Lifting Equipment
A User's Pocket Guide

Published by the:

Lifting Equipment Engineers Association

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Disclaimer

This pocket guide will be found to be a useful and authoritative source of information for all those people who are responsible for safety in the use of lifting equipment.

Every effort has been made to achieve the highest degree of accuracy in the generation of the data and advice supplied, but ultimate responsibility for safety must continue to rest with the persons and organisations charged with specific duties in current legislation. In particular, certain items covered by this guide are supplied in the form of proprietary designs for which the designer, manufacturer, etc must accept full responsibility.

Third edition ..... May 2010

PREFACE

The lifting of heavy loads using cranes and other lifting machines goes back to the earliest days of civilisation. One of the most crucial elements of any lifting operation is connecting the load to the lifting machine ie slinging.

Unsafe slinging poses risks, not only to the load and anything or anyone in its path if it falls; but also to the crane or lifting machine and the structure from which it is suspended. The sudden release of a load can trigger a catastrophic chain of events resulting in loss of life and massive damage to property.

Designers of heavy equipment have become much more aware of the need to incorporate lifting points into their products and, if the value of the contract or the frequency of the lift warrants it, the lifting gear may be tailored specifically for the job. However that still leaves the vast majority of lifting operations where the slinger has to deal with loads of all shapes and sizes usually without purpose made lifting points and often where space or headroom is restricted. For this the slinger uses general purpose lifting gear arranged and assembled to suit the particular job.

Slinging a load safely is therefore a responsible job requiring knowledge and skill to do it well. Knowledge of the equipment available, selecting the most suitable for a particular job, knowing how to check it before use and how to assemble and use it correctly is vital.

In some cases a lifting machine may not be available or cannot access the site and then the rigger is called upon to provide the means, often temporary, of lifting the load. Selecting and erecting the appropriate equipment is an equally responsible and vital job if the lift is to be safe.

The Health and Safety at Work etc Act 1974 was the first of a new generation of industrial safety legislation which places greater emphasis on the responsibilities of everyone involved in industry, the need for safety training and for information about equipment for use at work. Shortly after it came into force the Lifting Equipment Engineers Association, under its old name of the Chain Testers' Association of Great Britain, started to draft a Code of Practice for the Safe Use of Lifting Equipment (COPSULE) to bring together the best known practices.

The first sections were launched in 1981 but development continued. A seventh edition was published in May 2009. The code was designed as a comprehensive source of reference for managers and as such is a large document. A need was

identified for a smaller sized summary for the rigger and slinger, a user's pocket guide.

Throughout the guide the information is cross referenced to the code so that if further, more detailed information is required it may be readily found. The guide is not intended as a substitute for proper training but as a tool of the trade for the qualified rigger and slinger.

HOW TO USE THIS GUIDE

The guide is in three parts. Part 1 deals with matters common to most lifting equipment and includes information on the law, general procedures and guidance on the selection and use of lifting equipment. Part 2 provides a summary of the most important safe use information peculiar to each item of equipment covered. It should be read in conjunction with the general information in Part 1. Part 3 contains useful supporting information, data etc.

INTRODUCING THE LIFTING EQUIPMENT ENGINEERS ASSOCIATION

The Association was formed in 1944 in London but soon expanded to become the Chain Testers' Association of Great Britain. The present name was adopted in 1988 to more accurately reflect the activities of members. Since 2000 the number of overseas members has grown rapidly and they now have the same status as UK members. Large users of lifting equipment can have associate status.

Essentially technically orientated, the Association aims to provide members with a source of technical information and a means of authoritative representation. It should be recognised that the LEEA has a wide range of organisations amongst its members. Between them they are daily involved in the design, manufacture, hire, repair, refurbishment, maintenance and use of lifting equipment.

Quality

Members are required to conform to documented technical requirements which set stringent standards for equipment, personnel, procedures and records. Applicants for membership are subjected to a technical audit before being accepted into full membership and a continuing programme of periodic audits is carried out by LEEA staff and independent bodies.

Safety

The Association is keen to ensure safety in use and has a close liaison with the Health

and Safety Executive and other safety organisations. The 'Code of Practice for the Safe Use of Lifting Equipment', published by the Association, has been sold worldwide and is the most up to date and authoritative source of information and advice available anywhere. It is included in a list of standards and codes approved by the HSE.

Standards
The Association has always been involved in the preparation of British, International and European Standards. It is also active in the legislative field.

Through Technical Committee meetings, all members have the opportunity of expressing their views and seeking advice. The knowledge and experience gained by each of the members is therefore brought together for the benefit of all.

Training and Qualifications
UK legislation has long required lifting equipment to be tested and examined before first use and tested and/or examined periodically throughout its life by a competent person. In the absence of an official licensing system, the Association developed its own diploma qualifications for the Tester and Examiner and these have run for over 50 years. The Association provides training courses, leading to the diploma examinations.

There is also a TEAM (Test, Examine And Maintain) card scheme for qualified personnel. It provides authoritative evidence of the holder's qualifications and is only issued to engineers who have passed the LEEA's Diploma examination. It lists the Diploma modules that the holder has successfully completed. There are four modules, covering the major overhead lifting product families: general lifting gear, manual lifting machines, powered lifting machines, runways and light crane structures.

Technical support for members
Full time staff and an elected Technical Committee, a reference library and contacts with other organisations enable the Association to support its members in dealing with both day to day problems and more fundamental questions.

Benefits of Membership
The benefits of the LEEA are not therefore confined only to its members. When dealing with member companies, the user can be confident that he is dealing with organisations that are capable and have adequate facilities for the work they undertake and that the personnel concerned are qualified to do their jobs.

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LIFTING EQUIPMENT AND THE UK LAW

Overview

UK legislation is now based on European Directives and the most relevant for new lifting equipment is the 'The Supply of Machinery (Safety) Regulations 2008'. (These implement Directive 2006/42/EC and replace earlier regulations with the same name dated 1992 and a 1994 amendment) The regulations cover a wide range of machinery including manual and power operated lifting machines and lifting accessories such as slings, shackles, lifting beams, clamps and other equipment used to attach the load to the lifting machine.

The regulations for the use of lifting equipment are the Provision and Use of Work Equipment Regulations 1998 (PUWER) and the Lifting Operations and Lifting Equipment Regulations 1998 (LOLER). Both are accompanied by approved codes of practice (ACoPs) and guidance. PUWER applies to *all* equipment provided for use at work and LOLER is *additional* for lifting equipment. Therefore for lifting equipment, both sets of regulations apply.

The above regulations are 'risk based' and 'goal setting'. Generally they apply across all industries.

The main requirements of PUWER

Employers must ensure that work equipment is suitable for its purpose, is maintained, is inspected to ensure it has been correctly installed and remains in serviceable condition, that the people who use the equipment have been trained and have the information and instructions they need and that records are kept. In general these are all sensible requirements and reinforce the existing requirements of the Health and Safety at Work etc Act 1974.

Employers must also address specific risks or hazards and this applies to equipment from all dates of manufacture and supply. For relatively new equipment, many of the requirements will have been addressed by the manufacturer. In some cases a risk assessment may show that upgrading of the equipment or installation is required.

Regulation 10 requires equipment first provided for use after 31st December 1992 to comply with any 'essential requirements', ie the requirements in legislation such as the Machinery Safety Directive. However equipment complying with these requirements may still present a hazard or risk that is unacceptable and, in effect, the new equipment cannot be used until further steps are taken. This could be, for example, because the equipment is used in an application different from that

originally envisaged by the manufacturer or because safety depends upon the way it is installed.

The main requirements of LOLER

LOLER applies to lifting operations and lifting equipment, including accessories for lifting, across all sectors of industry. The requirements cover three main topics: ensuring the equipment is initially safe; ensuring it is used safely; and ensuring it remains safe for use. This guide focuses on the latter two.

Lifting operation means:

an operation concerned with the lifting or lowering of a load.

Lifting equipment means:

work equipment for lifting or lowering loads and includes its attachments used for anchoring, fixing or supporting it.

Accessory for lifting means:

work equipment for attaching loads to machinery for lifting.

The term load includes a person. There are particular requirements for equipment used for lifting persons. However the equipment covered by this pocket guide is not usually intended or rated for lifting persons so should NOT BE USED for such applications unless the manufacturer has specifically stated that it is suitable.

There are requirements to mark lifting equipment and accessories for lifting with their safe working loads. Also lifting equipment which is designed for lifting persons should be marked to that effect and lifting equipment which is not designed for lifting persons but might be so used in error should be so marked.

Ensuring the equipment is used safely

Regulation 8 (Organisation of lifting operations) places particular emphasis on planning and supervision because failures in these functions is a frequent cause of accidents. It states: "Every employer shall ensure that every lifting operation involving lifting equipment is properly planned by a competent person; appropriately supervised; and carried out in a safe manner."

Ensuring the equipment remains safe for use

Regulation 9 deals with thorough examination and inspection. A thorough examination should be done by a competent person and, where it is appropriate to carry out testing for the purpose described in the regulation, the term includes such testing by a competent person as is appropriate for the purpose.

All lifting equipment should be thoroughly examined as follows:

(1) Before first use. (There is an exception for equipment which has not been used and for which the employer has received an EC Declaration of Conformity made not more than 12 months before it is put into service.)

(2) Where safety depends upon the installation conditions, after installation and before first use. (This also applies if equipment is moved to a new location.)

(3) Within a specified maximum period of time or in accordance with an examination scheme. The specified maximum periods between thorough examinations are as shown in Table 1.

(4) Each time that exceptional circumstances which are liable to jeopardise the safety of the lifting equipment have occurred.

Type of Lifting Equipment	Max Period
Lifting equipment for lifting persons and lifting accessories	6 months
All other lifting equipment	12 months

Table 1
Maximum Periods Between Thorough Examinations

Lifting equipment including accessories for lifting should be inspected by a competent person at suitable intervals between thorough examinations to ensure that health and safety conditions are maintained and that any deterioration can be detected and remedied in good time.

Regulation 9 also requires that if lifting equipment leaves an undertaking or is obtained from another undertaking, it must be accompanied by physical evidence that the last thorough examination required has been carried out.

Regulation 10 requires the person making a thorough examination to report as follows:

(1) Notify the employer forthwith of any defect which he thinks is, or could become, a danger to persons.

(2) Make a written report* to the employer and any person from whom the equipment has been hired or leased.

(3) Where there is a defect which he thinks involves an existing or imminent risk of serious personal injury, he must send a copy of his report to the relevant enforcing authority (usually either the HSE or the Local Authority).

This last requirement is included because it means that the equipment has already passed the point where it should have been repaired or removed from service indicating a failure in the inspection and maintenance regime.

Summary of requirements
The requirements of the legislation can be summarised as follows:

(1) The equipment is safe and suitable for its purpose.
The manufacturer must identify the hazards associated with the equipment he makes and eliminate them or reduce the risk to an acceptable level. To show he has done so he affixes the CE mark to the equipment and issues a EC Declaration of Conformity. If safety depends upon the installation conditions, it should be thoroughly examined after installation to ensure that it is safe.

Employers have a general duty to provide their employees with suitable and safe equipment.

(2) The personnel who use the equipment are suitably trained.
The manufacturer or supplier is obliged to provide instructions for use and the employer is obliged to ensure the equipment is properly used by training the employees based on generally accepted practice and the instructions provided by the manufacturer. Often such information and training needs to be tailored to the particular industry or site.

Employees have a duty to cooperate with their employers and use the equipment in the way it is intended.

(3) The equipment is maintained in a safe condition.
All equipment should be inspected at appropriate intervals to ensure that health and safety conditions are maintained and any deterioration detected and remedied in good time. It should also be thoroughly examined by a competent person and a record kept of the result. Any equipment found to be unfit for a further period of service should be withdrawn. It is good practice to check equipment each time before use. Some equipment also requires regular preventive maintenance. When repairs affect load bearing parts, the equipment should be thoroughly examined and, if appropriate, tested before further use.

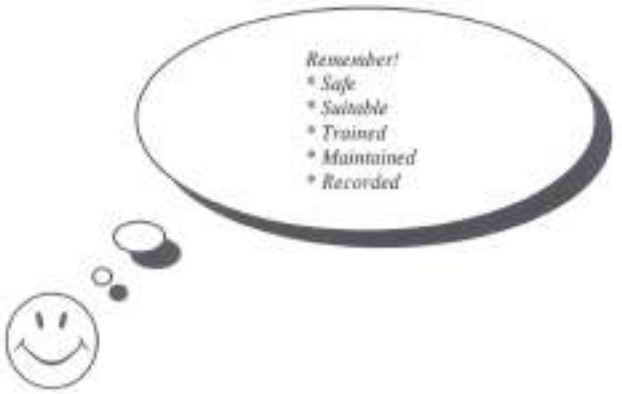
Employees should cooperate by making equipment available for inspection, thorough examination and maintenance.

(4) Records of conformity, test, examination etc are kept

All equipment should have a 'birth certificate' to show that, when first made available for use, it complied with the relevant requirements. For new equipment this will be an EC Declaration of Conformity** plus a manufacturer's certificate if called for by the standard worked to. It may also include a report of thorough examination following installation.

When equipment is tested and / or examined in service, a record of the results should be kept. The records should be cross referenced to enable the history of the equipment to be traced.

The above is a very simplified summary but reflects the spirit of the legislation where everyone has a responsibility for safety.



*A report of thorough examination should contain the following information:

1. The name and address of the employer for whom the thorough examination was made.
2. The address of the premises at which the thorough examination was made.
3. Particulars sufficient to identify the lifting equipment including where known its date of manufacture.
4. The date of the last thorough examination.
5. The safe working load of the lifting equipment or (where its safe working load depends on the configuration of the lifting equipment) its safe working load for the last configuration in which it was thoroughly examined.

6. In relation to the first thorough examination of lifting equipment after installation or after assembly at a new site or in a new location-
   (a) that it is such thorough examination;
   (b) (if such be the case) that it has been installed correctly and would be safe to operate.
7. In relation to a thorough examination of lifting equipment other than a thorough examination to which paragraph 6 relates-
   (a) whether it is a thorough examination-
      (i) within an interval of 6 months under regulation 9(3)(a)(i);
      (ii) within an interval of 12 months under regulation 9(3)(a)(ii);
      (iii) in accordance with an examination scheme under regulation 9(3)(a)(iii); or
      (iv) after the occurrence of exceptional circumstances under regulation 9(3)(a)(iv);
   (b) (if such be the case) that the lifting equipment would be safe to operate.
8. In relation to every thorough examination of lifting equipment-
   (a) identification of any part found to have a defect which is or could become a danger to persons, and a description of the defect;
   (b) particulars of any repair, renewal or alteration required to remedy a defect found to be a danger to persons;
   (c) in the case of a defect which is not yet but could become a danger to persons-
      (i) the time by which it could become such danger;
      (ii) particulars of any repair, renewal or alteration required to remedy it;
   (d) the latest date by which the next thorough examination must be carried out;
   (e) where the thorough examination included testing, particulars of any test;
   (f) the date of the thorough examination.
9. The name, address and qualifications of the person making the report; that he is self-employed or, if employed, the name and address of his employer.
10. The name and address of a person signing or authenticating the report on behalf of its author.
11. The date of the report.

** For general purpose lifting equipment for use in the UK the Declaration of Conformity must be typed, or written by hand in block capitals, be in English and contain the following particulars:

1. business name and full address of the manufacturer and, where appropriate, the manufacturer's authorised representative;
2. name and address of the person authorised to compile the technical file, who must be established in an EEA state;
3. description and identification of the machinery, including generic denomination, function, model, type, serial number and commercial name;
4. a sentence expressly declaring that the machinery fulfils all the relevant provisions of the Directive and where appropriate, a similar sentence declaring conformity with other Directives and/or relevant provisions with which the machinery complies. These references must be those of the texts published in the Official Journal of the European Union;
5. where appropriate, a reference to the published harmonised standards used;
6. where appropriate, the reference to other technical standards and specifications used;
7. the place and date of the declaration;
8. the identity and signature of the person empowered to draw up the declaration and behalf of the responsible person.

GENERAL LIFTING PROCEDURE

Some basic information about load balance and stability
Before lifting, it is essential to ensure that when clear of the ground, the load will adopt the intended attitude and remain securely attached to the lifting machine without overloading any of the lifting gear. This means that the load must be both balanced and stable.

Balance
In most lifts, you will want the load to be level when clear of the ground. To do this position the hook of the lifting machine vertically above the C of G of the load.

The legs of the sling(s) should be distributed as evenly as possible according to the lifting points available. The angle which each leg makes with the vertical affects the proportion of the load which will be imposed on it so all legs should be, as far as practicable, at the same angle.

If the load tilts on lifting, the loads in the sling legs will be unequal. This effect is especially significant when the angle between the legs is small.

If a rigid load is lifted on four or more lifting points it may be found that only two or three legs take the majority of the load with the remaining legs providing a relatively small "balance force". If this is the case, larger capacity slings will be required.

Stability
In this context, stability means 'resistance to toppling'. An object with a narrow base and a high C of G will need less force to topple it than one with a wide base and a low C of G.

As the height of the C of G increases relative to the width of the base, a point will be reached where the object will fall over unless it is supported by external means. At this point, the object is regarded as being unstable. A similar situation exists with a suspended load.

It is essential when slinging a load to ensure that it is stable. A load will be inherently stable if the lifting gear is attached ABOVE the C of G and properly disposed around it. If the attachment points are below the C of G refer to COPSULE section 1 appendix 1.3 for more detailed guidance.

When it is intended to 'turn over' the load in the air or position it at an inclined

attitude, special consideration should be given to the questions of balance and stability to ensure that at all stages of the operation the load remains balanced, stable and securely attached without overloading any item of lifting equipment.

On occasions, particularly when using a single leg sling, it may be necessary to lift a load such as a pipe or drum with the sling positioned a short distance away from the centre of gravity. The load when lifted will then take up a tilted position but will be inherently stable.

Before you start you need to know the following:

About the load:

- What constitutes the load?
- Is it in one piece or likely to fall apart?
- Is it strong enough to support itself from the lifting points or does it need support to be lifted?
- Are there any special problems eg delicate load, very hot, cold, corrosive or sharp load?
- Are there lifting points and if not how can the lifting gear be attached?
- What does it weigh? (This is ESSENTIAL – do not guess – if in doubt over estimate.)
- Where is the centre of gravity (C of G)?
- Is it fixed down or free to be lifted?
- If it is fixed will it be stable when the fixings are released or will it need support?

About the lifting machine:

- Is there a suitable lifting machine which can be positioned above the C of G of

the load? (To be suitable it must, in particular, be of sufficient capacity and not so fast as to make it difficult to control and position the load, and it must permit any sideways movement required.)

- If there isn't a suitable lifting machine, is there a suitable lifting point from which a lifting machine can be attached? (To be suitable it must, in particular, be of sufficient strength bearing in mind any other loads imposed on it, be vertically above the C of G of the load and permit such sideways movement as is required.)
- If there isn't either a suitable lifting machine or lifting point, is there access for a portable structure?

About the site:

- Is there a clear and safe path to the landing site or are there exposed persons or obstructions in the way?
- Are there any special environmental problems eg very hot/cold or wet, the presence of fumes, solvents, acids or other chemicals?
- Is the landing site level and strong enough to take the load? (Watch out for excessive floor loadings, soft ground and hidden weak spots such as ducts and drains.)
- Does the load have to be turned or orientated before landing?
- Has the landing site been prepared or do you need packing, supports, tools etc?

Having done your research you are ready to start
The basic 9 point procedure is as follows:

(1) Cooperate with others

Ensure you have checked with other personnel that:

- you have the authority to erect any structure or lifting machine required;
- you have the authority to make the lift;
- you can clearly communicate with the crane driver and any assistants and have an agreed code of signals;
- you will not conflict with other activity in the area or under the path of the load.

(2) Select and install the lifting structure and / or lifting machine

If there is an existing lifting machine ensure that:

- it is of adequate capacity;
- it is not so fast as to make it difficult to control and position the load;
- it provides adequate headroom and height of lift;
- it can be positioned so that the hook is over the C of G of the load;
- it permits any sideways movement required.

In addition, if you have to provide this equipment specially for the job, ensure that:

- it has been properly installed and, if appropriate, tested and / or thoroughly examined by a competent person after installation.

(3) Select the lifting gear

Decide on the lifting gear required ensuring that:

- if the load is not strong enough to support itself, additional support is provided;
- the load will stay together and loose pieces cannot fall off;
- the safe working load of the lifting gear takes account of both the weight and the mode of use;
- the load is not damaged by the lifting gear;
- the lifting gear is not damaged by the load;
- the lifting gear is not damaged by the environment;
- the load can be controlled in the air – use a tag line if necessary.

