Developing Professionals for the Lifting Equipment Industry

City & Guilds | Accredited Programme

Lifting Machines Power

Advanced Programme

Training Course Step Notes

City & Guilds | Accredited Programme

LEEA Learning and Development Agreement

In the interests of all parties and to ensure the successful achievement of the LEEA Lifting Machines Power Advanced Programme, the following arrangements are to be confirmed:

Student:

I agree to:

- Follow the instructions of my LEEA training facilitator at all times
- Follow all rules and procedures regarding health and safety matters whilst on site
- Respect the tidiness and cleanliness of training areas and rest area facilities
- Notify my LEEA training facilitator immediately if I have any concerns
- Inform my LEEA training facilitator of any learning difficulties at the soonest opportunity (this may be done privately between you and your LEEA training facilitator)
- Keep to agreed session times and return from rest breaks and lunchtime periods in a timely fashion
- Keep my mobile phone on 'silent' for the duration of all training sessions and to leave the class if I have to make or receive an urgent call, for the benefit of my fellow students
- Provide feedback to the LEEA facilitator regarding the training I have received
- Respect the opinions of my fellow students and to actively engage in group discussion
- Strictly adhere to the rules regarding LEEA Assessments

Signed _____

Date _____

LEEA Training Facilitator

I agree to:

- Safeguard the health, safety and welfare of my students throughout the training programme
- Provide my students with quality training, maintaining the highest of professional standards throughout
- Maintain confidentiality for all students at all times
- Provide regular feedback to students on their progress, identifying areas which may need additional study
- Keep appropriate records of any assessments conducted
- Ensure that all students are able to discuss any issues or concerns which may arise during the training course

Signed _____

Date _____

Disclaimer

These Step Notes are a useful and authoritative source of information for the LEEA LMP Advanced Programme student.

Whilst every effort has been made to achieve the highest degree of accuracy in the generation of the data and information supplied, ultimate responsibility remains with the student and their employer to ensure that current legal requirements are followed.

First Edition.....December 2016

Contents

1. Legislation

Moral, Legal and Financial Reasons for Health and Safety Legislation

Employers have a moral responsibility to ensure appropriate working conditions are provided
This is known as a common law duty of care

Unsafe working conditions are likely to have an impact on production

- Loss of output leading to lowering of morale and motivation
- Loss of sales turnover and profitability

Society and customer expectations of a company's approach to managing safety - health and safety culture
Negative public relations would have a damaging effect on any business

Financial cost from loss of output:

- Fines
- Damages
- Legal costs
- Insurance

Etc.

The Legislative Framework

Health and Safety at Work etc. Act 1974 (UK)

- The act is general in nature
- There is no reference to specific articles or substances
- The act applies to all sectors

Specific duties of care for:

- Manufacturers/suppliers of articles or substances
- Employers
- Employees

The health and safety at work act (HSWA) is an enabling act for specific regulations

Status in UK: legal requirement.
International: adopted as best practise, and requested by LEEA member companies.

Notes:

The Main Purposes of the HSWA

The Health and Safety at Work Act covers nearly all occupations. It is designed to protect people at work including staff, visitors, contractors and members of the public. The HSWA supersedes nearly all of the previous health and safety laws in the UK.

The main purposes of the Act are set out in section 1 as follows:

- To secure the health, safety and welfare of persons at work
- To protect other people from hazards arising from work
- To control the keeping and use of dangerous substances and materials, including explosives and highly flammable materials
- To control the emission of noxious substances from certain premises

It sets out a framework of general duties, primarily on employers, but also on employees and the controllers of premises, and on designers, manufacturers, importers and suppliers in relation to articles and substances used at work.

Regulations from the HSWA

Regulations are one form of delegated legislation made possible by section 15 of HSWA which gives powers to the secretary of state (UK) to make regulations for matters concerned with health and safety at work.

Regulations are not acts of Parliament but do have the support of the law and therefore must be complied with.

Regulations are increasingly drafted by reference to European Directives (these will be discussed at a later stage in this module).

