i>Hoist Trolley</i>	Check carrier rollers				
	Check guide rollers				
	Check rope tensioner				
	Check rope wear pads				
	Check rope failure brake				
<i>Counter Weight Trolley</i>	Check carrier rollers				

Component	Task	Completed		Comments
		Yes	No	
Ropes	Hoist rope			
	Trolley rope(s)			
	Luffing rope			
	Bridle ropes			
	Erection ropes			
Hook Block	Check sheaves			
	Check swivel bearings			
	Check hook			
	Check fittings			
Jib Sections	Check pins			
	Check bolts			
	Check sheaves			
	Check for damage			
	Check for cracks			
	Check for corrosion			
	Check tie bars and pins			
Tower Sections	Check for damage			
	Check for cracks			
	Check for corrosion			
	Check bolt/pin holes for wear			
	Check bolts/pins			
	Check ladders			
Tower Head	Check bolts/pins			
	Check sheaves			
	Check for damage			
	Check for cracks			
	Check for corrosion			
	Check ladders			
Platforms	Check bolts/pins			
	Check for damage			
	Check for cracks			
	Check for corrosion			

Component	Task	Completed		Comments
		Yes	No	
Slew Ring Section	Check bolts			
	Check bearing play			
	Rotate and grease ring			
	Check for damage			
	Check for cracks			
	Check for corrosion			
	Check ladders			
	Lubricate open gears			
Cab	Check security of glass and frames			
	Check locks			
	Check wiper motor are and blade			
	Check seat condition and security			
	Check for damage			
	Check for cracks			
	Check for corrosion			
Base	Check for damage			
	Check for cracks			
	Check for corrosion			
	Check bolts/pins			
Additional Items	Wire rope dressing			
	Gear dressing			
	Slew bearing grease			
	General purpose grease			
	Grease gun			
	Gearbox oil			
	Earth stake and cable			
	Anemometer			
	Illuminated sign			
	Gearbox oil			
	Duty board			
	Jib marker flags			
Illuminated sign				

Tower Crane Workshop Maintenance and Inspection Record (Electrical)					
Make:		Plant No.		Date:	
Model:		Electrician's Name:		Signature:	
Component	Task	Completed		Comments and Test Results	
		Yes	No		
Hoist Assembly					
Motor	Check for damage				
	Check mountings				
	Check connections				
	Check insulation resistance				
	Check function				
Brake	Check for damage				
	Check mountings				
	Check connections				
	Check insulation resistance				
	Check mechanism				
	Check adjustment				
	Check friction material				
	Check function				
Resistance Bank*	Check for damage				
	Check mountings				
	Check connections				
Controls	Check for damage				
	Check mountings				
	Check connections				
	Check contactors				
	Check PLC settings*				
	Check functions				
Limiting Devices	Check for damage				
	Check mountings				
	Check connections				
	Check settings				
	Check functions				
* If applicable					

Bibliography

Legislation

Health & Safety at Work etc Act 1974.

Management of Health & Safety at Work Regulations 1999/SI3242.

Workplace (Health, Safety & Welfare) Regulations 1992/SI3004.

Provision & Use of Work Equipment Regulations 1998/SI2306.

L22 *Safe use of work equipment*, HSE Books.

Lifting Operations & Lifting Equipment Regulations 1998/SI2307.

L113 *Safe use of lifting equipment*, HSE Books.

Personal Protective Equipment at Work Regulations 1992/SI2966.

Work at Height Regulations 2005/SI735.

Supply of Machinery (Safety) Regulations 1992/SI3073 & 1994/SI2603.

The Construction (Design and Management) Regulations 2007/SI320.

The Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 1995 (RIDDOR).

The Air Navigation Order 2000.

Standards

BS 6166-3:1998, *Lifting slings — Part 3: Guide to the selection and safe use of lifting slings for multi-purposes*

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

BS 7121-2:2003, *Code of practice for safe use of cranes — Part 2: Inspection, testing and examination*

BS 7121-5:2006, *Code of practice for safe use of cranes — Part 5: Tower cranes*

BS 7262:1990, *Specification for automatic safe load indicators*

BS 7671:2008, *Requirements for electrical installations — IEE Wiring Regulations 17th edition.*

BS 7883:2005 - *Code of practice for application and use of anchor devices conforming to BS EN 795.*

BS 8437:2005 - Code of practice for selection, use and maintenance of personal fall protection systems and equipment for use in the workplace.