(4) Check the lifting gear

- Check the lifting gear to ensure it is fit for use.

(5) Assemble the lifting gear

- Position the lifting machine hook vertically above the C of G.
- Attach the lifting gear ensuring that all pieces are free to align correctly.
- Hoist to take up the slack, keeping fingers, toes etc clear and check that the gear is correctly positioned.

(6) Make a trial lift

- Ensure the load is not fixed down, keep fingers, toes etc clear and make a trial lift ie lift just clear of the ground.
- Ensure the load is level and secure. If not, lower it, reposition the lifting gear and try again.

(7) Lift and travel the load

- Lift and travel the load to the landing site, carefully avoiding obstacles and people and warning exposed persons to clear the area.
- Check the landing site is prepared and lower the load, stopping just clear of the ground.

(8) Make a trial landing

- Check the position of the load and packers/supports etc to ensure the load will be supported without trapping the slings.

- Gently lower until landed but do not allow the lifting gear to go slack.
- Ensure the load is safe and will remain stable when the gear is removed and, if not, lift it clear again and reposition supports, packers etc and try again.
- Slack off the gear and remove it by hand.

(9) Clear up

- Check the gear and return it to safe storage, placing into quarantine any item that is damaged.

SELECTION AND USE OF LIFTING MACHINES AND SUPPORTING STRUCTURES

Factors Influencing Choice of Lifting Machine and Supporting Structure

Lifting jobs tend to fall into two categories; those done regularly and those which are one off or rarely done. For the former there is usually a lifting machine already installed and the decisions about the suitability of the machine were made long ago. It

is a nevertheless a worthwhile exercise to review such decisions from time to time to ensure they are still valid. For the one off job, there may be a lifting machine which might be suitable or one may have to be provided especially. The SWL of the machine is obviously important but there are numerous other factors which affect safety such as speed, controllability and the facility to travel the load horizontally.

The following factors are not necessarily in order of importance, nor do they represent an exhaustive list, but are some of the considerations appropriate to selecting a lifting machine. Users are advised to consult a LEEA member if in any doubt as to the suitability of a lifting machine for any purpose, environment etc.

When selecting a lifting machine consider:

- What does the load weigh?
- What is the size and shape of the load?
- Is the load hazardous, fragile etc?
- What height does the load have to be lifted?
- Is the load to be lifted, jacked or pulled? (It may be necessary initially to raise the load by jacking to gain sufficient access for other lifting equipment to be employed in the final lifting and/or moving operation.)
- Is it necessary to move the load and if so in which direction and over what distance?
- Is the equipment to be used for just the one job or will it will be used again?
- Is a suitable suspension point available or is it necessary to provide one?
- If a structure is required, can it be attached to the building or must it be free standing?
- What headroom is available?
- Are there are any obstructions which may impede the operation?
- Is the working area spacious or confined?
- Is there a suitable electrical supply available?
- Is there a suitable compressed air supply available?
- Is the job indoors or outside?
- Is the area a hazardous area or are there any environmental problems which may affect the equipment or the operative?
- Does the operative need to be in a remote position?
- Are any special measures necessary to comply with regulations or other safety requirements?

TYPES OF LIFTING MACHINE AND SUPPORTING STRUCTURE

Pulley blocks

For the lightest of loads, it may be possible to use a simple pulley block arrangement. Pulley blocks are used in association with fibre rope or wire rope and the effort can be either direct from the operative onto the rope or by a winch. The mechanical advantage is dependant on the number of falls of rope in the system.

It must be realised that, when used without a winch, the operative carries a proportion of the load and is effectively the brake as pulley blocks are not self sustaining. It is strongly recommended that such arrangements are restricted to the lightest loads and avoided if possible.

Pulley blocks are more commonly used in association with winches, where the winch provides the effort and self sustaining feature, thus enabling heavier loads to be lifted. A feature of pulley blocks which must not be overlooked is the resulting load imposed on the supporting structure. This load comprises the weight of the pulley blocks and rope, the load including any slings etc used to connect the load, the applied effort used in raising and sustaining the load and the effects of friction at the sheaves. See the guidance on the use of pulley blocks on page 19.

Hand operated chain blocks

Hand operated chain blocks are self sustaining lifting machines providing an easy means of lifting, or lowering a load with acceptable operative effort. They are designed for vertical lifting where the load is directly below the hook, but may be used with girder trolleys to move suspended loads along runways.

They are relatively light in weight and easy to install, so suit temporary applications. Being operated by a hand chain, they can be high above the operative or the operative may be on a different level to the load. They are popular for maintenance purposes and ideal where there is no power. The larger capacities may require more than one operative.

Hand operated chain lever hoists

Hand operated chain lever hoists are a self sustaining lifting machine providing a simple means of raising loads through short distances. They are designed to operate in any position, making them suitable for pulling as well as lifting. They may be used with girder trolleys to move suspended loads along runways. They are ideal for applications requiring frequent re-positioning and are often used in maintenance work, the erection of structures and positioning of machinery etc.

Wire rope grip/pull lifting machines

These are lever operated machines which use a gripping action to haul a wire rope. They are self sustaining and may be used for both lifting and pulling applications. They may be used in conjunction with pulley blocks either to increase the mechanical advantage or to divert the line of pull. Don't forget the resulting load imposed on the supporting structure. See the guidance on the use of pulley blocks on page 19.

The wire rope passes through the machine and can be stored on a special coiler separate from the machine. This makes them ideal for extremely high lifts. They are frequently used for maintenance and construction work.

Winches

Self sustaining winches are often used in association with pulley blocks, either to increase the mechanical advantage or to divert the line of pull. They provide a means of lifting or pulling loads from a fixed point. They can require less headroom than either hand or power operated blocks and the operative may be remote from the load. They are therefore ideal for use in confined spaces. There is a wide range of hand operated winches and both electric and pneumatic power operated winches.

Winching speed can vary so ensure it suits the application. Don't forget the resulting

load imposed on the supporting structure. See the guidance on the use of pulley blocks on page 19.

A type of winch known as the suspended mounting hand operated winch, or pole hoist, is available and is often associated with man-carrying rescue applications. However it also has some advantages for lifting loads.

Power operated blocks

Power operated blocks are self sustaining and may be used with girder trolleys to move suspended loads along a runway. Whilst most may be used for either temporary or permanent applications, some designs are only suitable for permanent installations. Both electric and pneumatic powered types are available and the controls can be remote from the block. Some have more than one speed. Single speed blocks may be too fast for applications where precise positioning is required.

Travelling girder trolleys

Travelling girder trolleys provide an easy way of moving a suspended load along a runway track. They are available as push travel, hand chain travel or power travel versions. They may be separate from the lifting machine, which may be suspended by its top fitting from the trolley load bar, or built into the machine as an integral item.

Runways

Runways fitted with a trolley and lifting machine provide a relatively simple means of lifting and moving a suspended load but only along the line of the runway track. They are usually a permanent installation but can be temporary. The traditional runway is a standard 'I' section beam but there are now several proprietary sections available. Runways may form part of the building structure, be built onto the building members or be built into self supporting structures.

Mobile gantries

A mobile gantry provides an alternative to a permanent runway and is ideal where an occasional application calls for both lifting and limited movement of the load in a single plane. It is, in effect, a runway mounted on its own free standing supporting structure. Whilst the structure is portable, and is usually mounted on wheels or castors for ease of positioning, they are generally unsuitable for movement under load. They are intended to be positioned over the load which can then be raised, moved along the track and lowered.

Various types of mobile gantry are available and designs range from heavy duty gantries intended for permanent erection to light duty fold away designs intended for

one off lifting operations. Capacities vary with the design so consult the manufacturers to establish the available range.

Slewing jib cranes

Slewing jib cranes provide, in effect, a runway which slews. When fitted with a trolley and lifting machine, loads may be lifted and moved to any position within the arc of coverage. The jib may be mounted onto a suitable building column, wall or similar structure or be built into its own self supporting column.

They are ideal for use where loads have to be swung out over the edge of a loading dock etc or in a machine shop to lift items in and out of machine tools etc.

Slewing jib cranes are usually custom built from standard components to suit specific applications and are rarely suited to temporary applications. Light duty jibs may be found to be too 'bouncy' for applications which require precision positioning.

Overhead travelling cranes

An overhead travelling crane provides lifting and movement of the load in all directions. They range from small manually moved beams with a hand chain block to massive bridge structures which incorporate specially manufactured crab units. They are ideal where repeated lifting and movement of loads anywhere within the area of coverage is required.

Because they require permanent tracks, overhead travelling cranes are rarely suitable as a temporary installation. Depending on how they are controlled, the speed may be excessive for some applications. However because they can be easily positioned, they can also be used as a 'sky hook' from which to suspend a more suitable lifting machine. Also some light duty cranes may be found to be too "bouncy" for applications which require precision positioning.

Although no specific information is given in respect of overhead travelling cranes in this guide, the guidance offered in respect of travelling trolleys, hand operated chain blocks and power operated blocks may be applied where appropriate. See also BS 7121: Part 1 – Code of practice for the safe use of cranes.

Tripods and shearlegs

Where only a simple suspension point is required but no suitable purpose made suspension point or building member is available, a tripod or set of shearlegs may be suitable. They provide a fixed suspension point for a lifting machine but they are not suitable where any sideways movement is required. Any attempt to swing the load to

one side can easily cause the tripod or shearlegs to overturn.

They are usually constructed from tube or light sections and have three, or occasionally four, legs which hinge at the top where the suspension point is. Alternatively, they may have provision for a winch to be mounted on the legs with a top sheave over which the rope passes. They are free standing and the legs may have feet or points at their bases.

Tripods and shearlegs are generally available in heights up to 6 metres and the legs are arranged so that the span of the feet when erected is one third of the height. Capacities usually range from 500kg to 5 tonnes. In most cases they are easily erected by one or two people.

No specific information is given in this guide and the manufacturer's instructions should be sought and followed.

Jacks

Some loads lend themselves to being jacked up rather than slung and lifted from above. Jacks are often used to raise loads a short distance to enable lifting gear to be attached. They are also used where loads have to be lowered precisely into their final position, such as plant installation.

They require floors or supporting members which are able to withstand the forces through the jack base when the load is raised. This is usually a smaller area than the contact area of the load and therefore greater forces are imposed. Strong support packing to follow behind the jack is also required.

Although some mechanical jacks are available, the majority are hydraulic.

SAFE USE OF LIFTING MACHINES AND SUPPORTING STRUCTURES

Having selected suitable equipment, it is important that it is properly installed/erected and fit for use. It is also important that the people using the equipment understand how it is designed to be used and follow a procedure which ensures they remain in control of the load at all times throughout the operation. The following gives general guidance on these matters but as a first step always ask for, and ensure you obtain, keep and follow, the manufacturer's instructions.

Follow the GENERAL LIFTING PROCEDURE on page 7. In addition note the following points:

Installation/Erection of the Equipment

If the equipment has been in storage, a check should be made to ensure that no damage or deterioration has occurred whilst in store.

Ensure that the structure from which a lifting machine is suspended is adequate for the load it is intended to carry.

Use of existing structures to support a lifting machine

Often such structures are primarily designed for other purposes, eg a building from which a runway is suspended. It is important to ensure that they are adequate for the purposes of lifting but, because of other loads which may be imposed, proof load testing alone is not adequate. The following is recommended.

Runways: A structural engineer or other suitably qualified person should do a theoretical check on the structure and provide written confirmation that the structure is adequate. The runway track should be designed, tested and certified in accordance with the requirements of BS 2853 and should, together with all connections to the supporting structure, be periodically thoroughly examined.

Other lifting points: As with runways, a suitably qualified person should do a theoretical check and provide written confirmation that the lifting point is adequate. The connection between the lifting machine and the structure should be properly designed for lifting purposes, tested and certified, eg a beam clamp. All connections should be thoroughly examined at the appropriate intervals.

Marking: All runways and approved lifting points should be clearly identified and marked with their safe working loads. BS 449 and BS 2853 require specific allowances for dynamic loading which are greater for power operated lifting machines. It is recommended that power operated machines are not used on runways or lifting points designed only for manually operated equipment. To avoid confusion, it is recommended that the SWL marking should include the word 'MANUAL' or 'POWER' as appropriate.

Floor or ground loadings for free standing lifting equipment

For any free standing lifting equipment, ensure that the surface on which it stands will take both the total weight and the local loading under the supports. This is often left to the rigger or slinger to decide but, if there is any doubt, the matter should be referred to a suitably qualified person.

Beware of hidden dangers, such as underground pipes, drains and cables. The use of

floor spreader plates, to distribute the imposed loads over a larger surface area, should always be considered. Also watch out for the deflection of floor spans which might tilt the equipment and alter the radii or make it unstable, particularly if the equipment can move under load.

If the load is to be landed on the same surface, ensure it does not cause a local overload as it might stand on a smaller area than the lifting machine.

Use of pulley blocks

With pulley blocks, the load imposed on the supporting structure and the equipment which connects the pulley block to the structure is increased by the hoisting effort. The increase in load is as given in table 2.

Number of Sheaves						
Top Block	1	1	2	2	3	3
Bottom Block	0	1	1	2	2	3
Load on Top fitting = load lifted x Factor	2.08	1.56	1.39	1.3	1.25	1.22
Assuming 8% per sheave for friction						

Table 2
Loads Imposed by Sheave Blocks

Use of travelling trolleys

Where a travelling trolley is used, check that the track is sufficiently level at all loads up to the maximum that the trolley, machine etc will not run away under gravity.

When fitting a trolley onto an 'I' section track, ensure it is correctly adjusted for the width of beam, that the wheels align, are in full contact with the track and that anti-tilt devices are correctly set. Check also that end stops are in place, are effective and contact the wheel treads, not the flanges.

Use of lifting machines

With a hook suspended lifting machine, the top hook should be fitted with a safety

latch to prevent displacement and the support should fit freely into the seat of the hook and not exert any side thrust upon the point or latch.

After erection, check that the lifting chain or rope hangs freely and is not twisted or knotted. This is especially important with power operated chain blocks. Take care with multi-fall blocks in case the bottom hook has been turned over between the falls, imparting a twist to the chain or rope.

The height of lift should be checked to ensure that the hook will reach its lowest point without the chain or rope running fully out. Ensure any limits are correctly set and functioning. Ensure the brake is operating correctly especially if the equipment has been in storage a long time.

Connecting the electrical power supply

The electrical power supply and feed system should be of correct size and type for the machine and installed by a qualified person to the Electricity at Work Regulations 1989 and the supplier's instructions.

For travelling machines with a cable supply, ensure the cable is long enough to allow the machine to travel to its furthest point without the cable coming under tension. It is good practice to leave the earth wire longer than the others so that if an accidental force on the cable pulls the wires from their terminals, the earth wire will be the last to be disconnected.

Before connecting the power supply, insulation resistance, polarity and earth continuity tests should be carried out, care being taken not to damage any low voltage circuits or electronic devices.

After connecting the power supply, check that all motions work as the controls indicate eg when the 'down' button is pressed the machine lowers and vice versa. This is especially important in the case of plug in connections as the phasing at the socket is not guaranteed. If the direction of motion is incorrect, disconnect the mains supply and reverse two phases. Do not change the controls as the limit switches may not function.

Connecting the compressed air supply

The air feed line should be of the correct size and provide the required pressure and delivery rate specified by the manufacturer for the machine. It should be installed by a qualified person in accordance with the supplier's instructions.

The air must be dry and, depending on the source, this may require the incorporation of a filter to remove moisture. Many lifting machines also require the air to be lubricated.

For travelling machines, ensure that the supply hose is long enough to allow travel to the furthest point without undue stress on the hose and connections.

Maintenance

A routine preventive maintenance programme should be drawn up. For power operated machines, this can be combined with maintenance of the associated power supply/air supply system and control equipment.

Some essential precautions when using lifting machines

- Do not use a lifting machine to lift people unless it has been designed or specially adapted for that purpose or the hazards associated with lifting people have been addressed in some other way.
- Do not raise, lower or suspend a load greater than the marked safe working load.
- Exception for machines designed to pull as well as lift, always ensure that the line of lift is vertical.
- Do not use the load chain or wire rope to form a sling, ie it must not be wrapped around the load and back hooked or choke hitched.
- Never load the point of the hook. The sling should be located in the seat of the hook and the safety catch closed.
- Do not crowd the hook with slings. Use a shackle to join the slings first.
- Avoid shock loading. If the machine has dual speed, start the lift in slow speed before going to full speed.
- Most manually operated lifting machines, and especially lower capacity ones, are designed for operation by one person. If more than one person is required, it is likely that either the load exceeds the safe working load of the machine and/or it is in need of maintenance. Whichever is the case, an unduly high operating effort requires investigation before the lift proceeds. This guidance is not intended to preclude using more than one person to operate the machine, which may be found advantageous, but is to indicate the degree of operating effort normally required.
- Most power operated lifting machines are fitted with an overload device designed to protect the lifting machine. This may be mechanical, electrical or thermo-electrical. If the lifting machine fails to lift the load, it is likely that the load exceeds the safe working load and should be checked before resetting the controls.

- Never change the motion direction of an electrically powered machine without first allowing the motor to stop. Quick reversal of direction causes shock loading and heavy current surges.
- Avoid unnecessary inching as this causes burning and pitting of contacts and could burn out the motor.
- Do not leave an unattended load suspended from a lifting machine unless absolutely essential in which case ensure that the danger area is cordoned off.
- Except where special provision is made, do not allow anyone to pass under or ride upon the load. The area should be kept clear.
- With a push travel trolley, move a suspended load by pushing rather than pulling wherever possible. To move an unladen machine, pull on the bottom hook.
- Never attempt to move a power operated machine by pulling on the pendant control or a supply cable or hose.
- Avoid load swing as this may endanger the operative and result in increased loadings on the lifting machine and its supporting structure.
- Avoid running into the end stops as this will cause load swing, put shock loading on the lifting machine and its supporting track or structure. End stops are a final safety device only.
- Avoid excessive or intentional use of limit devices, They are a safety feature intended to protect the lifting machine.
- No person other than a Competent Person or someone under the supervision of a Competent Person should attempt to dismantle the lifting machine or replace load bearing components.
- Ensure the travel path is clear and free from obstructions before operating the lifting machine. The operative must always have a clear view of the hook path to avoid accidental hook engagement or collision.
- Always make a trial lift so the load is just clear, then check the integrity of the lifting machine and method of slinging. Only if the load is stable and balanced should the lift proceed. See page 7 for information on load balance and stability.

Storage and Handling

When not in use, lifting machines should be returned to storage or parked in a safe position such as at the end of a runway. When parked, the hook should be raised out of the way of people in the area. Ensure any hanging loops of chain etc do not present a danger.

SELECTION AND USE OF LIFTING GEAR

Factors Influencing Choice of Lifting Gear

Obviously anyone faced with lifting a grand piano will select a different type of sling (probably a man made fibre webbing) from that chosen for lifting hot metal ingots (probably a chain sling). However lifting gear is not just about slings. Some loads are best lifted with accessories such as lifting beams or clamps or may need a removable lifting point such as an eyebolt. In practice many lifting arrangements will use a combination of two or more pieces of lifting gear.

A word of warning about the quality of lifting gear: It may be tempting to 'make up' your own lifting gear from whatever is available but this is a dangerous practice. Chain, wire rope, fibre rope, webbing, shackles, eyebolts, turnbuckles etc come in a wide variety of designs and grades and only a few are designed for and suitable for lifting. To the uninitiated they may look the same but they are not. Equally important is the way slings are terminated. Knots in rope etc cause stresses that are avoided by proper terminations. Wire rope grips sometime known as Bulldog Grips are not suitable for making the termination of slings. Chain should only be joined or shortened by purpose designed components. Beware also of equipment intended only for lashing purposes as this is rarely suitable for lifting.

The following factors are not necessarily in order of importance, nor do they represent an exhaustive list, but are some of the considerations appropriate to selecting lifting gear. Users are advised to consult a LEEA member if in any doubt as to the suitability of lifting gear for any lifting purpose, environment, etc. In making a selection, a balance will be struck between various, sometimes conflicting, considerations and the final decision may be one of several compromise solutions.

When selecting the lifting gear consider:

- What constitutes the load?
- Is it in one piece or likely to fall apart?
- Is it strong enough to support itself or does it need support to be lifted?
- Are there any special problems? eg the load is delicate, very hot, cold, corrosive, sharp etc or there are similar environmental problems.
- Are there lifting points and if not how can the lifting gear be attached?
- What does it weigh?
- Where is the centre of gravity (C of G)?
- What allowances must be made for the lifting mode?