There are many sets of regulations applying to health and safety. Some apply to all places of work and others are specific to particular industries, operations, substances, materials or premises.
Here are a couple examples of such regulations:

- The Manual Handling Operations Regulations 1992
- The Control of Substances Hazardous to Health Regulations 2002

Health and Safety at Work Act Section 2

Duties of the Employer

"Duty to ensure so far as is reasonably practicable, the health, safety and welfare at work of all his/her employees"

- Safe plant and systems of work
- Safe use, handling, storage and transportation of articles and substances
- Information, instruction, training and adequate supervision

- Safe place of work and a safe means of access and egress

- Safe working environment and adequate welfare facilities

Health and Safety at Work Act Section 6

Duties of Designers, Manufacturers, Importers and Suppliers

- To ensure, so far as is reasonably practicable, that articles they design, construct, make, import, supply etc. are safe and without risk to health at all times e.g. when it is being set up, cleaned, used or maintained by someone at work

- To carry out or arrange such testing and examination necessary to perform the duties above

- To ensure that those supplying the item have adequate information about its designed and tested use. This includes essential conditions for dismantling and disposal

- Take steps to ensure, so far as is reasonably practicable, that those supplied are given updated information where it becomes known that the item gives rise to serious risk to health and safety

Health and Safety at Work Act Section 7

Duties of the Employees

- States that employees must not endanger themselves, or others, by their acts or omissions

- Also, they must co-operate with their employers; as long as this does not lead to an increased risk to health and safety, or is an illegal act; so that employers can comply with their statutory duties

This makes responsibility for safety a joint employer/employee effort

Management of Health and Safety at Work Regulations 1992 (Revised 1999)

In addition to section 2 (2) c of the HSWA, the Management of Health and Safety at Work Regulations 1999 (MHSWR) require employers to ensure the effective planning, organisation, control, monitoring and review of preventive and protective measures. All these arrangements must be recorded and made known to employees. This is usually accomplished by the design of a company health and safety policy.

- MHSWR underlines the requirements for employers to provide instruction and training

- Employers must ensure that their personnel are properly trained to use any equipment necessary in the course of their work, but the regulations also place an obligation on employees to undergo such training and follow the instructions given by their employer

- Operatives are required to only use equipment for which they are trained and to use it in the manner and for the purpose for which they have been trained

LEEA Definition of a 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, i.e. competent for the purpose.

The term has never been fully defined in law but, for the purpose of thoroughly examining lifting equipment, 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 thoroughly examined 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 LEEA that competency can be a corporate responsibility.