BS EN 795:1997 - *Protection against falls from a height — Anchor devices — Requirements and testing*

BS EN 970:1997 - *Non-destructive examination of fusion welds. Visual examination*

BS EN 12385-1:2002, *Steel wire ropes — Safety — Part 1: General requirements*

BS EN 12385-2:2002, *Steel wire ropes — Safety — Part 2: Definitions, designation and classification*

BS EN 12385-3:2004, *Steel wire ropes — Safety — Part 3: Information for use and maintenance*

BS EN 12385-4:2002, *Steel wire ropes — Safety — Part 4: Stranded ropes for general lifting applications*

BS EN 13411 Parts 1 – 6, *Wire rope terminations*

BS EN 13557:2003, *Cranes — Controls and control stations*

BS EN 13586:2004, *Cranes — Access*

BS EN 14502-1:2005, *Cranes — Equipment for the lifting of persons — Part 1: Suspended baskets*

BS EN 62305 Parts 1 – 4, *Protection against lightning*

BS ISO 4309:2004, *Cranes. Wire ropes. Care, maintenance, installation, examination and discard*

BS EN ISO/IEC 17020:2004, *General criteria for the operation of various types of bodies performing inspection*

BS EN ISO 9001:2000, *Quality management systems. Requirements*

Other Publications

HSE Leaflet INDG218 – Guide to Risk Assessment

HSE Leaflet INDG163 – Five Steps to Risk Assessment.

HSE Leaflet INDG 73 – Working alone in safety

HSE publication L73 - *A guide to the Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 1995*, HSE Books.

HSE publication HS(G) 107 - *Maintaining portable and transportable electrical equipment*

Tower crane stability, 2006. CIRIA C654. Construction Industry Research and Information Association.

Crane Stability on Site, 2003. CIRIA C703. Construction Industry Research and Information Association.

Cranes and planes - A guide to procedures for operation of cranes in the vicinity of aerodromes. Airport Operators Association (AOA).

A voluntary code of practice for the safe use of cranes in and around airports. Off-highway Plant and Equipment Research Centre.

Code of practice for the safe use of lifting equipment. Lifting Equipment Engineers' Association.

TWR 01, *Tower Crane Installation Training Programme*. 2004. Construction Industry Training Board (CITB).

The Inspection of Steel Wire Ropes. CASAR Drahtseilwerk Saar GmbH. (www.casar.de)

Useful Websites

British Institute of Non-destructive Testing	www.bindt.org
Construction Confederation	www.constructionconfederation.co.uk
Construction Plant-hire Association	www.cpa.uk.net
Construction Industry Training Board	www.citb-constructionskills.co.uk
Health and Safety Executive	www.hse.gov.uk
Safety Assessment Federation	www.safed.co.uk
United Kingdom Accreditation Service (UKAS)	www.ukas.com

Technical Information Notes

The CPA Tower Crane Interest Group publishes a series of Technical Information Notes dealing with various aspects of tower crane operation. These can be downloaded free of charge from the CPA website at www.cpa.uk.net and are in the *Special Interest Groups* section under *Tower Crane Interest Group*. At the time of publication the following TINs are available. New TINs are being added and readers should check the website for new additions and revisions.

TIN	Subject	Issue Date	Current Issue
000	Technical Information Note Index	30.07.07	F
001	Access to Tower Cranes After Commissioning	30.07.07	B
002	Raising and Lowering of Small Material	30.07.07	B
003	Tower Crane Access Procedures	30.07.07	B
004	Installing Wire Ropes on Winch Drums and Storage Reels	30.07.07	B
005	Housekeeping on Tower Cranes	30.07.07	B
006	Tower Crane Access Ladders	30.07.07	B
007	Duty Boards	30.07.07	B
008	Tower Crane Edge Protection	30.07.07	B
009	Security of Access to the Crane Base	30.07.07	B
010	Tower Crane Anti-Collision Systems	30.07.07	B
011	Attachment of Floodlights, Illuminated Signs and Christmas Decorations	27.02.06	A
012	Tower Crane Access Signage	30.07.07	B
013	Rescue of Personnel From Height on Tower Cranes	30.07.07	C
014	Pre-Erection Component Checks	30.07.07	B
015	Risk Assessment – General Access to Tower Cranes (including for maintenance)	30.07.07	B
016	Fall Protection Equipment For Tower Crane Operators	30.07.07	C
017	Radio Communication for Lifting Operations	30.07.07	B
018	Tower Crane Life	30.07.07	B
019	Contract Lifting and Crane Hire When Erecting, Dismantling and Using Tower Cranes on Construction Sites	30.07.07	B
020	The Effect of Wind on Tower Cranes In Service	12.06.07	B
021	Maintenance Principles for Tower Cranes	12.06.07	B
022	The Use of Tag Lines with Tower Cranes	12.06.07	B

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