If the load is not in one piece consider:

- lifting the parts separately;
- using the lifting gear to hold the parts together, eg a bundle of tubes held by a double wrap and choke hitch;
- holding them together by other means eg a load binder.

If the load is not strong enough to support itself consider:

- a lifting beam;
- a cradle.

If there are special problems eg the load is delicate, very hot, cold, corrosive, sharp etc or there are similar environmental problems consider:

- whether a particular type of lifting gear is more suitable. See page 26 for information on the various sling types.
- whether special packing or protection is required to avoid the load being damaged by the lifting gear.
- whether the lifting gear may be damaged by the load or the environment.

If there are lifting points consider:

- whether they are intended for the whole load or just a component, eg eyebolt in a motor.
- what sort of terminal fittings will mate with the lifting points.
- whether the lifting points may be used at an angle or just vertical.

If there are no lifting points consider:

- whether removable lifting points can be used, eg eyebolts in existing tapped holes.

- whether other accessories suited to the load can be used eg plate clamps, case grabs, pallet forks, pipe hooks.
- whether the slings can go through or wrap around the load.

If the weight is not known consider:
- whether the information might be available elsewhere eg packing/delivery notes, product handbook, component drawings.
- whether the load can be weighed eg take delivery vehicle to a weigh bridge.
- whether the load can be estimated – it usually can. A skilled estimator can get within 10% so allow for some error. (See page 104 for the weights of materials and estimation techniques.)

If the position of the C of G is not known consider:
- whether the information might be available elsewhere eg packing/delivery notes, product handbook, component drawings.
- whether the position of the C of G can be estimated – it usually can. The estimate may not be exact but the trial lift will allow you to check and adjust if required. (See page 104 for estimation techniques)

All lifting gear is designed for use in one or more modes. The maximum load that can be lifted varies with the mode. (See page 29 for information on the allowances to be made and table 3 for a summary)

Remember!
Choose the lifting gear carefully.
In particular it must be suitable for:
* *The weight and type of load*
* *The available lifting points*
* *The position of the C of G*
* *The mode of use*
* *The environment*

Multipurpose Slings

Slings of various types are, without doubt, the most commonly used lifting gear. They may be used on their own or in combination with other lifting gear such as lifting beams, shackles or clamps. They are very versatile and, in the hands of a skilled slinger, can be used safely in a wide variety of arrangements. However to use them safely the slinger needs a good understanding of the characteristics of the various types of sling, the way they are rated, the geometry and mode of use the rating assumes and the effects of deviating from the assumed conditions. Finally the slinger needs to know the difference between good slinging practice and bad. The following deals with those matters.

SLING TYPES

Chain slings

Grade 8 mechanically assembled slings are now the most common. Grade 4 is also available but is normally assembled into slings by welding. Grade 8 is, for the same SWL, much lighter than grade 4 and there is a wide range of fittings for specific purposes. Grade 4 can be more suitable in some environments, particularly hot or corrosive, but specialist advice must be sought. Chain slings are more durable than other types in an abrasive environment.

Wire rope slings

Wire rope slings can be made from a variety of rope constructions. The termination is usually by a ferrule secured eye (FSET) with or without thimbles but it can also be hand spliced. Wire rope slings are relatively economical particularly for the higher capacities and longer lengths. Having a degree of rigidity they can also be pushed through or under loads.

They have the disadvantage that they are susceptible to kinking if bent round too small a radius and care is needed to avoid hand injuries from broken wires.

Other wire slings

Slings are also made from wire coil in the form of a belt and from plaited small diameter wire rope. These have the advantage of spreading the weight over a larger surface of the load.

Fibre rope slings

Fibre rope slings are made from both natural and man-made fibre ropes. Size for size the ascending order of strength is as follows:

sisal > manila > polyethylene > polypropylene > polyester > polyamide (nylon)

Nylon is approximately two and a half times as strong as manila grade 1 of the same diameter. Polypropylene ropes will float.

Natural fibre ropes are liable to rot and mildew in damp conditions and are not recommended for use in chemical environments. Man-made fibre ropes have varying resistance to chemicals as follows:

Polyamide (nylon) is virtually immune to alkalis but it is attacked by moderate strength acids. It also loses up to 15% of its strength when wet.
Polyester is resistant to moderate strength acids but is damaged by alkalis.
Polypropylene is affected little by acids and alkalis but is damaged by solvents.

All fibre ropes are prone to deterioration at high temperatures. Man-made fibres rarely show a sharp melting point; they will either soften over a range of temperatures or they will char or decompose before melting.

Webbing slings
Webbing slings are manufactured in a similar variety of materials as man-made fibre ropes. They are light in weight and can be made in various widths which is an advantage when trying to avoid local damage to a load. They can also be fitted with sleeves as added protection to the sling or the load. They have a similar resistance to chemicals and temperatures as the man-made fibre ropes.

Roundslings
Although not strictly a different material, the construction of roundslings is so different as to merit a separate classification.

These slings are endless man-made fibre slings formed by winding one or more yarns round a former and joining the ends produce a single hank. The hank is inside a protective woven tubular sheath. They are light in weight and can flatten to the shape of the load. They can also be fitted with sleeves as added protection to the sling or the load. They have a similar resistance to chemicals and temperatures as the man-made fibre ropes.

SLING CONFIGURATIONS
There are five basic configurations ie single leg, two leg, three leg, four leg and endless. Single leg slings can be in a reevable form. For loads such as wooden cases, drums, long pipes, logs etc, special slings are available and recommended.

METHODS OF RATING LIFTING SLINGS

When a multi-leg sling is used with the sling legs at an angle, the load in each leg will increase as the angle increases.

It should be noted that in the UK the angle was traditionally measured as the included angle α (alpha) between the legs of a two leg sling and between the opposite legs of a four leg sling. As three leg slings do not have an 'opposite' leg it was taken for these as twice the angle to the vertical. This has led to some confusion so the new generation of European standards all measure the angle between the leg and the vertical labelled as β (beta). Until the older equipment is all phased out, both systems are likely to be found. See figure 1 on page 29.

For the sling to be used safely, an allowance must be made for the angle and this is achieved by rating the sling in one of two ways. The two methods of rating are the 'uniform load method' and the 'trigonometric method'.

The uniform load method is the simpler option, having inherent safety advantages, permitting only one working load limit up to an included angle α of 90° (β up to 45° to the vertical) and a reduced working load limit at included angles α between 90° and 120° (β between 45°and 60° to the vertical). This information is marked on the sling and the need to estimate angles is kept to a minimum. This is the method which should be used for all multipurpose slings.

The trigonometric method allows the working load limit to vary as the angle between the sling legs varies. This method was the one traditionally used in the United Kingdom and provided the maximum utilisation of the sling's capacity, but has been gradually superseded over the last thirty years. For multipurpose applications, the operative requires tables showing the safe working loads at various angles for each size of chain, rope, etc. This method also requires the operative to judge the angle accurately so has the inherent danger that if he should misjudge it, the sling may be overloaded. It is strongly recommended that this method should only be used for slings designed for a single purpose.

It should be clearly understood however, that whilst equipment designed to be used under the trigonometric method may be re-rated according to the uniform load method, the reverse is NOT always possible and may be dangerous. It is therefore recommended that, to avoid confusion, all items of a given type (eg all chain slings) at the location should be rated by the same method.

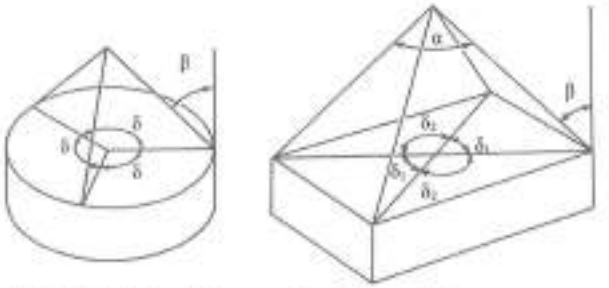
RATING ASSUMPTIONS AND DEVIATIONS FROM THE ASSUMED CONDITIONS

Both methods assume certain conditions of use which ensure that no part of the sling is overloaded. It is important to understand that although the weight to be lifted may be within the maximum lifting capacity of the sling, using it in the wrong way can overload part of the sling. Some deviations from the assumed conditions are prohibited such as loading a hook on the tip. Others are permitted provided an appropriate allowance is made. With multipurpose slings, the designer has little if any information about the intended use so the onus to make such allowance falls on the user.

The assumed conditions fall into two categories: the geometry and the mode of use.

Geometry

It is assumed that all legs of the sling are in use and are at more or less the same angle β to the vertical. It is also assumed that the sling legs are symmetrically disposed in plan, ie for three leg slings, all included angles δ (delta) between the legs in plan are equal; for four leg slings, the opposite included angles δ_1 and δ_2 between adjacent legs, in plan, are equal. See figure 1.



α (alpha) = included angle between diagonally opposite legs
β (beta) = angle of sling leg to the vertical
δ (delta) = included angles between legs in plan (three leg)
δ_1 and δ_2 = opposite included angles between adjacent legs in plan (four leg)

Figure 1
Geometry of Three and Four Leg Slings

As a general guide, the loading can be assumed to be symmetric if all the following conditions are met:

(a) all sling legs are in use
(b) the load is less than 80% of the marked SWL
(c) none of the sling legs exceeds the maximum permitted angle β to the vertical for marked SWL
(d) sling leg angles β to the vertical are all at least 15°
(e) sling leg angles β to the vertical are all within 15° so each other
(f) in the case of three and four leg slings, the plan angles δ are all within 15° of each other

If the slinging geometry does not comply with the assumptions or the general guide above, then the load will not usually be evenly distributed amongst the legs. The amount of load that will be imposed on an individual leg depends upon the following:

(1) The number of legs in the sling, or in use.
(2) The angle between each of the legs and the vertical.
(3) The distribution of the legs in plan view.
(4) The total load being lifted.

The relationship between these factors is complex, especially for three and four leg slings. What happens as these factors vary can be identified in general terms, although to quantify the effect requires complex calculation.

If not all the legs are in use, then the safe working load of the sling must be reduced. The amount by which it should be reduced can be calculated exactly, but it is rather complex as a number of factors need to be taken into account. An easy way of ensuring that the sling is never overloaded is to reduce the safe working load from that marked on the sling according to the number of legs in use, eg:

a 4 leg sling with only 2 legs in use, REDUCED SWL = $\frac{2}{4}$ ie $\frac{1}{2}$ x SWL MARKED

a 3 leg sling with only 2 legs in use, REDUCED SWL = $\frac{2}{3}$ x SWL MARKED

This inevitably means that in some cases the sling will be under-utilised. If maximum utilisation is required, then reference should be made to a person who understands the factors involved and can therefore perform the necessary calculations.

If the angle β between each of the legs and the vertical is not the same, the loading in the leg with the smaller angle to the vertical increases. Ultimately if one leg is vertical it will take all the load. Unequal angles to the vertical may occur because of the position of attachment points on the load, particularly with an irregularly shaped load. However it often happens because the load tilts when lifted due to the position of the centre of gravity being misjudged. The effect is significant, and becomes greater as the included angle α between the legs decreases. There is some reserve of strength to counter this but, as a guide, a multi leg sling should not be used with an included angle α of less than 30° (β less than 15° to the vertical) or a difference in angles to the vertical of more than 12°(ie equal to 6° of tilt) without an allowance being made.

For three and four leg slings the problem becomes three dimensional in that the distribution of the legs, when viewed in plan, also affects the share of the load imposed on each leg. The sling geometry of three and four leg slings is as follows:

Three leg slings: With a three leg sling, it is assumed that, viewed in plan, the legs are at 120° to each other. If two of the legs are closer than that, the third leg will receive a greater share of the load. Ultimately, if two of the legs are side by side, ie at zero angle to each other, then they will receive only half the load between them leaving the third leg to take the other half on its own and thus be overloaded.

Four leg slings: With a four leg sling, it is assumed that, viewed in plan, the legs are symmetrically disposed, the lower attachment points making the corners of a rectangle. Ideally, the nearer the rectangle is to a square the better, but this is by no means essential. However the smaller the angle between the legs the greater the effect of unequal angles. On a four leg sling, the unequal effect can occur across either or both of the horizontal axes, ie along the length of the rectangle and/or across the width of the rectangle.

The four leg sling is also affected by the rigidity of the load. Even if all the legs have the same angle to the vertical and are symmetrically disposed in plan, small differences in the leg lengths due to manufacturing tolerances or the positions of attachment points may prevent the load being equally distributed. The uniform load method of rating takes some account of this by rating a four leg sling at the same working load limit as a three leg sling of the same size and grade. However if the load is very rigid, the majority of it may be on only two diagonally opposite legs with the other two providing balance. In such cases, the sling should be de-rated to two-thirds of its standard rating.

Mode of Use

Single leg and multi-leg slings are rated for use with the leg or legs in a 'straight pull', ie the legs are not bent around the load, choked, back hooked or otherwise prevented from taking up a straight line under load.

Endless chain and wire rope slings are rated for choke hitch but for historical reasons the standard rating for textile slings assumes a straight pull. (Note also that very large capacity endless wire rope slings are also usually rated in straight pull.)

In all cases, it is also assumed that any edges around which the sling passes have a large enough radius to avoid damage to the sling. For chain and wire rope endless slings, the rating takes account of the chain and wire rope being bent around itself on the bight.

The way the sling is used may vary from these assumption conditions, and this may be desirable, offering a more secure way of attaching to certain loads. The options, together with the appropriate mode factors to be applied to the standard ratings, are given in table 3.

Slings used in combination

Slings may be used in combination with other slings and lifting gear. For example two roundslings with shackles to connect them to the load. The combined safe working load of the arrangement must take account of the angle of the slings by applying an angle factor to both the slings and the shackles. The angle factors are given in table 4. The factors for eyebolts are different and are given in their special section on page 82.

Remember that, as for multi leg slings, if the slings are not at the same angle they will not receive an equal share of the load. Remember also that, if the slings are choked or used in some mode other than in line, the appropriate mode factor in table 3 will apply in addition to the angle factor.

Two other points should be noted. First, if the slings are not of the same in line capacity, they will not be able to take the same share of the load. Second, if they are not of the same type, the way they tighten up and extend as the tension is applied may vary and alter the intended geometry of the arrangement.

MODE FACTORS Maximum load to be lifted = mode factor x SWL marked on the sling Key: NP = not preferred, NA = not applicable								
1	2	3	4	5	6	7	8	9
Material	Single leg in line 	Single leg choked 	Single leg basket 	Single leg back hooked 	Single leg halshed 	Endless in line 	Endless Choked 	Endless basket 0-90° 
Chain	1	0.8	1.4	1	NP	NP	1	NP
Wire rope	1	0.8	1.4	1	1.6	NP	1	1.4
Webbing	1	0.8	1.4	NA	NP	1	0.8	1.4
Fibre rope	1	0.8	1.4	1	1.6	1	0.8	1.4
Roundsling	NA	NA	NA	NA	NA	1	0.8	1.4

Table 3 Summary of Mode Factors

ANGLE FACTORS Maximum load to be lifted = angle factor x SWL marked on the sling *		
	Angle β of sling legs to the vertical	
Combination of slings	$0 < \beta \leq 45°$	$45° < \beta \leq 60°$ **
1 x single leg or endless sling	0.7	0.5
2 x single leg or endless sling	1.4	1.0
3 x single leg or endless sling	2.1	1.5
4 x single leg or endless sling	2.1	1.5
2 x two leg slings	1.5	1.0

Table 4
Summary of Angle Factors

Notes to table 4

(1) The factors for eyebolts are different and are given in their special section on page 82.

(2) * This assumes that all the slings are of the same SWL. If they are not the factor should be applied to the lowest SWL. The factor also applies to any other gear used in line with the sling eg shackles.

(3) ** Combinations should not be used in this range unless the upper ends of the slings or gear are joined by a shackle or link. If they are placed directly onto the hook of the lifting machine they will load the hook incorrectly.

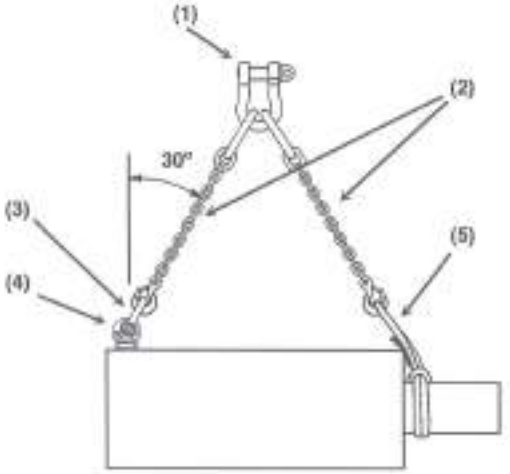


Figure 2
Examples of the Application of Mode and Angle Factors

(1) Single bow shackle
used with its axis vertical so no reduction required
capacity = SWL marked

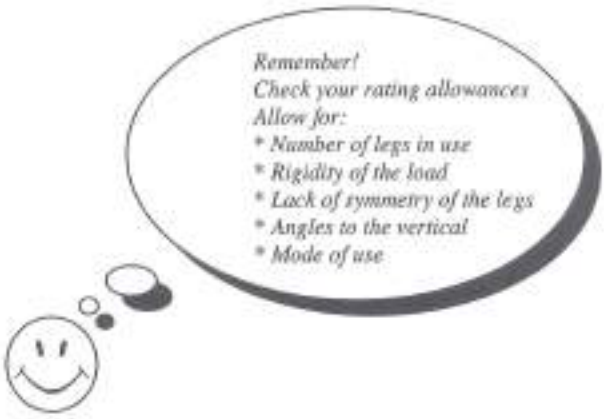
(2) Pair of single leg chain slings of the same SWL
Angle of sling legs to the vertical = 30° so factors selected from the range $0 \leq 45°$
capacity of pair = 1.4 x the SWL marked on one sling

(3) Single shackle
Angle to the vertical = 30°so factors selected from the range $0 \leq 45°$
capacity = 0.7 x SWL marked

(4) Single collar eyebolt
Angle of line of pull to the vertical = 30°
factor selected from the separate factors for eyebolts on page 82
capacity = 0.4 x SWL marked

(5) Single Roundsling

Angle to the vertical = 30° so factors selected from the range 0 ≤ 45°
Also make allowance for choke hitch from table 3 on page 33
capacity = 0.7 x SWL in choke hitch = 0.7 x 0.8 x SWL in straight pull



GOOD SLINGING PRACTICE

Good slinging practice must ensure that the load is as safe and secure in the air as it was on the ground and that no harm is done to the load, lifting equipment, other property or persons.

Follow the GENERAL LIFTING PROCEDURE on page 7. In addition note the following points:

- Do not exceed the SWL or rated angle of any equipment.
- Take account of the geometry and mode of use.
- The sling must not be twisted, knotted or kinked in any way.
- Attach the sling securely to the load and machine and position the sling hooks to face outwards.
- *Never load the point of a hook.*
- *Do not hammer, force or wedge slings or accessories into position; they must fit freely.*
- Any choke angle must not exceed 120° and any basket 90°.

- Do not hammer down a choke to increase the grip on a bundle. Use a double wrap and choke instead.
- Use packing to prevent damage to the sling from corners or edges and to protect the load. See below for guidance on packing.
- When attaching more than one sling to the hook of the machine, use a shackle to join the slings and avoid overcrowding the hook. This is good practice whatever the angle of the slings and essential at included angles over 90° ie over 45° to the vertical.
- Place the hooks of free legs back onto the master link and take care to ensure that empty hooks do not become accidentally engaged.
- Ensure the load is balanced and will not tilt or fall.
- Ensure that the load is free to be lifted.
- Keep fingers, toes etc clear when tensioning slings and when landing loads.
- Check that there are no overhead obstacles such as power lines.
- Except where special provision is made, do not allow anyone to pass under or ride upon the load. The area should be kept clear.
- Never drag slings or other lifting gear over floors etc. It can damage the sling or gear.
- Never attempt to drag a trapped sling from under a load. It can damage the sling and might topple the load.
- Never use a sling to drag a load.
- Never use slings in contact with chemicals or heat without the manufacturers approval.
- Never use damaged or contaminated slings.
- On completion of the lift check all equipment and return to proper storage.

Packing

Adequate packing between sling and load is necessary. The objects of packing are:

(1) To provide an adequate radius around which a sling may pass without unacceptable loss of load carrying capacity.

(2) To assist the sling in gripping the load.