Primary Elements of Competency

Information

Instruction

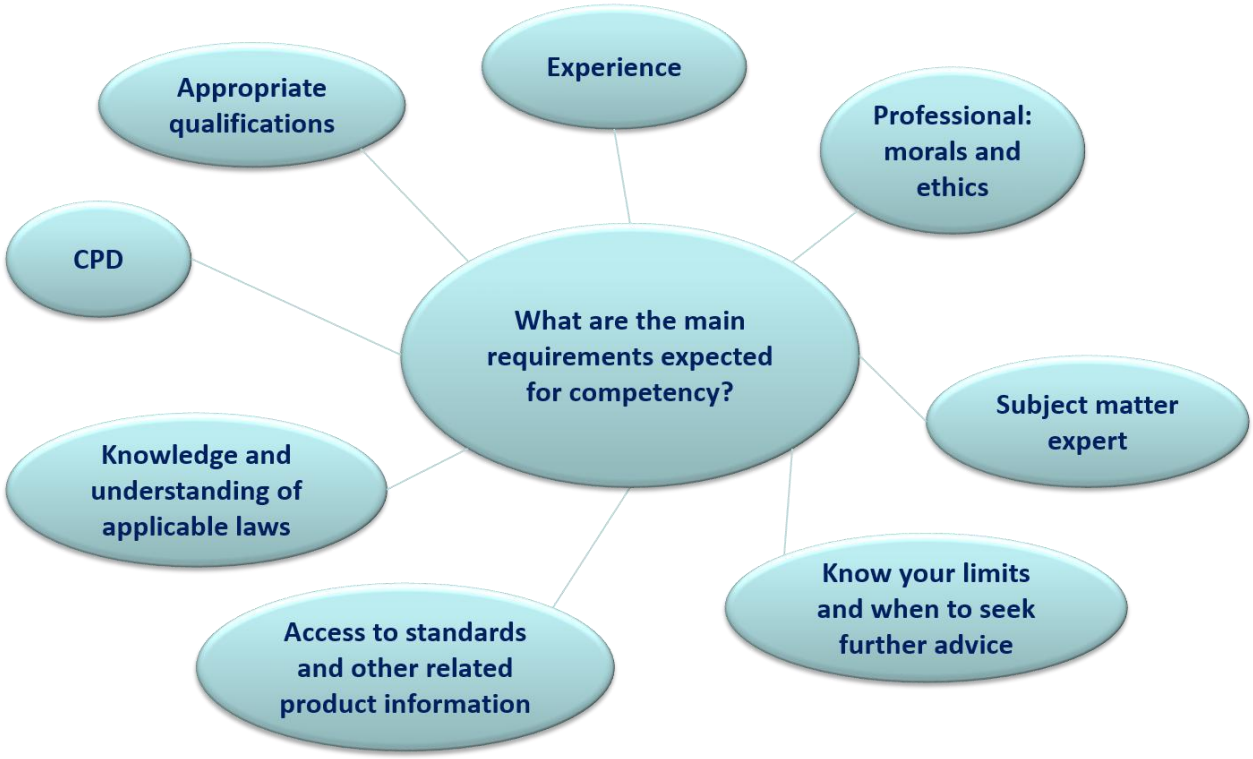
Training

Supervision

Note: LEEA Foundation Course and Advanced Programme certificates are not evidence, declaration or proof of competency.

Notes:

What are the Required Elements of Competency?



Risk Assessment

What is, "Risk Assessment"?
Put simply, it is a careful examination of what, in your work, could cause harm to people, so that you can weigh up whether you have taken enough precautions or should do more to prevent harm.

What are the 3 main reasons to assess and manage risk?

Human Harm

Injury and illness.

Legal Effects

Duty of care and consequences of unsuitable or insufficient risk management.

Economic Effects

Substantial financial costs are related to accidents at work.

Notes:

Definitions

Hazard

A hazard is something (object or situation) that has the potential to cause harm.

Danger

A liability or exposure to harm; something that causes peril.

Likelihood

How likely is it that someone could be harmed by the hazard?

Severity

If the potential for harm was to occur, how severe would the accident be.

Risk (a Combination of Likelihood and Severity)

Risk is the likelihood that the harm from the hazard is realised.

Net Result (Risk) = Likelihood x Severity, i.e. How likely x How severe the consequence

Notes:

5 Steps to Risk Assessment

- Identify the hazards
- Decide who might be harmed and how
- Evaluate the risks and decide on **control measures**
- Record your findings and implement them
- Review your assessment and update if necessary

Control Measures:

Hierarchy of control measures: **(ERIC-PD)**

Eliminate

Reduce

Isolate

Control

PPE

Discipline

Monitor and Review

Ensure control measure compliance (discipline)

Be vigilant - note changes:

Additional hazards presented? E.g. traffic, pedestrians etc., changes in production activity

Record your findings and change the risk assessment as necessary. This may result in the requirement for additional control measures.

Notes:

Are You Following a 'Safe System of Work'?

- You have evaluated the hazards
- You have identified who may be harmed
- You have evaluated the risk and decided upon control measures
- You have recorded your findings
- You will review and monitor the situation

If you have completed the above checklist, you are now following a "Safe System of Work"

The European Machinery Directive

A European directive is a directive to the member states of the European community, which has been adopted by the council of ministers, to introduce legislation with common requirements throughout the community. The directives are used to remove barriers to trade and introduce common safety requirements.

The Machinery Directive is largely based on risk assessment and use of European standards for critical features such as guards and emergency stops. Machinery directive provides the harmonisation of the essential health and safety requirements (EHSRs) for machinery.

It applies only to products that are intended to be placed on or put into service in the market for the first time.

What is a 'Machine'?

Machinery: "an assembly, fitted with or intended to be fitted with a drive system other than directly applied human or animal effort, consisting of linked parts or components, at least one of which moves, and which are joined together for a specific application".

Manufacturer is responsible for verifying whether a particular product falls within the scope of the Machinery Directive.

Note: The definition here is for 'Machinery' within the scope of the directive in the 'strict' sense, but the directive also has other definitions covering machinery in the 'broader' sense. The strict sense definition excludes manual lifting machines, accessories, ropes, chains and webbing. All of which are covered by the broader sense definitions.

Notes:

Supply of Machinery (Safety) Regulations 2008 – SM(S)R

Machinery Directive is implemented in the United Kingdom under the Supply of Machinery (Safety) Regulations.