(3) To prevent damage to the load itself.

With regard to (1) above, it is important to realise that when a sling is bent around a corner its strength will be considerably reduced. Whilst a small radius will prevent the cutting action of a sharp edge, IT WILL NOT PREVENT THE LOSS OF STRENGTH DUE TO THE SLING BEING LOADED IN THIS WAY.

For example, a chain sling passing around a corner may have one or more links loaded in bending, which could result in premature failure of the chain. (See figure 4)

In the case of a wire rope sling, too small a radius would result in a permanent kink (see figure 4) and some of the individual wires being overloaded. Although in both of these examples failure may not occur immediately, permanent damage will have been done which may subsequently result in failure.

Various materials are suitable for packing. Whatever is used must be capable of taking the crushing forces which will be imposed upon it, and it should be positioned to make best use of its strength.

Where a particular load is lifted regularly, purpose designed re-usable packing may be found economical but for general purposes, the operative should have available a good selection of materials according to the nature of the work (eg timber blocks, rubber, sections of vehicle tyres, conveyor belts, etc).

When positioning packing, it is essential to ensure that it will stay in place throughout the lift, as packing which falls or flies out will be a hazard in itself as well as imposing shock loads upon the lifting equipment. It may therefore be necessary to provide some independent means of securing the packing in place.

The amount of packing required varies according to the particular job and in a guide of this type it is not possible to cater for every situation. The illustrations below provide some examples of good and bad practice.

Figure 3
Good standard – adequate radius – no kinking

Figure 4

Bad practice – timber packing will split and may fall out

Bad practice – packing ineffective chain links may be bent

Remember!
Adequate packing:
* *Maximises the strength of the sling*
* *Prevents the load damaging the sling*
* *Prevents the sling damaging the load*
* *Assists the sling to grip the load*

HAND CHAIN BLOCKS

The following is based on Section 2 of COPSULE.

Using Hand Chain Blocks Safely

- Check the block before use – do not use a defective block.
- For hook suspension, ensure the support fits freely into the seat of the hook. If the hook is not fitted with a safety catch, mouse the hook to prevent displacement.
- For trolley suspension, ensure the trolley is correctly set for the beam width.
- Check that the chains are not twisted, particularly with a multi-fall block.
- Check that the bottom hook will reach the lowest point required without running the chain fully out.
- Never replace the load chain with a longer one without consulting the supplier.
- Never use undue effort to force the block to operate.
- Never allow oil or grease to come into contact with the brake.
- Never use the load chain as a sling.

In-service Inspection

Regularly inspect the block. If any of the following defects are found, refer to a Competent Person:

Chain

- signs of wear, particularly on the bearing surfaces inside the crown of the links;

- links are bent, notched, corroded or stretched;
- they do not hang freely or articulate freely;
- the slack end anchor is insecure or the slack end stop is missing.

Block body and fittings
- visible damage or distortion of hooks, trolley or block frame;
- missing safety catches;
- missing or damaged covers;
- illegible markings.

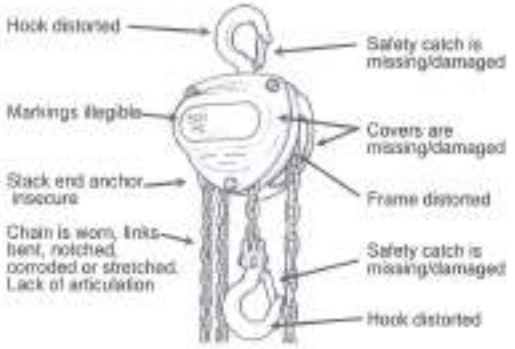


Figure 5
Hand Chain Block Inspection Points

Operation
- the load slips;
- the load chain jumps or makes a cracking noise during lifting or lowering;
- excessive operating effort is required;
- the brake locks on or off.

Maintenance
Follow any specific maintenance instructions issued by the supplier but in particular keep the load chain lubricated and check the operation of the brake. The brake must be kept free of oil, grease etc.

HAND OPERATED CHAIN LEVER HOISTS

The following is based on Section 3 of COPSULE.

Using Chain Lever Hoists Safely

- Check the hoist before use – do not use a defective hoist.
- Ensure the support fits freely into the seat of the top hook. If the hook is not fitted with a safety catch, mouse the hook to prevent displacement.
- Check that the chain is not twisted particularly with a multi-fall hoist.
- Check that the bottom hook will reach the lowest point required without running the chain fully out.
- Never replace the load chain with a longer one without consulting the supplier.
- Never extend the lever or use undue effort to force the lever hoist to operate.
- Never allow oil or grease to come into contact with the brake.
- Never use the load chain as a sling.

In-service Inspection

Regularly inspect the lever hoist. If any of the following defects are found, refer to a Competent Person:

Chain

- signs of wear – with link chain particularly on the bearing surfaces inside the crown of the links – with roller chain particularly on the pins indicated by slackness between the links;

- links are bent, notched, corroded or stretched;
- they do not hang freely or articulate freely;
- the slack end anchor is insecure or the slack end stop is missing.

Hoist body and fittings
- visible damage or distortion of hooks, lever or body;
- missing safety catches;
- missing or damaged covers;
- illegible markings.

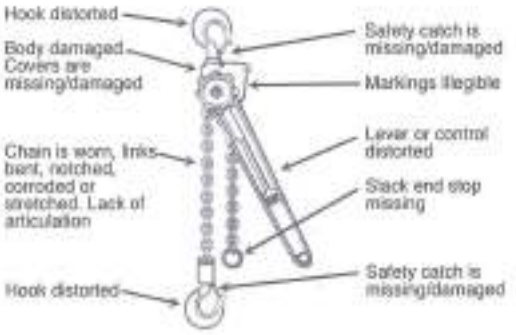


Figure 6
Chain Lever Hoist Inspection Points

Operation
- the load slips;
- the load chain jumps or makes a cracking noise during lifting or lowering;
- excessive operating effort required;
- the brake locks on or off.

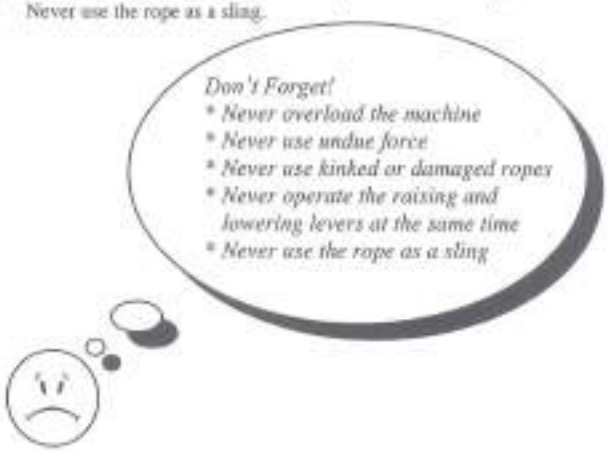
Maintenance
Follow any specific maintenance instructions issued by the supplier but in particular keep the load chain lubricated. Check the operation of the brake. The brake must be kept free of oil, grease etc.

WIRE ROPE GRIP/PULL LIFTING MACHINES

The following is based on Section 4 of COPSULE.

Using Wire Rope Grip/Pull Lifting Machines Safely

- Check the machine and any pulley blocks before use – do not use a defective machine or block.
- Use only the correct rope for the machine.
- Coil and uncoil the rope carefully to ensure it does not kink.
- Ensure the machine is free to align with the rope and the rope is free of any obstructions.
- Ensure that the sheaves of any pulley blocks match the rope.
- Ensure the anchorage points are adequate for the loads taking account of the effect of any pulley blocks.
- Use only the operating lever provided with the machine and do not extend this with tubes etc. Undue force will damage the machine or cause safety pins to shear.
- Never use kinked or damaged ropes or ropes with broken wires.
- Never operate the raising and lowering levers at the same time.
- Never use grip/pull machines if the rope is twisted or trapped.
- Never use the rope as a sling.



In-service Inspection

Regularly inspect the grip/pull machine, rope and pulleys. If any of the following defects are found, refer to a Competent Person:

Machine body and fittings

- there is visible damage or distortion of terminal fittings, the operating levers or the casing;
- the shear pins are distorted or broken;
- missing safety catches;
- illegible markings.

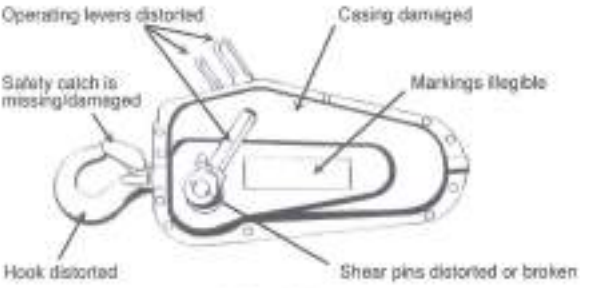


Figure 7
Wire Rope Grip/Pull Lifting Machine Inspection Points

Pulleys

- the sheaves are not matched to the rope ie check groove profile, sheave diameter and SWL;
- there is visible damage or distortion of the pulley frame, sheave or terminal fittings;
- signs of wear in the sheave bearings or axle pin;
- insecurity of any components particularly the axle pin;
- illegible markings.

Rope

- an incorrect rope is fitted;
- the rope is kinked, worn, corroded or has broken wires;
- the rope termination is damaged, cracked or pulled.

Figure 8
Pulley Block Inspection Points

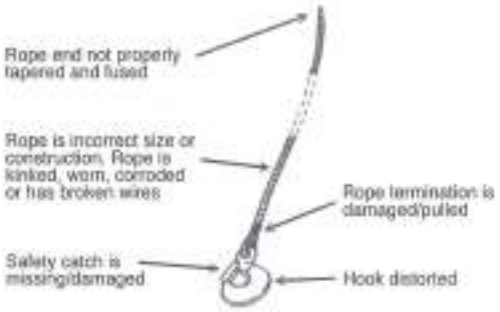


Figure 9
Wire Rope Inspection Points

Operation

- the load slips;
- the operation is jerky;
- the rope will not progress through the machine but 'hunts' back and forth.

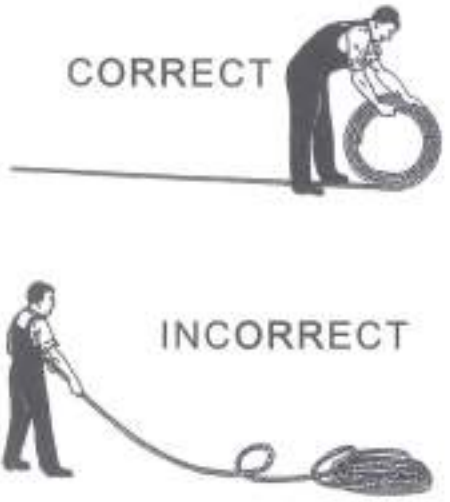


Figure 10
Correct and Incorrect Methods of Uncoiling Wire Rope

Maintenance
Follow the specific instructions for maintenance issued by the supplier. In particular keep the machine well lubricated. Lack of lubrication will result in a jerky movement or failure to operate. It is impossible to over lubricate grip/pull machines.

POWER OPERATED BLOCKS

The following is based on Section 5 of COPSULE.

Using Power Operated Blocks Safely

- Check the block before use – do not use a defective block.
- For hook suspension, ensure the support fits freely into the seat of the hook. If the hook is not fitted with a safety catch, mouse the hook to prevent displacement.
- For trolley suspension, ensure the trolley is correctly set for the beam width.
- Check that the chain or rope is not twisted, particularly with a multi-fall block.
- Check that the bottom hook will reach the lowest point required without running the chain or rope fully out.
- If the block has more than one speed, always start in the slow speed.
- Avoid unnecessary inching of the load.
- Never change motions without first allowing the motor to stop.
- Never replace the load chain or rope with a longer one without consulting the supplier.
- Never use the load chain or rope as a sling.

In-service Inspection

Regularly inspect the block. If any of the following defects are found, refer to a Competent Person:

Chain

- signs of wear, particularly on the bearing surfaces inside the crown of the links;
- links are bent, notched, corroded or stretched;
- it does not hang freely or articulate freely;
- the slack end anchor is insecure or the slack end stop is missing.

Wire rope

- signs of wear or visible broken wires, kinks or corrosion;
- under no load the falls of rope cross over each other.

Machine body and fittings

- visible damage or distortion of hooks, trolley or hoist frame;
- missing safety catches;
- missing or damaged covers;
- electrical connections are insecure;
- illegible markings.

Figure 11
Power Operated Chain Block Inspection Points

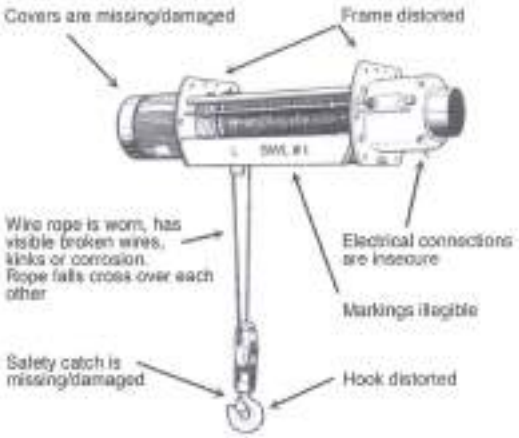


Figure 12
Power Operated Wire Rope Block Inspection Points

Operation

- block will not lift;
- the load slips;
- the motion controls are reversed;
- over-runs when the control is released;
- the limit switches do not function.

Maintenance

Follow the specific instructions for maintenance issued by the supplier.

WINCHES USED FOR LIFTING

The following is based on Section 6 of COPSULE.

Using Winches Safely

- Check the winch before use – do not use a defective winch.
- Ensure the anchorage and suspension points are suitable for the full loads that will be imposed taking account of the effect of any pulley blocks. Do not use timber bearers.
- Ensure the correct rope is fitted, that it is of adequate length and the winch drum can accommodate it.
- Ensure the rope is wound in the right direction. If the direction of rotation is indicated, the winch must raise the load when turning in that direction. Never try to raise loads in the opposite direction to that indicated.
- Do not over wind the rope on or off the drum. At least two turns must always remain on the drum but some manufacturers design for more and their recommendation must be followed.
- Ensure the sheaves are correct for the size and type of rope, that fleet angles are not too great, the rope is not twisted and the rope path is clear.
- Check that the operating handles are secure.
- With manual winches, use only the slow speed to raise/lower loads. With power operated winches, select a speed appropriate to the specific lifting operation.
- Never use the pawl to arrest descending loads.
- Never use the rope as a sling.
- Ensure oil, water or other foreign matter does not come into contact with lined brakes.

In-service Inspection

Regularly inspect the winch. If any of the following defects are found, refer to a Competent Person:

Winch frame and fittings

- the winch frame is corroded, damaged or distorted;
- the rope drum flanges are chipped or cracked;
- the rope anchorage is damaged;
- the ratchet/pawl is damaged, worn or corroded;
- the brake is worn or slipping;
- the gears are worn, damaged or not positively locating;
- there are loose or missing bolts, keys or other fixings;
- illegible markings.

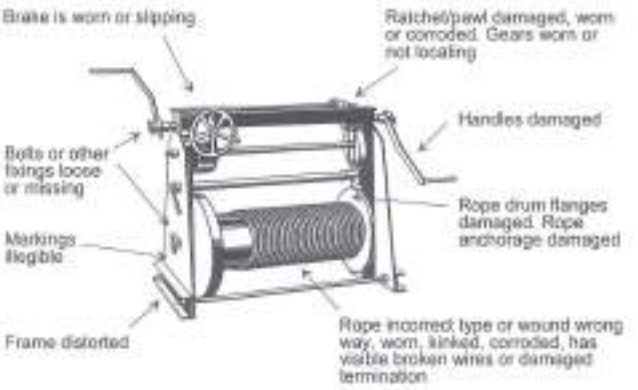


Figure 13
Hand Winch Inspection Points

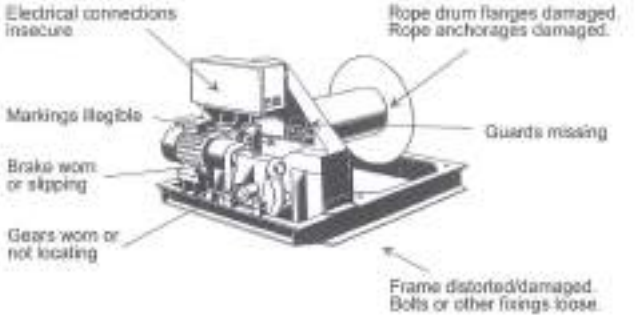


Figure 14
Power Winch Inspection Points

Pulleys

- the sheaves are not matched to the rope ie check groove profile, sheave diameter and SWL;
- there is visible damage or distortion of the pulley frame, sheave or terminal fittings;
- signs of wear in the sheave bearings or axle pin;
- insecurity of any components particularly the axle pin;
- illegible markings.

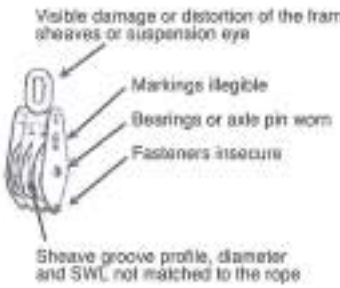


Figure 15
Pulley Block Inspection Points

Wire rope

- an incorrect rope is fitted;
- the rope is kinked, worn, corroded or has broken wires;
- the rope termination is damaged, cracked or pulled;
- the rope is wound in the wrong direction.

Operation

- the load slips;
- excessive operating effort is required;
- the rope does not wind evenly.

Maintenance
Follow the specific instructions for maintenance issued by the supplier.

TRAVELLING GIRDER TROLLEYS

The following is based on Section 7 of COPSULE.

Using Trolleys Safely

- Check the trolley before use – do not use a defective trolley.
- Ensure the wheel profile is suitable for the track.
- Check the trolley width is correctly set for the track and the suspension point is central to the runway.
- Ensure the track is fitted with positive end stops which engage onto the tread, not the flange of the trolley wheels.
- Never force or wedge the suspension hook of blocks onto the suspension point.
- Never side load a trolley as this will cause them to tip and may damage the track or cause the trolley to detach from the track and fall.
- Push rather than pull loads suspended on push/pull trolleys.

In-service Inspection

Regularly inspect the trolley. If any of the following defects are found, refer to a Competent Person:

- loose or distorted side plates, load bar or suspension eyes;
- wear or damage to the wheel treads and flanges;
- insecure wheels and axle pins;
- damaged or worn hand chain;
- damaged controls;
- worn or chipped drive gears;
- illegible markings.

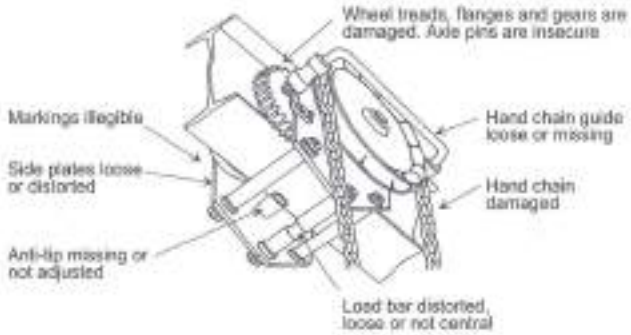


Figure 16
Travelling Girder Trolley Inspection Points

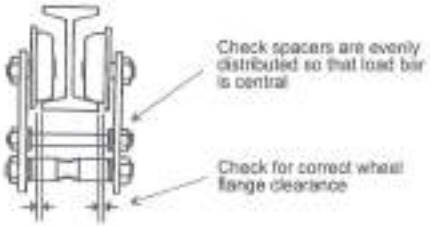


Figure 17
Checking the Adjustment of a Travelling Girder Trolley

Maintenance

Maintenance may be combined with that of the block but should ensure that the trolley is clean and that moving parts are regularly lubricated. Keep the running surface of wheels and contact surface of track free of any contamination including lubricants.

BEAM CLAMPS

The following is based on Section 8 of COPSULE.

Using Beam Clamps Safely

- Check the clamp before use – do not use a defective clamp.
- Ensure the beam is adequate for the load, in good condition and suitable for the application.
- Check the clamp is of the correct profile and size, or correctly adjusted, for the beam width and that it seats correctly on the beam flange.
- Never use beam clamps which are unidentified or uncertified for lifting applications.
- Never replace bolts, shackles etc without consulting the supplier.
- Never force or wedge hooks of lifting machines into the attachment eye or fitting.
- Never side load a beam clamp without the authority of the supplier.

In-service Inspection

Regularly inspect the beam clamp. If any of the following defects are found, refer to a Competent Person:

- distortion, cracks, corrosion or other damage;
- wear of clamping screw threads;
- insecure fixings;
- illegible markings.

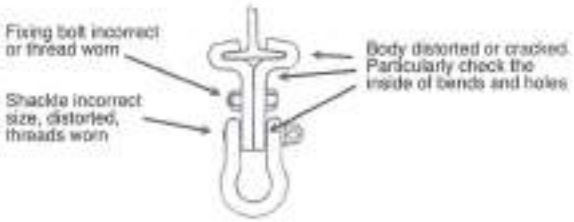


Figure 18
Fixed Beam Clamp Inspection Points

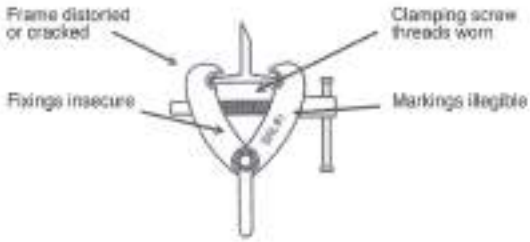


Figure 19
Adjustable Beam Clamp Inspection Points

Maintenance
Beam clamps should be cleaned and any moving parts lubricated at appropriate intervals unless the supplier's specific instructions indicate otherwise.

SLEWING JIB CRANES

The following is based on Section 9 of COPSULE.

Using Jib Cranes Safely

- Check the jib crane before use – do not use a defective jib crane.
- Take the load gently and avoid shock loads. Similar care is needed when lowering loads as sudden loading/unloading may cause the jib arm to whip.
- Push rather than pull the load when slewing the jib arm.
- Do not let the trolley crash into the travel stops as the load will swing outward increasing the radius and therefore the resultant loads on the jib crane.
- Never attempt to drag loads along the ground.
- Never place ladders against, or climb on, unrestrained jib arms.

In-service Inspection

Regularly inspect the jib crane. If any of the following defects are found, refer to a Competent Person:

- any structural defects, damage, distortion or cracked welds;
- loose or missing bolts;
- damaged or missing runway end stops;
- difficulty in slewing or jib arm slews on its own;
- difficulty in moving trolley or trolley moves on its own;
- illegible markings.

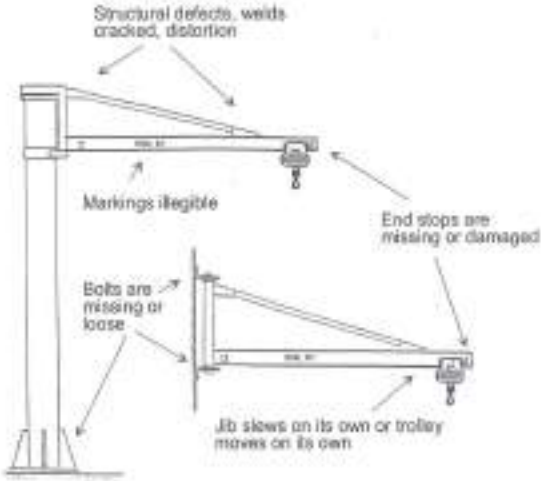


Figure 20
Slewing Jib Crane Inspection Points

Maintenance

The maintenance requirements may be combined with those of the lifting machine. Lubricate bearings and pivot points. Where the slewing motion is obtained by manual gears or powered drive, the gear wheels and drives must be kept in good order and lubricated. Bolts and fixings should be checked to ensure they are tight and if necessary re-torqued. The running surface of the track should be clean and kept free of debris etc.

RUNWAYS

The following is based on Section 10 of COPSULE.

Using Runways Safely

- Check the runway before use – do not use defective runways.
- Ensure the runway is clearly identified and marked with the SWL.
- Ensure the runway has positive end stops which engage onto the tread, not the flange of the trolley wheels.
- Do not side load the runway or attempt to drag loads.
- Push rather than pull on suspended loads.
- Do not let the trolley crash into the travel stops as the load will swing thus increasing the resultant loads on the runway and structure.
- In the case of runways fitted with more than one lifting machine, take care to avoid collision or any one span of the runway becoming overloaded due to the proximity of the lifting machines.
- Never attach additional steelwork or suspend pipes, cables etc from runways.

In-service Inspection

Regularly inspect the runway. If any of the following defects are found, refer to a Competent Person:

- any structural defects, damage, distortion, corrosion or cracked welds;

- loose or missing bolts;
- damaged or missing runway end stops;
- track not level or running face uneven;
- difficulty in moving trolley or trolley moves on its own;
- illegible markings.

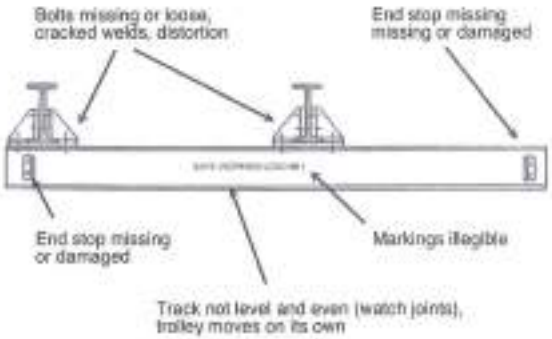


Figure 21
Runway Inspection Points

Maintenance
The maintenance requirements may be combined with those of the lifting machine. Bolts and fixings should be checked to ensure they are tight and if necessary re-torqued. The running surface of the track should be clean and kept free of debris etc. End stops must be in place, correctly set and secure.

MOBILE GANTRIES

The following is based on Section 11 of COPSULE.

Using Mobile Gantries Safely

- Check the mobile gantry before use – do not use defective gantries.
- If it has been dismantled, ensure it is correctly erected and that all bolts, pins etc are in place.
- Ensure the surface on which the gantry is placed is level, even and capable of taking the imposed loads. Where necessary use floor plates to achieve this. Beware of hidden dangers such as buried cables, pipes etc.
- Position the gantry so that the lifting machine is directly over the load and the beam is in line with the direction of travel required.
- Where fitted, apply brakes, parking jacks or wheel locks before attempting to raise the load.
- Avoid swinging loads. The centre of gravity of the load should always be under the runway centre line or the gantry may topple over.
- Never rotate loads unless the centre of gravity will remain under the centre line of the runway beam.
- Never attempt to move a gantry whilst under load.
- Disconnect power supplies etc before attempting to move the gantry to a new position.
- Never use a vehicle, winch etc to tow a gantry. They can easily topple over if not moved with care.
- Never place ladders against, or climb on, unrestrained gantries.

In-service Inspection

Regularly inspect the mobile gantry. If any of the following defects are found, refer to a Competent Person:

- any structural defects, damage, distortion or cracked welds;
- loose or missing bolts, locking pins etc;
- damaged wheels, jacks or ineffective brakes;
- damaged or missing runway end stops;
- illegible markings.

Figure 22
Mobile Gantry Inspection Points

Maintenance

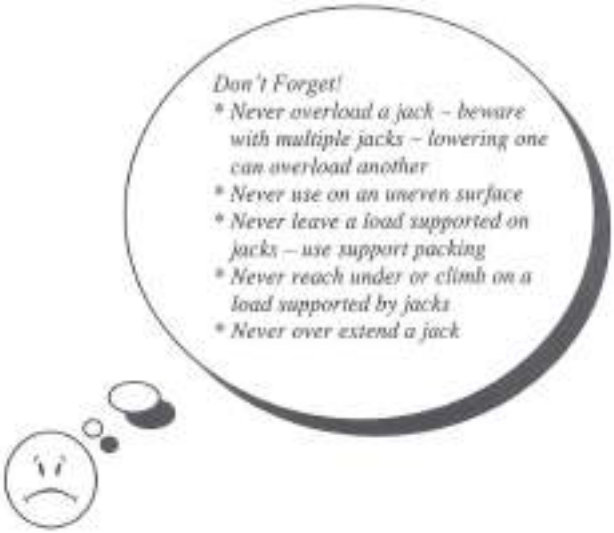
The maintenance requirements may be combined with those of the lifting machine. Bearings and screw jacks should be lubricated. The running surface of the track should be clean and free of debris etc.

JACKS

The following is based on Section 12 of COPSULE.

Using Jacks Safely

- Most jacking operations require the use of several jacks. Care is needed as it is not possible to raise or lower jacks in perfect unison. This results in uneven loading with the load being transferred from one jack to another. It can be more hazardous when lowering as the jack being lowered transfers its share to the other jacks. The capacity of the jacks should be adequate to account for this.
- Check the jacks and packing before use – do not use a defective jack or inadequate packing.
- Ensure the surface on which the jack is placed is level, even and capable of taking the imposed loads. Where necessary use floor plates to spread the load over a wider area. Avoid hidden dangers such as buried cables, pipes and ducts which may affect the load bearing capability of the floor.
- Ensure the load is capable of withstanding the forces imposed by the jacking operation.
- Use packing capable of withstanding the load without crushing.
- Ensure the jack is positioned so that the load is applied to the jack in the correct plane. Never load a jack off centre.
- The head of the jack should be in full, firm contact with the jacking point of the load. Use packers if necessary to prevent the head of the jack from slipping.
- Lift and lower in small stages following up with support packing to minimise the risk of a load falling or all the load coming onto a single jack. Do not raise the load higher than necessary.
- Ensure the load is kept level within the limits of operation.
- Never over extend the jack.
- Never leave a load supported on jacks unless they are specifically designed for that purpose. Use packing, screwed collars, trestles etc which are capable of withstanding the imposed load without crushing.
- Never reach under, work or climb on a load supported by jacks. Always keep hands and toes clear.



In-service Inspection

Regularly inspect jacks. If any of the following defects are found, refer to a Competent Person:

General

- damaged, cracked or distorted body;
- base cracked, distorted or does not sit solidly on the floor;
- operating lever/handle bent or cracked;
- toe or claw attachment cracked or distorted.

Hydraulic jacks

- oil leaks;
- ram scored, nicked or distorted;
- release valve inoperative.

Figure 23
Hydraulic Jack Inspection Points

Mechanical jacks

- rack teeth or screws chipped, worn or corroded;
- swivel head seized.

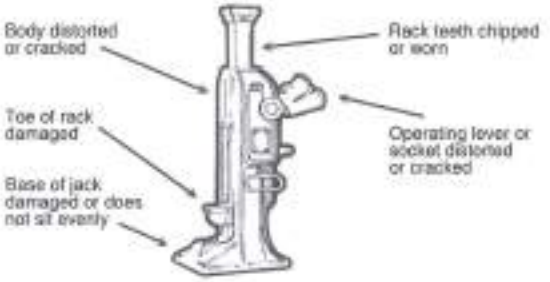


Figure 24
Mechanical Jack Inspection Points

Operation

- jack fails to lift or lower;
- load slips or creeps down.

Maintenance

Jacks should be cleaned to remove any dirt or debris paying particular attention to racks, screws, the area around top ram seals etc. Hydraulic oil levels should be checked and the oil topped up or drained and replaced. Moving mechanical components should be lubricated etc. Care is necessary in the case of ratchet jacks as excessive grease can cause the holding pawl to stick or become retarded in operation allowing the rack to free fall thus dropping the load.

CHAIN SLINGS

The following is based on Section 13 of COPSULE.

Using Chain Slings Safely

- Check the sling before use – do not use a defective sling.
- Remember to allow for the mode of use when selecting the sling.
- Ensure the master link fits freely onto the lifting machine.
- Do not force or wedge slings or fittings into position; they must fit freely.
- Position the hooks of multi-leg slings to face outward from the load.
- Do not lift on the point of any hook.
- Back hook free legs to the master link to avoid lashing legs which might accidentally become engaged or otherwise be a hazard.
- Ensure that the chain is not twisted or knotted.
- Never shorten a sling leg other than by means of an integral chain clutch.
- Do not use chain slings at temperatures above 200°C or below minus 40°C or in contact with chemicals, particularly acids* and acid fumes, without consulting the supplier.

*HSE Guidance Note PM 39 – Hydrogen Embrittlement of Grade T Chain.

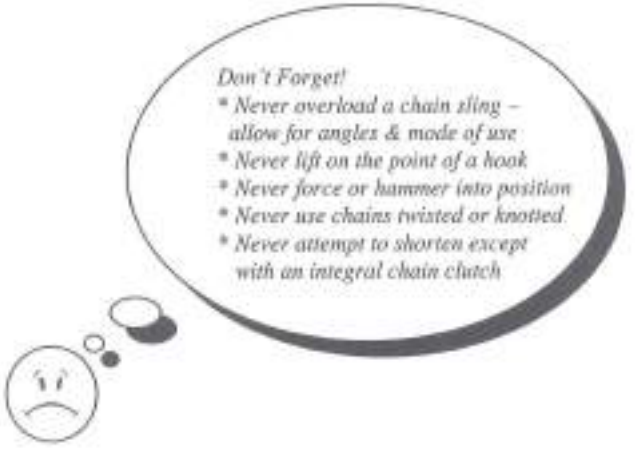


Figure 25
Correct and Incorrect Use of a Chain Clutch

In-service Inspection
Regularly inspect chain slings. If any of the following defects are found, refer to a Competent Person:

- wear, distortion, cracking, corrosion, discolouration due to heat or other damage to any part of the sling;
- ineffective or missing safety catches;
- illegible markings.

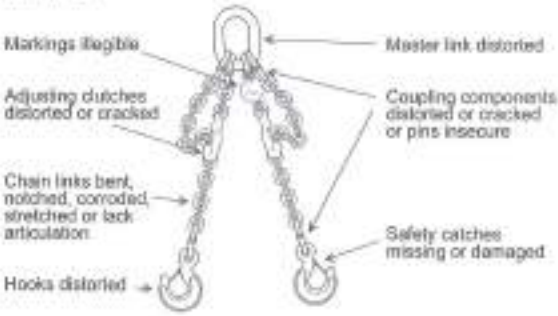


Figure 26
Chain Sling Inspection points

Maintenance
Maintenance requirements are minimal. Keep chain slings clean and protect from corrosion.

WIRE ROPE SLINGS

The following is based on Section 14 of COPSULE.

Using Wire Rope Slings Safely

- Check the sling before use – do not use a defective sling.
- Remember to allow for the mode of use when selecting the sling.
- Ensure the master link fits freely onto the lifting machine.
- Do not force or wedge slings or fittings into position; they must fit freely.
- Position the hooks of multi-leg slings to face outward from the load.
- Do not lift on the point of any hook.
- Back hook free legs to the master link to avoid lashing legs which might accidentally become engaged or otherwise be a hazard.
- Ensure that the wire rope is not twisted or kinked.
- Ensure that the effective diameter of pins, hooks etc upon which soft eyes fit is at least 2 x the wire rope diameter.
- Use packing to protect the wire rope from sharp edges and small radii.
- Position the splices of endless slings in the standing part of the sling away from hooks and fittings.
- Never join wire rope slings made from different lay directions of rope together as this will cause them to unlay thus seriously affecting their capacity.
- Never attempt to shorten, knot or tie wire rope slings.
- Do not use wire rope slings at temperatures above 100°C or below minus 40°C or in contact with chemicals without consulting the supplier.

In-service Inspection

Regularly inspect wire rope slings. If any of the following defects are found, refer to a Competent Person:

- wear, distortion, cracking, corrosion, discolouration due to heat or other damage to any part of the sling;
- signs of movement at splices or ferrules;
- broken or cut wires;
- kinks (some permanent setting due to previous use around a load is acceptable but check carefully for other signs of local damage);
- protrusion of core;
- ineffective or missing safety catches;
- illegible markings.

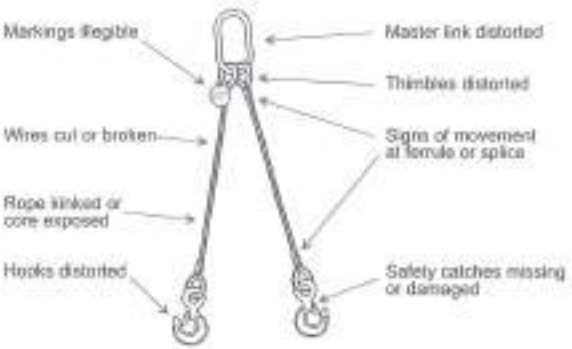


Figure 27
Wire Rope Sling Inspection Points

Maintenance

Maintenance requirements are minimal. Keep wire rope slings clean and protect from corrosion. Use non-acidic lubricants.

FLAT WOVEN WEBBING SLINGS

The following is based on Section 15 of COPSULE.

Using Flat Woven Webbing Slings Safely

- Check the sling before use – do not use a defective sling.
- Remember to allow for the mode of use when selecting the sling.
- Check that the sling engages correctly with fittings and the lifting machine, ensure smooth radii are formed.
- Do not twist or cross slings and do not overcrowd fittings.
- Do not force or wedge slings or fittings into position; they must fit freely.
- Position the sling so that the load is uniformly spread over its width and use packing to protect the sling from sharp edges.
- Position the bight for a choke lift at the natural (120°) angle to avoid heat from friction.
- Ensure that the stitching is in the standing part of the sling away from hooks and other fittings.
- Do not lift on the point of any hook.
- Never attempt to shorten, knot or tie flat woven webbing slings.
- Never expose flat woven webbing slings to direct heat or flames.
- Do not use flat woven webbing slings at temperatures above 80°C or below 0°C without consulting the supplier.
- Never use flat woven webbing slings which are cut or which have loose or damaged stitching.

NOTE: The material from which the webbing sling is manufactured may be identified by the colour of the label or printing on the label: Polyester = Blue, Polyamide (Nylon) = Green, Polypropylene = Brown and the sling may also be dyed with a colour code to indicate the SWL in straight pull.

In-service Inspection

Regularly inspect flat woven webbing slings. If any of the following defects are found, refer to a Competent Person:

- damaged, chaffed or cut webbing;
- damaged or loose stitching;
- heat damage (if due to friction this will appear as a hard shiny area on the surface);
- chemical damage;
- solar degradation;
- damaged or deformed end fittings;
- illegible markings.

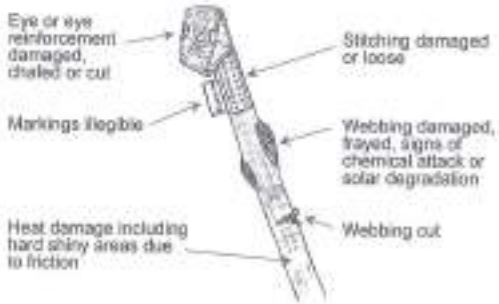


Figure 28
Flat Woven Webbing Sling Inspection Points

Maintenance

Maintenance requirements are minimal. Webbing slings may be cleaned with clean water and allowed to dry naturally. Remember weak chemical solutions will become increasingly stronger by evaporation.

ROUNDSLINGS

The following is based on Section 16 of COPSULE.

Using Roundslings Safely

- Check the sling before use – do not use a defective sling.
- Remember to allow for the mode of use when selecting the sling.
- Check that the sling engages correctly with fittings and the lifting machine, ensure smooth radii are formed which allow the sling to assume its naturally flattened form under load.
- Do not twist or cross slings and do not overcrowd fittings.
- Do not force or wedge slings or fittings into position; they must fit freely.
- Position the bight for a choke lift at the natural (120°) angle to avoid heat from friction.
- Keep labels away from hooks and fittings.
- Use packing to protect the sling from sharp edges.
- Do not lift on the point of any hook.
- Never attempt to shorten, knot or tie roundslings.
- Never expose roundslings to direct heat or flames.
- Do not use roundslings at temperatures above 80°C or below 0°C without consulting the supplier.
- Never use roundslings with cut or damaged outer covers.

NOTE: The material from which the roundsling is manufactured may be identified by the colour of the label or printing on the label: Polyester = Blue, Polyamide (Nylon) = Green, Polypropylene = Brown. The outer sleeve of the sling will also be colour coded to indicate the SWL in straight pull.

In-service Inspection

Regularly inspect roundslings. If any of the following defects are found, refer to a Competent Person:

- damaged or cut outer cover;
- damaged stitching;
- exposed inner core;
- heat damage (if due to friction this will appear as a hard shiny area on the surface);
- chemical damage;
- solar degradation;
- illegible markings.