The Supply of Machinery (Safety) Regulations 2008, SI No 1597 implement the Machinery Directive and contain Essential Safety Requirements which the machinery, including lifting machines and lifting accessories must meet.

Manufacturers, importers (into the European Union) and suppliers placing such equipment on the market for service in the community have a duty to:

- Design, build and supply equipment that is safe and meets the essential safety requirements
- To carry out such tests as may be necessary to ensure the requirements of above are met
- To maintain records of all calculations, tests and other relevant information that go to make up a Technical File which may be called upon by the enforcing authorities and which must demonstrate that the Essential Safety Requirements have been met
- Issue with each item of equipment information on the installation, maintenance, care and safe use
    - Issue a **Declaration of Conformity** and affix the CE mark, or issue a **Declaration of Incorporation** depending on its nature and intended use. In this context, if you manufacture or import (from outside the European Union) an item for your own use, you assume the full responsibilities of the manufacturer and must therefore meet all of the requirements of the regulations

To support the machinery directive, the joint European Standards Organisation, CEN/CENELEC, has been producing Harmonised European Standards.

Most of these standards have been published but there are still some left in the pipeline. As and when they are published, they will supersede any existing British Standards or other European National Standards covering the same products.

These Harmonised Standards have a special status in that products made to the standard are deemed to meet the Essential Health and Safety Requirements of the Relevant Directives, and therefore the UK Regulations, in so far as the standard addresses such essential requirements.

They therefore provide a relatively easy way for manufacturers to know that their products meet the legal requirements and equally a convenient way for purchasers to specify their needs.

Following the publication of the new Machinery Directive 2006/42/EC in 2006, all the relevant Harmonised Standards have been amended to make reference to it.

The Technical File

The Essential Health and Safety Requirements that apply to the lifting equipment:

- A description of the methods used to eliminate these hazards or reduce risks
- The standards used in the design; information from the user
- Design information (calculations, drawings, procedures, etc.)
- Material traceability; tests reports and instructions for use

Aligned to the requirements of the Machinery Directive, the Supply of Machinery (Safety) Regulations state that lifting equipment must be designed and built to sustain a static overload of:

Manually operated machines:	1.5 x WLL
Other machines:	1.25 x WLL
Lifting accessories:	1.5 x WLL

Machinery must be capable of sustaining a dynamic overload of: -

1.1 x WLL

Previous standards and directives have used different values therefore it is important to always consult manufacturers documentation for specific requirements.

Lifting machines must also be supplied with instructions for:-

- Care and safe use
- Installation, commissioning and testing
- Maintenance and adjustments
- Limitations of use and possible misuse
- Noise and vibration emissions
- Training

PUWER and LOLER Regulations

Provision and Use of Work Equipment Regulations 1998 (PUWER)

- Applies to all work equipment

Lifting Operations and Lifting Equipment Regulations 1998 (LOLER)

- Applies to lifting equipment in addition to PUWER

Both PUWER and LOLER apply to all sectors of industry.

Status of PUWER and LOLER

United Kingdom: legal requirement.

International: good practice demanded by customers and local authorities, integral to the LEEA code of practice.

Notes:

The Essentials of PUWER

PUWER places duties on the employer to ensure that:

- It is the duty of the employer to ensure that work equipment coming into his undertaking meets with any EHSRs and in the case of lifting equipment this would be of directive 2006/42/EC
- Work equipment is suitable for the purpose for which it is to be used
- The working conditions and risk to health and safety of personnel in which the work equipment is used is to be considered
- Equipment is suitably maintained and a log kept up to date
- Equipment is inspected on a regular basis (refer to LOLER)
- All inspection and maintenance records are kept and recorded
- All persons using work equipment have sufficient information pertaining to its use, e.g. operating manuals and guides to safe use

PUWER requires employer to address risks or hazards of equipment from all dates of manufacture and supply.

Equipment first provided for use after 31st December 1992 must comply with any 'essential requirements'

Equipment may still present a hazard or risk if:

- Application different from that originally envisaged
- Safety depends upon the way it is installed
- Technical mismatch between the supply side and user side legislation

Employers can ensure compliance by checking:

- CE Marking
- EC Declaration of Conformity

PUWER requires that, when providing equipment for use at work the purchaser obtains equipment complying with the relevant European Directives. e.g. In the case of offshore containers requesting the Certificate of Conformity which shows compliance with BS EN 12079 will ensure that the offshore containers meet this requirement.