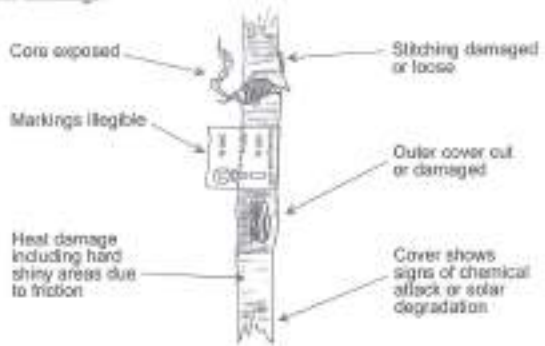


Figure 29
Roundsling Inspection Points

Maintenance

Maintenance requirements are minimal. Roundslings may be cleaned with clean water and allowed to dry naturally. Remember weak chemical solutions will become increasingly stronger by evaporation.

FIBRE ROPE SLINGS

The following is based on Section 17 of COPSULE.

Using Fibre Rope Slings Safely

- Check the sling before use – do not use a defective sling.
- Remember to allow for the mode of use when selecting the sling.
- Check that the sling engages correctly with fittings and the lifting machine and ensure smooth radii are formed.
- Do not twist or cross slings and do not overcrowd fittings.
- Do not force or wedge slings or fittings into position; they must fit freely.
- The diameter of components placed in a soft eye must be at least the diameter of the rope but not so large that the two parts of rope at the splice form an included angle greater than 30°.
- Position the bight for a choke lift at the natural (120°) angle to avoid heat from friction.
- Position the splice of an endless sling in the standing part of the rope away from the load, hook or point of choke.
- Use packing to protect the sling from sharp edges.
- Position hooks of multi-leg slings facing outward from the load.
- Do not lift on the point of any hook.
- Never attempt to shorten, knot or tie fibre rope slings.
- Never expose fibre rope slings to direct heat or flames.
- Do not use fibre rope slings at temperatures above 80°C or below 0°C without consulting the supplier.

In-service Inspection

Regularly inspect rope slings. If any of the following defects are found, refer to a Competent Person:

- signs of wear, cuts or abrasion;
- splices pulling or coming undone;
- heat damage;
- chemical attack;
- solar degradation;
- rot or mildew in natural fibre rope slings;
- damaged fittings and thimbles;
- illegible markings.

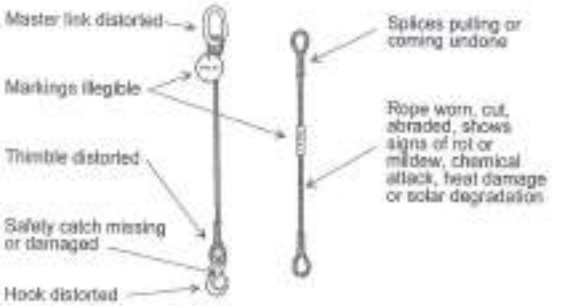


Figure 30
Fibre Rope Sling Inspection Points

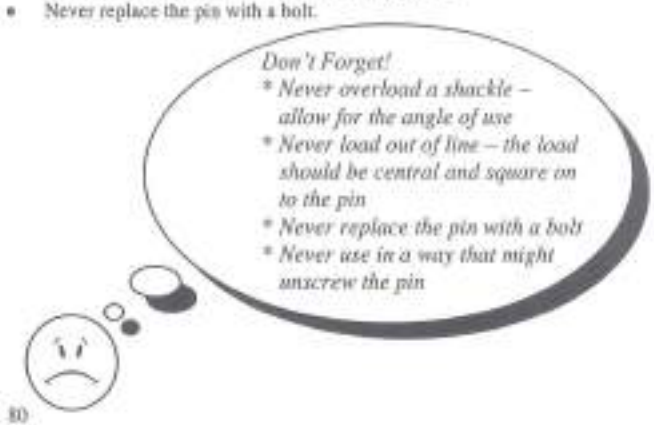
Maintenance
Maintenance requirements are minimal. Fibre rope slings may be cleaned with clean water and allowed to dry naturally. Remember weak chemical solutions will become increasingly stronger by evaporation.

SHACKLES

The following is based on Section 18 of COPSULE.

Using Shackles Safely

- Check the shackle before use – do not use defective shackles. In particular ensure the pin is the correct one in terms of type, fit and grade of material.
- Select the type of shackle and pin most suitable to the application.
- Remember to allow for the mode of use.
- Shackles should be fitted so that the body takes the load along its centre line and is not subjected to bending.
- When connecting several sling legs, position them in the bow of the shackle to avoid forces that tend to spread the shackle jaw.
- Ensure the load on the pin is central. Use spacers if necessary. *
- Ensure the pin is screwed fully into the shackle eye.
- Check that the thread is fully engaged with the body but is not too long so that tightening causes the body to deform.
- With bolt and nut type pins, ensure the nut jams on the inner end of the thread and not on the eye of the shackle. The bolt should be free to rotate with minimal side float. The split cotter pin must be fitted before making a lift.
- Avoid applications where movement can unscrew the pin eg when used with a sling in choke hitch. Position the pin away from the moving part or use a nut and bolt type pin which can rotate without unscrewing.
- Never replace the pin with a bolt.



* CAUTION
BS and ISO Standard shackles are designed and rated for the pin to accept a central point load. Other commonly available types are designed and rated for the load to be evenly distributed over the full width of the pin. Unless the basis for rating is clearly stated it should be assumed that the jaw must be fully filled and the load evenly spread across the shackle pin width.

In-service Inspection
Regularly inspect shackles. If any of the following defects are found, refer to a Competent Person:

- distorted, worn, stretched or bent body or pin;
- damaged or incomplete thread forms;
- nicks, gouges, cracks or corrosion;
- incorrect pin;
- illegible markings.

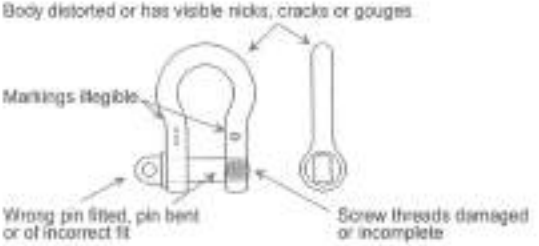


Figure 31
Shackle Inspection Points

Maintenance
Maintenance requirements are minimal. Keep shackles clean, the threads free of debris and protect from corrosion.

EYEBOLTS

The following is based on Section 19 of COPSULE.

Selecting the Correct Eyebolt

Eyebolts to BS 4278 are available in three standard types, eyebolt with link, collar eyebolt and dynamo eyebolt. Select the eyebolt to be used and plan the lift taking the following into account:

Types of eyebolt

Eyebolt with link – suitable for all general purpose applications.

Collar eyebolt – suitable for most general duties (A collar eyebolt fitted with a link is not the same as an eyebolt with link and must not be treated as such.)

Dynamo eyebolt – suitable only where a truly axial load is guaranteed.

Capacity

When used at an angle or in pairs it is necessary to reduce the SWL by the factors given in table 5.

ANGLE FACTORS Maximum load to be lifted = angle factor x SWL for a pair of eyebolts			
	Included angle α between the sling legs		
Type of eyebolt	$0 < \alpha \leq 30°$	$30° < \alpha \leq 60°$	$60° < \alpha \leq 90°$
Eyebolt with link	1.0	0.8	0.63
Collar eyebolt	0.63	0.4	0.25

Table 5
Angle Factors for Eyebolts Used in Pairs

Using Eyebolts Safely

- Check the eyebolt before use – do not use a defective eyebolt.
- Check the thread of both the eyebolt and hole, ensure they are compatible, fully formed, of sufficient length, undamaged and clear of any debris which may prevent proper engagement.
- Ensure the contact surface around the hole is flat, clean, perpendicular to the thread axis and big enough to support all the eyebolt collar.

- Tighten the eyebolt down firmly by hand. The collar must sit evenly on the contact surface. Do not use tommy bars, grips or wrenches to tighten eyebolts.
- With collar eyebolts used in pairs, the eyes must be in the correct plane. Use shims but do not machine the collar or over tighten. See figure 32.
- A hook of similar capacity may be engaged directly into the eye of a dynamo eyebolt or the link of an eyebolt with link. Collar eyebolts must be fitted with a shackle or link to accept hooks. The hooks must fit freely so do not wedge or force them into position.
- Never reeve a sling through the eyes, links or shackles fitted to eyebolts used in pairs as this will impose a severe resultant force onto the eyebolts.
- Dynamo eyebolts are only suitable for axial loading. Never use dynamo eyebolts for angular loading.
- When using eyebolts with multi-leg slings use eyebolts with links or collar eyebolts taking care to derate them for angular loading.
- Where a single eyebolt is used, use a swivel or swivel hook to prevent the eyebolt unscrewing if the load rotates.

Don't Forget!

* *Never overload an eyebolt – allow for the angle of use*
* *Never over tighten an eyebolt*
* *Never load a dynamo eyebolt at an angle*
* *Never use collar eyebolts out of the permitted alignment*
* *Never reeve a sling through a pair of eyebolts*
* *Never use in a way that might unscrew the eyebolt*

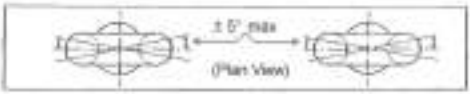


Figure 32
Correct Alignment of a Pair of Collar Eyebolts

In-service Inspection

Regularly inspect eyebolts. If any of the following defects are found, refer to a Competent Person:

- any signs of distortion to the eye, shank or link;
- worn, damaged, or incomplete threads;
- nicks, gouges, cracks, corrosion;
- illegible markings.

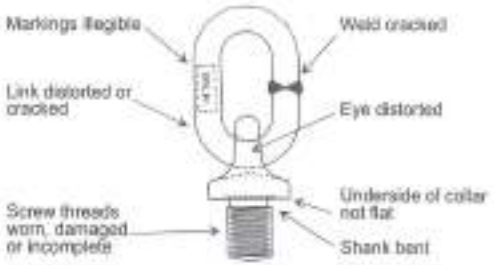


Figure 33
Eyebolt Inspection Points – Eyebolt with Link

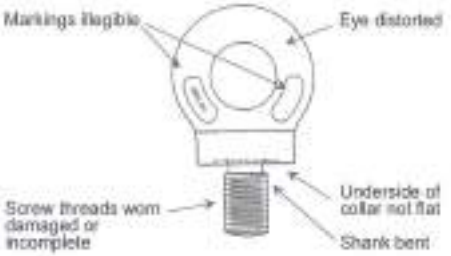


Figure 34
Eyebolt Inspection Points – Collar Eyebolt

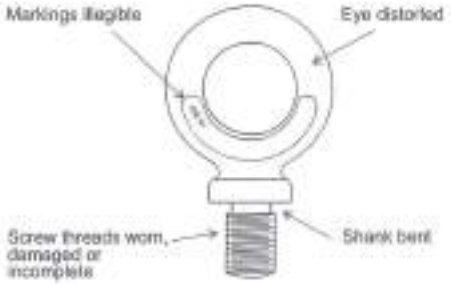


Figure 35
Eyebolt Inspection Points – Dynamo Eyebolt

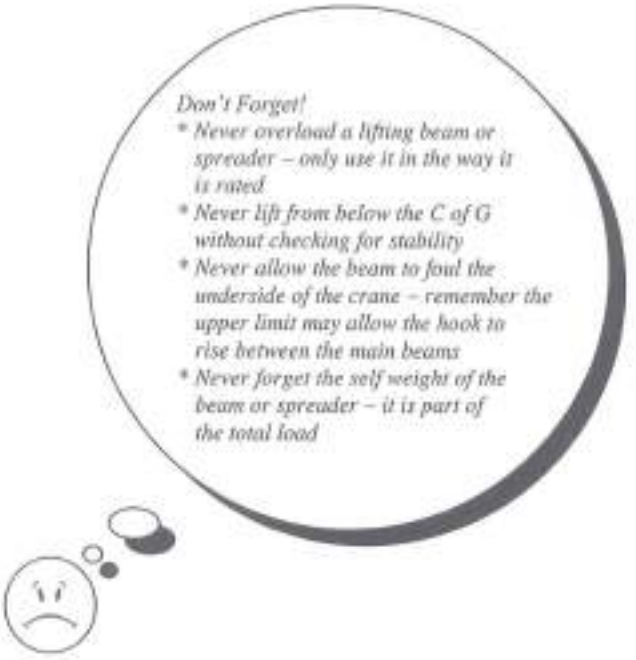
Maintenance
Maintenance requirements are minimal. Keep eyebolts clean, protect from corrosion and thread damage. Do not attempt to straighten bent eyebolts or re-cut threads.

LIFTING BEAMS AND SPREADERS

The following is based on Section 20 of COPSULE.

Using Lifting Beams and Spreaders Safely

- Lifting beams may incorporate various loose and detachable items of lifting gear. Refer to the separate requirements for the safe use of those items.
- Check the lifting beam before use – do not use a defective beam.
- Many lifting beams are designed for a specific purpose and should not be used for other purposes without consulting the supplier. This will include the size of crane hook from which they are suspended.
- The weight of the beam, together with its attachments, must be added to the weight of the load when calculating the total load that will be imposed on the crane hook. The self weight should be clearly marked on the beam.
- Ensure that the SWL on the individual lifting points is not exceeded. Extra care is needed where these are adjustable or where there is a choice of lifting points.
- Ensure the load remains stable and that the beam remains at its intended attitude during use. Particular care is required if the lifting points are below the centre of gravity of the load.
- Use tag lines to control long loads.
- Do not allow the beam to foul the underside of the crane, or any other obstructions, when raising or transporting loads. Remember that with a double girder overhead crane the upper limit switch may allow the hook to rise up between the girders but the lifting beam will foul them.
- Refer to the requirements of BS 7121: Part 1 when using beams with cranes in tandem.



In-service Inspection

Regularly inspect lifting beams. If any of the following defects are found, refer to a Competent Person:

- beam distorted, damaged or corroded;
- worn, loose or missing bolts or cracked welds;
- attachment points worn, damaged or distorted, holes and eyes worn or elongated;
- illegible markings.

Figure 36
Lifting Beam and Spreader Inspection Points

Maintenance
Maintenance requirements are minimal for lifting beams. Ensure that bolted joints are sound and that corrosion damage is prevented. Refer to the individual maintenance requirements for associated loose gear and attachments.

PLATE CLAMPS

The following is based on Section 21 of COPSULE.

Selecting the Plate Clamp

There are three basic types of plate clamp but the facility they offer may vary with make. Refer to the manufacturer's instructions to see what they are suitable for.

Types of plate clamp

Vertical plate clamp – designed to lift vertical plates but some designs are also suitable for lifting plates from the horizontal to the vertical.

Horizontal plate clamp – designed to be used in pairs to lift horizontal plates only. Some are in the form of a specially shaped hook without a cam, others have a cam which grips the plate. They are used in conjunction with a sling which must be of the right type to ensure that the geometry and therefore the gripping forces are correct.

Universal plate clamp – really a development of the vertical plate clamp they can be used for either horizontal or vertical plates and to rotate them. They may also permit angular loading in the plane of the plate.

Using Plate Clamps Safely – General

- Check the clamp before use – do not use a defective plate clamp.
- Ensure that the clamps are suitable for the thickness of plate to be lifted. Never exceed the maximum or minimum thickness for which the clamps are designed.
- Put the clamp onto the plate as far as it will go.
- Do not use clamps at an angle to the edge of the plate or for lowering from vertical to horizontal, or vice versa, unless they are designed for the purpose.
- Keep oil, grease and similar contaminates away from jaws which use a friction grip material to hold the plate.
- Never use plate clamps on hard or polished plate unless they have been specifically designed for that purpose.
- Take great care to ensure the plate is fully supported before attempting to release the clamp.
- Keep all persons clear of the danger zone and remember that a falling plate can 'glide' sideways. A large thin plate is likely to glide further. Also the higher it falls from, the bigger the danger zone.

Using Plate Clamps Safely – Vertical and Universal Types

- Some designs of clamp, particularly those with a moving cam action jaw where the initial grip is provided by a spring, have a minimum load and minimum plate

thickness they can safely lift. Wherever possible refer to the manufacturer's instructions but in the absence of specific guidance the load should not be less than 20% of the SWL and the plate thickness not less than 20% of the maximum.

- Some designs of plate clamp are suitable for lifting plates from the horizontal to the vertical and the inclusion of a pendant chain to provide articulation between the clamp and lifting hook is essential. However the use of pendant chains should always be considered to prevent the hook weight being imposed on the clamp as this might cause the clamp to be released.
- Position the clamp correctly. Place the clamp over the centre of gravity of the plate. If the plate is long and has a tendency to bend, use two clamps equally disposed about the centre of gravity in conjunction with a spreader beam.
- Take care to ensure no one clamp takes more than its SWL.
- Ensure the clamp is fully locked or tightened onto the plate before lifting.
- Under no circumstances should packing be placed between the plate and the jaws nor any attempt made to lift more than one plate in the clamp.
- When using the universal type, check the manufacturers instructions for the limitations on the angles they may be used at.

Using Plate Clamps Safely – Horizontal Type

- Always use horizontal plate clamps in pairs with the correct type, size and length sling and reeved in the manner for which they are designed. Some of these clamps are designed to be used with an endless loop of chain whilst others are for use with a two leg sling. Under no circumstances must an endless loop be substituted for a two leg sling or vice versa as this will alter the geometry and therefore the gripping forces on which the clamps rely for their safe operation.
- If the plates are likely to sag transversely, clamps which grip the plate by a cam must be used.
- Position the clamps correctly. Place the clamps over the centre of gravity of the plate. If the plate is long and has a tendency to bend use two or more pairs of clamps in conjunction with a spreader beam, equally disposed about the centre of gravity, to minimise the sag. Ensure the clamps face each other to balance the horizontal clamping forces.
- Take care to ensure no one clamp takes more than its SWL.
- Put the clamps onto the plate as far as they will go.
- If the sling is adjustable to accommodate various widths of plate ensure it is adjusted to give the correct geometry.
- Never attempt to rotate from the horizontal to the vertical or vice versa with this type of clamp.

Don't Forget!
Horizontal Type

* *Never overload a plate clamp*
* *Never use a single clamp – always in pairs*
* *Never exceed the permitted maximum or minimum thickness*
* *Never substitute an endless loop for a two leg sling or vice versa*
* *Never exceed the permitted range of sling leg angles*
* *Never use the camless type if the plate can sag*
* *Never attempt to rotate from the horizontal to the vertical with this type of clamp*

In-service Inspection

Regularly inspect the plate clamp. If any of the following defects are found, refer to a Competent Person:

- wear, damage or distortion to fixed and moving jaws;
- frame opening out or cracked;
- insecure, worn or bent pins, bolts etc;
- worn friction grip material;
- damaged, bent or unsatisfactory acting locking lever;

- tight, bent or damaged clamping threads etc;
- corrosion;
- illegible marking.

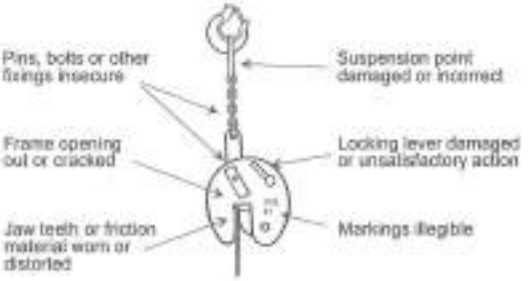


Figure 37
Vertical and Universal Plate Clamp Inspection Points

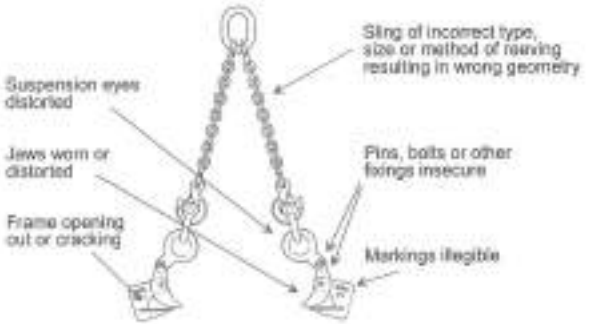


Figure 38
Horizontal Plate Clamp Inspection Points

Maintenance

Plate clamps should be cleaned and any moving parts lubricated at appropriate intervals, unless the suppliers specific instructions indicate otherwise. In the case of clamps with smooth jaws lined with a friction material, care must be taken to ensure no lubricant comes into contact with the friction material.

WARNING: Teeth of jaws must not be re-sharpened or re-cut unless this has been specifically approved by the maker.

RIGGING SCREWS AND TURNBUCKLES

The following is based on Section 22 of COPSULE.

Using Rigging Screws and Turnbuckles Safely

- Check the rigging screw or turnbuckle before use – do not use a defective rigging screw or turnbuckle.
- Never exceed the safe working load for the particular mode of use.
- When used in a multi-leg assembly, make an allowance for the sling leg angle.
- Ensure that it is compatible in size with any mating equipment.
- Never load in a way that induces bending. Rigging screws and turnbuckles must always be allowed to align straight along their centre line.
- Ensure that the terminal fittings are fully screwed through the female threads. A minimum length of at least 1.6 times the thread diameter should be maintained within the body at each end.
- Keep the inspection hole (if available) in the rigging screw body clear so as to see the position of the terminal fitting. Where there is no inspection hole, remove the terminal fitting and measure the length to verify the minimum required for safe engagement.
- Ensure that the plain length of the bolt fitted to a screwed fork is long enough that the securing nut seats on the thread and not the fork body.
- Never replace the bolt of a screwed fork with anything other than an identically dimensioned and rated bolt.
- Never use a long bar to tension a rigging screw or turnbuckle. Torque should only be applied by a short bar.
- Hexagon-ended turnbuckle bodies should be tensioned by a spanner on the hexagon.
- If locknuts are fitted, they must be tightened following final adjustment, taking care not to over-tighten them.
- The security of all locking devices should be regularly checked.

Don't Forget!

* *Never overload a rigging screw or turnbuckle*
* *Never load in a way that induces bending, they must be allowed to align straight*
* *Never use without at least 1.6 times the thread diameter within the body at each end*
* *Never replace the bolt of a screwed fork with anything other than an identically dimensioned and rated bolt*
* *Never use a long bar to tension a rigging screw or turnbuckle*

In-service Inspection

Regularly inspect rigging screws and turnbuckles. If any of the following defects are found, refer to a Competent Person:

- distorted body or end terminations, including load pins;
- damaged internal or external threads;
- worn thread and/or end terminations;
- nicks, cracks, gouges, corrosion;
- incorrect load pins fitted to fork fittings;
- damaged or missing locknuts;
- illegible markings.

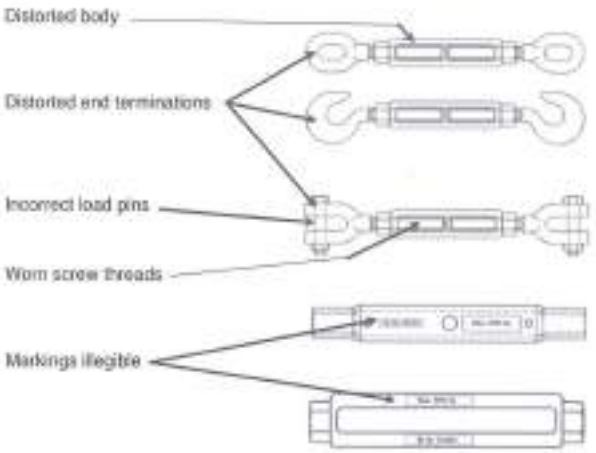


Figure 39
Rigging Screw and Turnbuckle Inspection Points

Maintenance

Maintenance requirements are minimal. Keep rigging screws and turnbuckles clean, protect from corrosion and damage. Screw threads should be greased. Do not attempt to straighten bent rigging screws or turnbuckles or re-cut threads.

BARREL LIFTERS

The following is based on Section 23 of COPSULE

Selecting the Correct Barrel Lifter
There are principally three types of barrel lifter:

A top gripping barrel lifter grips the top of a barrel and the only possible manipulation of the barrel whilst suspended with this type of lifter, is rotation about the vertical axis of the barrel utilising the swivel in the hook of the lifting machine.

An end gripping barrel lifter grips the ends of a barrel and the only possible manipulation of the barrel whilst suspended with this type of lifter, is rotation about the horizontal axis of the barrel utilising the swivel in the hook of the lifting machine.

A side gripping barrel lifter grips the side of the barrel and allows rotation of the barrel about its vertical axis utilising the swivel in the hook of the lifting machine and, if fitted with the appropriate mechanism, also facilitates tilting of the barrel or rotation about its horizontal axis.

Using Barrel Lifters Safely

- Check the barrel lifter before use – do not use a defective barrel lifter.
- Never use a barrel lifter to lift people or for loads other than barrels.
- Never attempt to lift barrels that the lifter has not been designed for. They may be designed to lift a specific size, shape or type of barrel or may be suitable to lift a range of barrels.
- Ensure that the surface of the load to which the barrel lifter is attached is clean and dry. Lubricants or other substances contaminating the surface may severely impair the ability of the barrel lifter to grip the load adequately.
- Never attempt to lift the load until you are satisfied that the barrel lifter is capable of doing so. The methods of ensuring this will vary from one manufacturer to another and it is essential that the manufacturer's instructions relevant to the particular type of barrel are consulted.
- Never subject the barrel lifter to shock loads.
- Ensure that the suspended barrel is transported gently to avoid swaying.
- Be aware of the danger of unbalanced loads.
- Take particular care when manipulating a suspended barrel to empty it. Be aware that during discharge, the position of the centre of gravity may change causing a lateral movement of the barrel. Also, if the arrangement is such that a

sudden discharge of the contents can occur, this may cause a recoil which, for some designs, may result in release of the barrel.

- Never attempt to release the barrel lifter until the load has been set down and is stable.
- The contents of the barrel may be hazardous and in such cases appropriate safe working practices and the use of personal protective equipment must be observed.

Don't Forget!

- *Never use a barrel lifter to lift people or for loads other than barrels*
- *Never attempt to lift barrels that the lifter has not been designed for*
- *Never attempt to lift the load until you are satisfied that the barrel lifter is capable of doing so*
- *Never subject the barrel lifter to shock loads*
- *Never attempt to release the barrel lifter until the load has been set down and is stable.*

In-service Inspection

Regularly inspect barrel lifters. If any of the following defects are found, refer to a Competent Person:

- general damage to the body of the barrel lifter;
- damage to the lifting eye or other means of suspension;
- failure or malfunction of any of the operating mechanisms;
- dirt, grit or other debris on the barrel pads or bands if fitted;
- missing or illegible markings, load rating information etc.

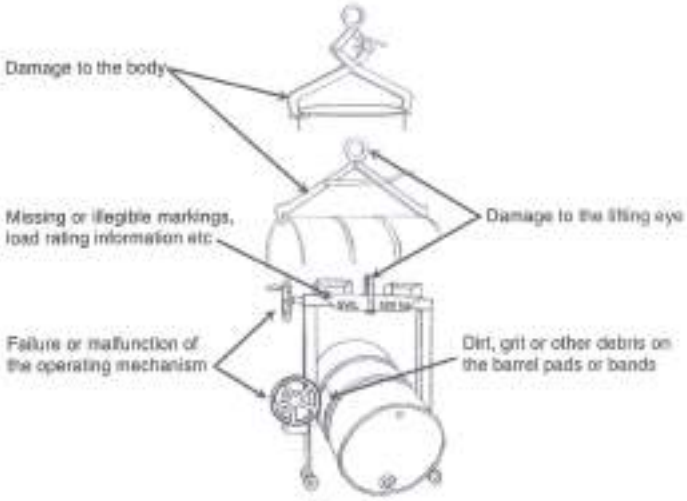


Figure 40
Barrel Lifter Inspection Points

Maintenance

The degree of maintenance required will vary dependant on the type and design of the barrel lifter. Simple mechanical mechanisms will have linkages which need to be checked for wear, security of link pins, distortion of components etc. For lifters fitted with gripping pads or bands, these may become contaminated or worn and are usually replaceable. Specific maintenance instructions issued by the manufacturer should be followed.

CRANE FORKS

The following is based on Section 24 of COPSULE

Using Crane Forks Safely

- Check the crane fork before use – do not use a defective crane fork.
- Never use a crane fork to lift people or to lift loads it is not suitable for.
- Never lift loads over people who are in the danger zone unless the crane fork has the features needed to address this situation. These features usually include a secondary positive holding device. If the crane fork does not have such features, it will be necessary to exclude persons from the danger zone.
- Ensure that the fork arms of the crane fork are correctly adjusted for width.
- Use the grab handles to control the crane fork and ensure that it is presented to the load so that the fork arms pass right through the pallet at the appropriate positions.
- The condition of the load is of paramount importance. The load itself must be capable of being lifted safely and of withstanding the forces imposed upon it. Loads comprised of loosely stacked materials should not be lifted without additional security such as strapping or netting.
- For crane forks fitted with manual adjustment, position the lifting eye so that the load will hang correctly when lifted.
- Make a trial lift to ensure that the load hangs correctly. When lifted, the fork arms should be tilted backwards by an angle equal to or slightly greater than 5° to prevent the load from sliding off the fork arms.
- Adjust as necessary before proceeding. For crane forks with a fixed suspension, this will require repositioning of the crane fork within the load.
- Be aware that a crane fork with an automatic mechanism to adjust the position of the lifting eye may not work at very low loads. Check the manufacturer's instructions for any minimum load information.
- Be aware of the danger of unbalanced loads causing the crane fork to tilt sideways. The C of G of the load should be located centrally between the fork arms.
- Never attempt to hoist the load until you are satisfied that the crane fork is capable of doing so. Methods of ensuring this will vary from one manufacturer to another and it is essential that the manufacturer's instructions relevant to the particular type of crane fork are consulted.
- Never subject the crane forks to shock loads.
- Remember to include the self weight of the crane fork when calculating the total load on the lifting machine.

Don't Forget!

* *Never use a crane fork to lift people or to lift loads it is not suitable for*
* *Never lift loads over people in the danger zone without the necessary safety features*
* *Never attempt to lift the load until you are satisfied that the crane fork is capable of doing so*
* *Never proceed with a lift unless the load hangs correctly*
* *Never subject the crane fork to shock loads*

In-service Inspection

Regularly inspect crane forks. If any of the following defects are found, refer to a Competent Person:

- general damage to the fork arms, mast or cross member;
- damage to the lifting eye or other means of suspension;
- damage to the adjustment mechanism if fitted;
- damage to the secondary holding device;
- missing or illegible markings, model, manufacturer, serial number, load rating information etc.

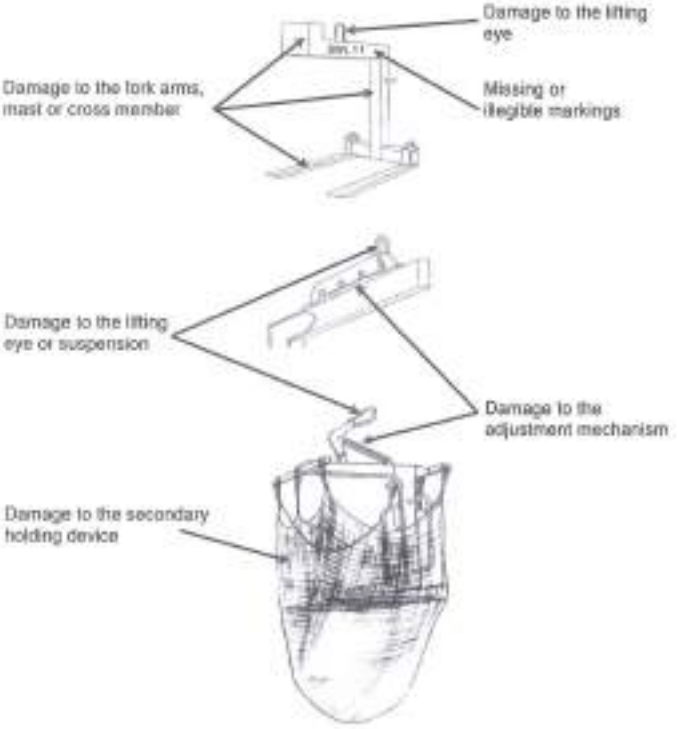


Figure 41
Crane Fork Inspection Points

Maintenance

Crane forks usually need little or no routine maintenance other than keeping them clean and dry. The adjustment mechanism may have linkages which need to be checked for wear, security of link pins, distortion of components etc. Specific maintenance instructions issued by the manufacturer should be followed.

MAGNETIC LIFTERS

The following is based on Section 25 of COPSULE

Selecting the Correct Magnetic Lifter

Magnetic lifters can be suitable for a variety of applications. Some may be used as general purpose lifting accessories and therefore require their capacity to be assessed for each application. Others may be dedicated to a single application and are selected specifically for it. Not every load with ferromagnetic properties can safely be handled with a magnetic lifter.

The magnetic lifter selected must match the characteristics of the load. As well as the weight, this includes the shape, surface finish and magnetic properties of the load.

The shape of the magnet should be compatible with that of the load. For example a magnet with a flat face can handle sheet material whereas for lifting round section material, a magnet with a V shaped recess in the face is more suitable. For long loads, an arrangement of several magnets used in conjunction with a lifting beam is generally suitable as it provides the load with adequate support along its length. The positioning and capacity of the individual magnets should be such as to ensure that the share of the load imposed on each does not exceed its working load limit. For flexible loads, the positioning should provide support at short enough spaces to prevent the load from peeling off the magnet.

Lifting magnets are normally rated for lifting a horizontal load in the vertical plane only. If the line of pull is not at right angles to the plane of the load, their lifting capacity will be substantially reduced and slippage may occur. For such applications, the advice of the manufacturer should be obtained.

Consideration should be given to the following:

- lifting capacity required;
- characteristics of the load eg shape, surface finish and magnetic properties;
- nature of the lifting operation;
- lifting machine it is to be used with;
- self weight of the magnetic lifter and degree of portability required;
- method of control and control features required;
- electrical requirements for electro or electro-permanent magnetic lifters;
- proximity of persons during operations;
- backup and other safety features required.

Using Magnetic Lifters Safely

- Check the magnetic lifter before use – do not use a defective magnetic lifter.
- Never use a magnetic lifter to lift people or to lift loads it is not suitable for.
- Never lift loads over people who are in the danger zone unless the magnetic lifter has the features needed to address this situation. These features can include a redundancy of critical supply cables and controls or a secondary mechanical means of securing the load. When establishing the danger zone, take account of the nature of the load. For example, sheet material can fly a considerable distance to the side. If necessary establish a "no go" area.
- Ensure that the load is of sufficient thickness to absorb the full magnetic flux of the magnet otherwise the lifting capacity will be reduced.
- Never magnetize the lifter before setting it on the load.
- Never attempt to hoist the load until you are satisfied that the magnetic lifter is capable of doing so. Methods of ensuring this will vary from one manufacturer to another and it is essential that the manufacturer's instructions relevant to the particular type of magnetic lifter are consulted. The capability may be checked by inserting a piece of non magnetic material between the load and the magnet and performing a test lift by raising the load a small distance from the ground. This is called an artificial air gap test.
- Ensure the load is balanced. An unbalanced load will tilt and may become detached by slipping.
- Be aware that flexible loads can peel off the magnet face. Do not attempt to lift a load if this is likely to happen. To overcome this problem, use two or more magnetic lifters in conjunction with a suitable lifting beam or spreader, ensuring that the share of the load taken by each magnetic lifter does not exceed its capacity.
- If the load is comprised of a stack of material, eg of steel plates, the magnetic lifter can only lift the material permeated by the magnetic field. For this type of application, magnetic lifters with variable power are required. This facilitates shedding of excess load by reducing the power then securing the remaining load by restoring full power. Without this facility, the lowest part of the stack lifted is likely to be very insecurely held and therefore present a high risk of becoming detached.
- Porous objects will have a lower density than solid objects made from the same material. This will affect the lifting capacity of the magnet. The same applies to loads with internal voids.
- Ideally, the surface of the load to be lifted magnetically should be flat and in intimate contact with the sole plate of the magnetic lifter. An air gap may be

present due to an irregular shape, surface texture or surface coating. If so check the capability of the magnet by the artificial air gap test.

- Always use the entire lifting pole surface.
- Never subject a loaded magnetic lifter to shock loads. Ensure that, once hoisted, the load is transported gently.
- Never attempt to "demagnetize" the magnetic lifter until the load has been set down. (except in scrap handling applications)
- Beware of accidentally picking up other magnetic objects when the magnetic lifter is activated.
- Include the self weight of the magnetic lifter when calculating the total load on the lifting machine.

Don't Forget!

- *Never use a magnetic lifter to lift people or to lift loads it is not suitable for*
- *Never lift loads over people in the danger zone without the necessary safety features*
- *Never magnetize the lifter before setting it on the load*
- *Never attempt to lift the load until you are satisfied that the magnetic lifter is capable of doing so*
- *Never subject the magnetic lifter to shock loads*
- *Never demagnetize the lifter until the load has been set down*

In-service Inspection

Regularly inspect magnetic lifters, including an operational check of all the controls and indicators. For battery operated models, check the condition of the battery and its state of charge; If any of the following defects are found, refer to a Competent Person:

- general damage to the body of the magnetic lifter;
- damage to the lifting eye or other means of suspension;
- damage to the magnet face;
- failure or dysfunction of any operating controls, warning indicators or other warning devices;
- missing or illegible markings, model, manufacturer, serial number, load rating information etc.

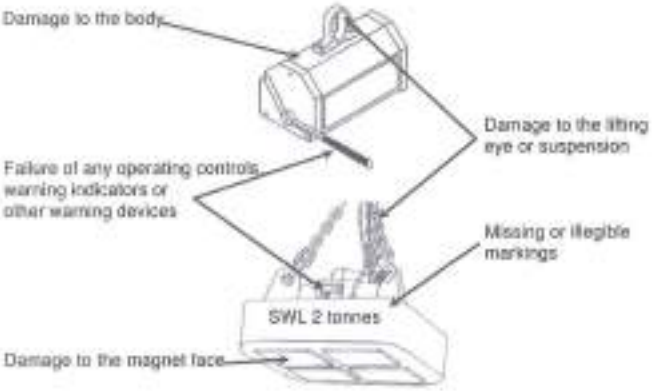


Figure 42
Magnetic Lifter Inspection Points

Maintenance

Magnetic lifters usually need little or no routine maintenance other than keeping them clean and dry since the working parts are contained within a substantial steel shell and any working mechanism is essentially very simple. Specific maintenance instructions issued by the manufacturer should be followed. The condition of all batteries must be checked on a regular basis.

VACUUM LIFTERS

The following is based on Section 26 of COPSULE

Selecting the Correct Vacuum Lifter

Vacuum lifters can be suitable for a variety of applications. However it is essential that the characteristics of the vacuum lifter are matched to those of the load.

Generally they are most suitable for lifting loads which have a smooth, non-porous surface such as metal plates, glass, stone slabs, cardboard boxes etc. If required, the vacuum lifter can have the facility to tilt a load, such as a steel or glass plate from horizontal to vertical or vice versa, and be capable of rotating the load. These facilities may be by means of either a manual or powered actuator.

Loads with a porous surface or a textured surface may be lifted with vacuum lifters provided that the means of generating the vacuum is sufficiently powerful to counteract the leakage of air. Turbine operated types are usually used in these applications.

Consideration should be given to the following:

1. lifting capacity required;
2. characteristics of the load in terms of shape, surface finish and porosity;
3. lifting machine it is to be used with;
4. self weight of the vacuum lifter and degree of portability required;
5. whether self actuating or powered type required;
6. for powered lifters, whether battery or mains power required;
7. for venture types, the pressure, volume and quality of air required;
8. method of control and control features required;
9. proximity of persons during operations;
10. back up and other safety features required.

Using Vacuum Lifters Safely

- Check the vacuum lifter before use – do not use a defective vacuum lifter.
- Never use a vacuum lifter to lift people or to lift loads it is not suitable for.
- Never lift loads over people who are in the danger zone unless the vacuum lifter has the features needed to address this situation. These features can include a redundancy of critical components and controls or a secondary mechanical means of securing the load. When establishing the danger zone, take account of the nature of the load. For example, sheet material can fly a considerable distance to the side. If necessary establish a 'no go' area.