Notes:

Provision and Use of Work Equipment Regulations (PUWER)

Regulation 4	**Suitability of Work Equipment**
Regulation 5	**Maintenance**
Regulation 6	**Inspection**
Regulation 7	**Specific Risks**
Regulation 8	**Information and Instructions**
Regulation 9	**Training**

Summary of the Key Requirements of PUWER

PUWER requires employer to address risks or hazards of equipment from all dates of manufacture and supply.

Equipment first provided for use after 31st December 1992 must comply with any 'essential requirements'.

Equipment may still present a hazard or risk if:

- Application different from that originally envisaged
- Safety depends upon the way it is installed
- Technical mismatch between the supply side and user side legislation

How does an employer check that equipment he has purchased complies with the requirements of PUWER?

- Locate the CE marking
- Obtain the EC declaration of conformity from the supplier

Notes:

Lifting Operations and Lifting Equipment (LOLER)

Regulation 4 **Strength and Stability**

Regulation 5 **Lifting Equipment for Lifting Persons**

Regulation 6 **Positioning and Installation**

Regulation 7 **Marking of Lifting Equipment**

Regulation 8 **Organisation of Lifting Operations**

Regulation 9 **Thorough Examination and Inspection**

Regulation 10 **Reports and Defects**

Regulation 11 **Keeping of Information**

Regulation 4 **Strength and Stability**

Requires the employer to ensure that the load they are planning to lift does not exceed the limits for strength and stability of the lifting equipment.

Regulation 5 **Lifting Equipment for Lifting Persons**

Details the additional safeguards that must be considered when using lifting equipment to lift people.

Regulation 6 **Positioning and Installation**

Details the considerations on where lifting equipment, both fixed and mobile equipment, should be sited.

Regulation 7 **Marking of Lifting Equipment**

Requires all lifting equipment to be marked with its SWL and information that gives the items characteristics, e.g. grade, angle of use etc.

Regulation 8 **Organisation of Lifting Operations**

Clarifies that each lifting operation needs to be planned, supervised and carried out safely.

Notes:

Regulation 9 Thorough Examination and Inspection

Before lifting equipment is put into service for the first time it is thoroughly examined for any defect unless the lifting equipment:

- Is less than 12 months' old
- Owner holds the original DOC
- Equipment that has not been used before will require thorough examination when entering service if the DOC is older than 12 months. Equipment can be damaged during long periods within the supply chain

Maximum fixed periods for thorough examinations and inspection of lifting equipment as stated in regulation 9 of LOLER are: -

- Lifting Accessories 6 months
- Lifting Equipment 12 months
- People Carrying Equipment 6 months

Or in accordance with a written scheme of examination.

Or each time that exceptional circumstances which are liable to jeopardise the safety of the lifting equipment have occurred.

The information to be contained in the report of thorough examination is given in schedule 1 of LOLER.

Minimum Requirements for a Report of Thorough Examination – Schedule 1 of LOLER

- The name and address of the employer for whom the thorough examination was made
- The address of the premises at which the thorough examination was made
- Particulars sufficient to identify the equipment including where known its date of manufacture
- The date of the last thorough examination
- The safe working load of the lifting equipment or (where its safe working load depends on the configuration of the lifting equipment) it's safe working load for the last configuration in which it was thoroughly examined
- In relation to the first thorough examination of lifting equipment after installation or after assembly at a new site or in a new location:
    - That it is such thorough examination;
    - (If such be the case) that it has been installed correctly and would be safe to operate
- In relation to a thorough examination of lifting equipment other than a thorough examination to which paragraph 6 relates –

- Whether it is a thorough examination:
    - Within an interval of 6 months under regulation 9(3)(a)(i)
    - Within an interval of 12 months under regulation 9(3)(a)(ii)
    - In accordance with an examination scheme under regulation 9(3)(a)(iii)
    - After the occurrence of exceptional circumstances under regulation 9(3)(a)(iv)

- (If such be the case) that the lifting equipment would be safe to operate

- In relation to every thorough examination of lifting equipment:
    - identification of any part found to have a defect which is or could become a danger to persons, and a description of the defect
    - particulars of any repair, renewal or alteration required to remedy a defect found to be a danger to persons