- Ensure that the surface of the load to which the vacuum lifter is to be attached is clean and dry. Light oil or other liquid coverings may be acceptable and may make the vacuum lifter more efficient but beware of potential adverse effects on the pads.
- Never actuate the lifter before setting it on the load.
- Never attempt to hoist the load until you are satisfied that the vacuum lifter is capable of doing so. Methods of ensuring this will vary from one manufacturer to another and it is essential that the manufacturer's instructions relevant to the particular type of vacuum lifter are consulted.
- Ensure the load is balanced. An unbalanced load will tilt and may become detached by slipping.
- Be aware that flexible loads can peel off the vacuum pad. Do not attempt to lift a load if this is likely to happen. To overcome this problem, use a vacuum lifter with two or more vacuum pads in conjunction with a suitable lifting beam or spreader, ensuring that the share of the load taken by each vacuum pad does not exceed its capacity.
- Vacuum lifters can be used to remove one plate or sheet of material from a stack. If used in this way, care should be taken to ensure that the top plate or sheet is free to move, ie not attached to the stack by strap banding etc. Also be aware that smooth finished plates and sheets can adhere to each other particularly if a liquid is present, eg oiled steel sheet or wet glass.
- Porous objects will have a lower density than solid objects made from the same material and will thus be lighter in weight. Their porosity will however allow the vacuum within the lifting pad to be dissipated through the load. This does not necessarily mean that the use of a vacuum lifter is out of the question. It does however mean that the vacuum dissipation must be taken into account.
- Ideally, the surface of the load to be lifted should be flat and in intimate contact with the lifting pads of the vacuum lifter. Air gaps may however be present due to irregular shapes and in this situation the advice of the manufacturer should be sought. Surface texture and the presence of a non-adherent coating on the material may have an adverse effect on the vacuum lifter's capacity. Air gaps may be tolerable within the limits laid down by the manufacturer.
- It is possible to lift loads with other than flat surfaces using vacuum lifters. Round sections for example can be handled provided that the vacuum lifter has suitably profiled lifting pads.
- Always use the entire lifting pad surface. Air leaks will catastrophically affect the safe use of a vacuum lifter.
- Never subject a loaded vacuum lifter to shock loads. Ensure that, once hoisted, the load is transported gently.

- Never attempt to release the vacuum lifter until the load has been set down in its final resting place.
- Include the self weight of the vacuum lifter when calculating the total load on the lifting machine.

Don't Forget!

* *Never use a vacuum lifter to lift people or to lift loads it is not suitable for*
* *Never lift loads over people in the danger zone without the necessary safety features*
* *Never actuate the lifter before setting it on the load*
* *Never attempt to lift the load until you are satisfied that the vacuum lifter is capable of doing so*
* *Never subject the vacuum lifter to shock loads*
* *Never deactivate the lifter until the load has been set down*

In-service Inspection

Regularly inspect vacuum lifters, including an operational check of all the controls and indicators. For battery operated models, check the condition of the battery and its state of charge; If any of the following defects are found, refer to a Competent Person:

- general damage to the body of the vacuum lifter;
- damage to the lifting eye or other means of suspension;
- damage or contamination of the vacuum lifting pads;
- failure or dysfunction of any operating controls, warning lights or other warning devices;
- air leaks from any hoses or couplings;
- missing or illegible markings, model, manufacturer, serial number, load rating information etc.

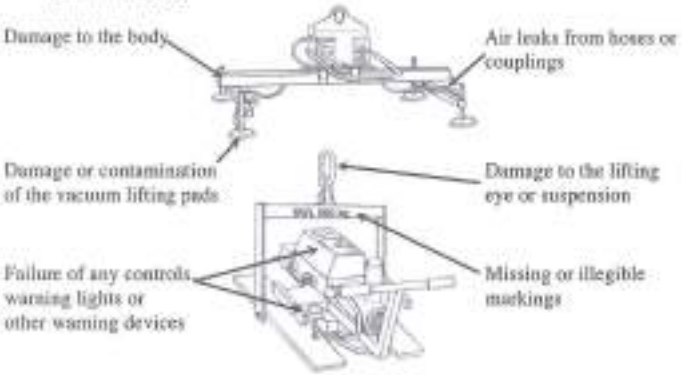


Figure 43
Vacuum Lifter Inspection Points

Maintenance

Vacuum lifters usually need little or no routine maintenance other than keeping them clean and dry since the working mechanism is essentially very simple. Specific maintenance instructions issued by the manufacturer should be followed. Vacuum pads and the seals around them must be inspected regularly and replaced in accordance with the manufacturer's instructions. For battery powered types, the condition of all batteries must be checked regularly.

INTRODUCING COPSULE

CODE OF PRACTICE FOR THE SAFE USE OF LIFTING EQUIPMENT

Written by industry experts aided by valuable advice and support from the Health and Safety Executive and incorporating over 400 pages, the Lifting Equipment Engineers Association (LEEA) code of practice is widely recognised as the authoritative guide to safe and legal lifting. First published in 1981, over 6,000 copies have already been sold. The seventh edition dated May 2009 was fully revised to incorporate the latest health and safety legislation and standards.

- Comprehensive – over 400 loose-leaf A4 pages in a sturdy ring binder.
- Easy to use – fully indexed for quick reference.
- Authoritative – written by industry experts.
- Up-to-date – completely revised to include the latest health and safety legislation and standards

Clearly written and easy to use, the Code of Practice for the Safe Use of Lifting Equipment is an ideal reference source for operating, maintenance, training and purchasing procedures. Identifying and addressing the common causes of lifting and handling accidents, the code promotes safer working practices and helps to ensure that all staff in positions of responsibility comply fully with the relevant health and safety legislation.

Based on the LEEA's impartial, in-depth expertise and experience, the Code of Practice for the Safe Use of Lifting Equipment covers both the general issues applicable to all lifting and handling operations and a wide range of specific equipment types.

Although the number of accidents in lifting operations is usually no greater than in other areas of industrial activity, experience has shown that a very high proportion of the accidents which do occur could easily have been avoided. Common causes of lifting accidents relate both to the lifting equipment itself and to the lifting practices employed:

- Failure to adequately plan the lifting operation
- Lack of knowledge of the principles involved in lifting
- Incorrect choice of equipment
- General misuse

- Inadequate provision for regular examination and maintenance
- Inadequate in-service inspection of equipment
- Failure to establish accurately the weight of the load to be lifted
- Failure to observe marked safe working load restrictions
- Failure to ensure security and stability of the load
- Failure to provide adequate training of operatives
- Failure to provide adequate supervision of lifting operations

Apart from the possible dire consequences of these failures and omissions, they represent contraventions of the laws relating to safety at work and may therefore be regarded as criminal offences.

The code is designed to provide a comprehensive and authoritative source of information for all those who have responsibility for the design, manufacture and supply of lifting equipment together with those responsible for management of lifting equipment including procurement, in-service inspection, maintenance, planning and supervision of lifting operations and safe use of lifting equipment, enabling them to ensure safety in use and to meet legal obligations.

Main section headings

General requirements:	Definitions Legal requirements Principles for the selection of lifting equipment Information to be exchanged between user and designer/supplier Marking, storage and handling In-service inspection Safe use of lifting equipment Training Recommended crane signals Load estimation – weight and centre of gravity Load security – balance and stability Structures Principles for the selection and use of multipurpose slings Principles for the selection and use of lifting appliances Planning the lifting operation Guidance on written schemes of examination

Specialised sections:	Hand operated chain blocks Hand operated chain lever hoists Wire rope lifting and pulling machines Power operated hoists Winches used for lifting purposes Travelling girder trolleys Beam clamps Slewing jib cranes Runways Mobile gantries Jacks Chain slings Wire rope slings Flat woven webbing slings Man-made fibre roundslings Fibre rope slings Shackles Eyebolts Lifting beams, spreaders and frames Plate handling clamps Rigging screws and turnbuckles Barrel lifters Crane forks Magnetic lifters Vacuum lifters
Format:	The format is loose leaf A4 in a sturdy ring binder
Price:	£146.00 including postage and packing within the UK.
Available from:	Available direct from the Association or via your local LEEA member.

GLOSSARY OF TERMINOLOGY

Competent Person

The term 'Competent Person' has long been used in legislation. Current legislation uses it for a variety of duties to describe a person with the necessary knowledge, experience, training, skill and ability to perform the specific duty to which the requirement refers. There can therefore be several 'Competent Persons', each with their own duties and responsibilities, ie competent for the purpose.

The term has never been fully defined in law, but for the purpose of lifting equipment verification, ie testing, examination and certification, the LEEA definition of a Competent Person is a person having such practical and theoretical knowledge and experience of the equipment which is to be tested, examined and certified that will enable him/her to detect defects or weaknesses which it is the purpose of the examination to discover and assess their importance to the safety of the equipment. The Competent Person should have the maturity to seek such specialist advice and assistance as may be required to enable him/her to make necessary judgements and be a sound judge of the extent to which he/she can accept the supporting opinions of other specialists. He/she must be able to certify with confidence whether it is free from patent defect and suitable in every way for the duty for which the equipment is required. It is the view of the LEEA that competency can be a corporate responsibility.

EC Declaration of Conformity

An EC Declaration of Conformity is a declaration made by the manufacturer, or other legally responsible person, that the equipment described complies with the relevant European Directive(s). It is the legal document enabling an item to be placed on the market and taken into service.

Factor of Safety

The factor of safety is the ratio between the minimum breaking load and the safe working load. In the Machinery Directive the term used is 'working coefficient'.

In-service Inspection

In-service inspection is a visual inspection carried out by the Responsible Person to check for obvious signs of damage or wear which might affect the equipment's fitness for use.

Jacking

Jacking is the act of raising a load with an machine (known as a jack) which is placed

under the load and which effectively pushes the load upward or lowers the load whilst supporting it from beneath.

Lifting
Lifting is the act of raising a load with an machine and other lifting equipment which is placed above the load and which effectively picks the load up or lowers it whilst supporting it from above.

Lifting Accessory
The term lifting accessory, or accessory for lifting, is used in current legislation to mean an item of equipment used to attach the load to a lifting machine but which is not in itself capable of providing any movement to lift or lower the load and generally covers equipment previously referred to as lifting gear or lifting tackle

Lifting Application
A lifting application is any application where, in the event of the machine or any of its associated equipment failing, the load does NOT BECOME STATIONARY. Thus, for example, if a load were being 'pulled' up an incline on wheels it would be regarded for the purposes of this guide as a lifting application as, in the event of a failure, the load would descend the incline under gravity.

Lifting Equipment
Lifting equipment is a generic term used to indicate loosely all equipment known as lifting accessories, lifting gear or tackle and lifting machines or appliances.

Lifting Machine or Appliance
A lifting machine or appliance is any machine which is able to raise, lower or suspend a load but excluding machines incorporating a guided load (ie lifts) and continuous mechanical handling devices (ie conveyors).

Lifting Mechanism
A lifting mechanism is that part of a lifting machine which provides the motive effort and performs the actual lifting operation and may be capable of travelling the load.

Manufacturer's Certificate
A manufacturer's certificate is a certificate issued by the manufacturer stating that his product conforms to a particular standard and containing such information as is required by the standard.

Minimum Breaking (or Failure) Load
The minimum breaking or failure load is the specified load (mass or force) below which the item of equipment does not fail either by fracture or distorting to such an extent that the load is released.

Mouse
A short length of cord used to secure a hook which does not have a safety catch.

Multipurpose Equipment
Multipurpose equipment is any equipment designed to a standard specification to lift a variety of loads up to the marked safe working load, ie used for general (multi) purposes, and not designed for one specific lifting application.

Operative
An operative is a trained person actually using the equipment.

Proof or Test Load
A proof or test load is a load (mass or force) applied by the manufacturer or by the Competent Person for the purpose of a test.

Pulling Application
A pulling application is any application where, in the event of the machine or any of its associated equipment failing, the load BECOMES STATIONARY.

Report of Thorough Examination
A report of a thorough examination is a report issued by the Competent Person giving the results of the thorough examination, detailing the defects found or stating that the item is fit for continued safe use. Where the competent person has carried out any test as part of the examination, the report will also contain details of the test. The report of thorough examination must be retained for inspection when required.

Responsible Person
A Responsible Person is a person who has sufficient knowledge and training to enable him/her to recognise obvious defects and is responsible to his/her employer for the 'in-service' inspection of equipment.

Safe Working Load (SWL)
The safe working load is the maximum load (mass) as assessed by a Competent Person which an item of lifting equipment may raise, lower or suspend under the particular service conditions. The safe working load will normally be the same as the

working load limit or the maximum safe working load where the term is used; but it may be less. Safe working load appears in statutory records.

Note:
Much confusion exists between the terms 'safe working load' and 'working load limit'. By way of explanation, working load limit is the 'maximum' safe working load under ideal conditions and in most cases the working load limit and the actual safe working load will be the same. However, depending upon the conditions of use, it may be necessary for the Competent Person to reduce the safe working load to a value less than the working load limit.

If the operating conditions are such that a reduction may be required, it is essential that the user declares this at the time of ordering. In the absence of such a declaration, the manufacturer or supplier will assume that the conditions of use are suitable for equipment rated with the safe working load equal to the working load limit.

The conditions where it may be necessary to reduce the working load limit to a lower safe working load are HAZARDOUS DUTIES. Hazardous duties could, for example, be environmental conditions such as extremes of temperature or lifting procedures such as a likelihood of shock loading or inaccuracy of weight.

When such circumstances arise, it is essential that the equipment used is correctly rated. Whilst it is the responsibility of the user to ensure this, the following advice should be considered:

(1) For specific installations where the equipment is fixed permanently in position, the equipment may be marked with the reduced safe working load for that specific duty.

(2) For specific installations where the equipment is portable, the user should provide written instructions to the operative which include an instruction to use a normally rated piece of equipment (ie SWL = WLL) but of appropriately higher capacity thus achieving the same effective reduction.

(3) For an industry or a definable section of an industry where the majority of tasks require equipment having a reduced working load, then all the equipment should have a reduced working load ie that corresponding to the most hazardous duty.

Single Purpose Equipment
Single purpose equipment is any equipment designed for and dedicated to lifting a specific load in a specified manner or working in a particular environment, ie used for a single purpose.

Statement of Conformity
A statement of conformity is a certificate issued by the manufacturer confirming that any necessary manufacturing tests have been carried out and confirming the safe working load. The statement of conformity has the same status as a test certificate and must be retained for inspection when required.

Note:
Some equipment is unsuitable for proof load testing due to the nature of the materials used, eg textile slings. It is in these cases only that a statement of conformity is issued by the manufacturers.

Structure
A structure is that part of a lifting machine which supports the lifting mechanism. It may be static providing a track upon which the lifting mechanism is able to travel or it may itself be capable of movement.

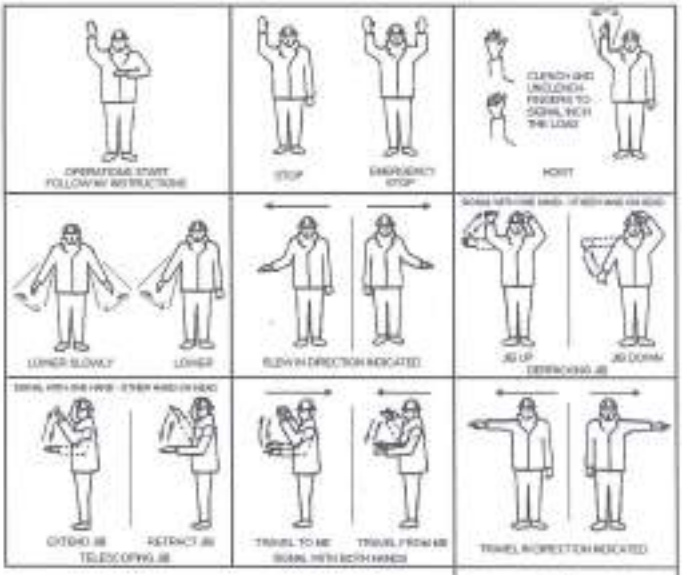
Test Certificate
A test certificate is a certificate issued by the Competent Person giving details of the test or tests and thorough examination conducted on an item of lifting equipment certifying its fitness for safe use. Prior to the introduction of the Supply of Machinery (Safety) Regulations it was the legal document that enabled an item of lifting equipment to be taken into service. Test certificates issued for equipment, which entered service prior to the introduction of the current regulations, remain valid until their normal expiry date. The test certificate must be retained for inspection when required.

Thorough Examination
A thorough examination is a visual examination carried out by a Competent Person carefully and critically and, where appropriate, supplemented by other means such as measurement and testing in order to check whether the equipment is safe to use.

Working Load Limit (WLL)
The working load limit is the maximum load (mass) that an item of lifting equipment is designed to raise, lower or suspend. In some standards and documents WLL is referred to as 'maximum safe working load.'

RECOMMENDED CRANE SIGNALS

The following illustrates the recommended crane signals as shown in BS 7121: 1989. Agricultural signals are given in BS 6736 – Hand Signals for Agricultural Operations.



Note:
The signaller should stand in a secure position where HE CAN SEE THE LOAD AND CAN BE CLEARLY SEEN by the driver. Face the driver if possible. Each signal should be distinct and clear.

Figure 44
Recommended Crane Signals

LOAD ESTIMATION – WEIGHT AND CENTRE OF GRAVITY

It is important to know with reasonable accuracy the weight of a load to be lifted and the position of its centre of gravity. There are various ways of obtaining this information.

Weight

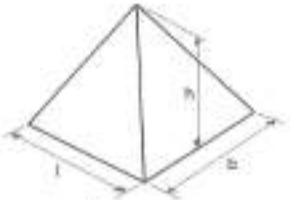
(1) See if it is marked on the load. If it is, check that it is the weight of all the load.
(2) See if the weight is on any documentation.
(3) Look at a drawing of the load but again check that it includes all the load.
(4) If the load is still on a trailer or truck, weigh it.
(5) Estimate the weight using the formula and tables.

Material	Weight in kg/m^3	Weight in lb/ft^3
Aluminium	2700	170
Brass	8500	530
Brick	2100	130
Coal	1450	90
Copper	8800	550
Concrete	2400	150
Earth	1600	100
Iron-steel	7700	480
Lead	11200	700
Magnesium	1750	110
Oil	800	50
Paper	1120	70
Water	1000	62
Wood	800	50

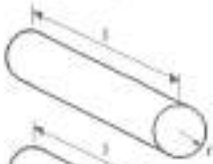
Table 6
Weights of Materials

Notes:
(1) In some cases, the above figures are average only and the actual weight may vary according to the particular composition/water content, etc.
(2) All figures have been rounded for convenience of use.
(3) When dealing with a hollow body, check whether it contains anything and whether any such contents are liable to move.

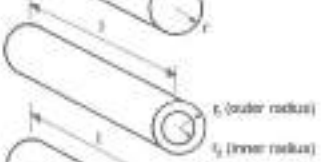
Pyramid = ⅓ l b h



Solid cylinder = $\pi r^2 l$



Thick walled pipe = $\pi (r_1^2 - r_2^2) l$



Thin walled pipe = π d l t

Rectangular solid = l b h

Sphere = $\frac{4 \pi r^3}{3}$

Figure 45
Volumes of common shapes

Value of π

π = 3.142 or 22/7 (If 3 is used add 5% to the estimate to correct the error.)

Imperial/Metric Conversion

1 ton = 2240 lb

1 tonne = 1000 kg = 2204.6 lb

For estimation purposes: 1 ton = 1 tonne

1 lb/ft^3 = 16.0185 kg/m^3

Ensure compatibility of units in all calculations.

Centre of gravity (C of G)

The centre of gravity is the point where the total weight of the body may be regarded as acting. Another way of saying this is that the C of G is the point about which the parts of a body exactly balance each other.

With a regularly shaped load (eg a rolled steel joist) the C of G is at the midpoint in each direction. For more complex shapes, however, it may be necessary to estimate the centre of gravity of the various parts of the load and then combine them to get a centre of gravity for the whole.

In figure 41, if the weights of the three parts A, B and C are W_A, W_B and W_C respectively, then having estimated them and the positions of their centres of gravity, we can take moments about a given point (eg one end) and thus determine the position of the line through which the centre of gravity of the whole acts and which is an unknown distance X from the given point.

Thus from the formula

$(W_A + W_B + W_C)\ X = W_A\ Y_A + W_B\ Y_B + W_C\ Y_C$

the unknown distance X can then easily be found.

Once the position has been estimated, it should be marked in some way (eg chalk, sticky tape) to guide you when attaching the slings.

This calculation will determine the position of the centre of gravity in one plane only. By applying the same method in the other two planes, the precise position can be determined.

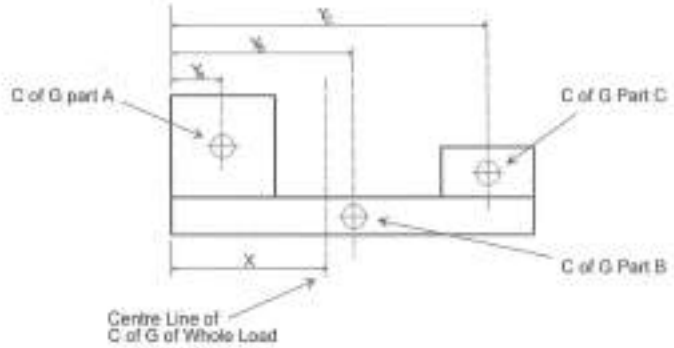


Figure 46
Calculating the Position of the C of G

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