- In the case of a defect which is not yet but could become a danger to persons -
    - The time by which it could become such a danger
    - Particulars of any repair, renewal or alteration required to remedy it

- The latest date by which the next thorough examination must be carried out

- Where the thorough examination included testing, particulars of any test

- The date of the thorough examination

- The name, address and qualifications of the person making the report; that he/she is self-employed or, if employed, the name and address of his employer

- The name and address of a person signing or authenticating the report on behalf of its author

- The date of the report

Model report of thorough examinations are available for LEEA members on the LEEA website.

Written Schemes of Examination

The Lifting Operations and Lifting Equipment Regulations 1998 permits a scheme of examination, drawn up by a competent person, as an alternative to the fixed maximum periods.

The benefit of an examination scheme is that, by focusing on the most safety critical areas, the examinations can be carried out the most cost effective way. This may provide a means of reducing examination costs, however, it may also provide a means of enhancing safety without increasing costs.

Notes:

Information for Written Schemes of Examination

The written scheme of examination should contain at least the following information:

- The name and address of the owner of the lifting equipment
- The name and contact details of the person responsible for the equipment. If responsibility is divided, e.g. between maintenance and operations, there may be more than one name, however it should be clear who should be notified in the event of a dangerous or potentially dangerous defect and to whom reports should be sent
- The name, qualifications and address of the person drawing up the scheme. If the competent person is not working on their own account, the name of their employing organisation and their position in that organisation should be given
- The identity of the equipment, i.e. a description including the make, model and unique identity number
- The location of the equipment if it is a fixed installation or the location where it is based for portable and mobile equipment
- Details of any information or references used in drawing up the scheme. For example, the manufacturer's manual, expected component life, or specific information on the design life of the crane structure and mechanisms as detailed in clause 7 of ISO 12482-1
- The basis for the scheme. For example, is it based on hours of service, duty monitoring, examining certain parts or components at different intervals to other parts?
- Details of any data logging system fitted, including a list of the parameters monitored and the means of data retrieval, monitoring and storage
- What determines when the thorough examination shall take place and who is responsible for monitoring that and instigating the examination?
- Identification of the safety critical parts requiring thorough examination
- A risk assessment should take account of:
    - The condition of the equipment
    - The environment in which it is to be used
    - The number and nature of lifting operations and the loads lifted
    - The details of any assumptions about usage, expected component life

  Etc.
- The frequency of thorough examination of those parts identified as safety critical taking into account the degree of risk associated with each part. This may include time or loading or duty cycle limits and vary for different parts of the equipment. Where the scheme is based on such criteria, we recommend that a maximum period between thorough examinations is always specified as equipment can deteriorate whether used or not

- The method of examination of those safety critical parts, which may include the degree of dismantling required and the techniques employed e.g. visual examination, measurement, NDT, operational test, load test

- The rejection criteria or a reference to where this information may be found

- An indication of the resources required to prepare the equipment and carry out the thorough examination. This may include qualified personnel, workshop facilities, specialist NDT and metallurgical facilities

- Any changes to equipment condition, operational or environmental parameters that will require a review of the scheme by the competent person. These may include damage to the equipment, change of use from general duty to heavy duty or moving from an inland location to a marine environment

- A requirement for the person responsible for the equipment to monitor its circumstances of use and inform the competent person who drafted the scheme of any changes

- The date of drawing up the scheme and the date at which any routine review is required

Further information on written schemes of examination can be found in the LEEA COPSULE Edition 8 Appendix 1.8.

Lifting Operations and Lifting Equipment Regulations (LOLER)

Regulation 10 Reports and Defects

- A person making a thorough examination for an employer under regulation 9 shall:
    - Notify the employer forthwith of any defect in the lifting equipment which in his opinion is or could become a danger to persons
    - As soon as is practicable make a report of the thorough examination in writing authenticated by him/her or on his/her behalf by signature or equally secure means and containing the information specified in schedule 1 to the employer; and where there is in his opinion a defect in the lifting equipment involving an existing or imminent risk of serious personal injury, send a copy of the report as soon as is practicable to the relevant enforcing authority

Where there is in his opinion a defect in the lifting equipment involving an existing or imminent risk of serious personal injury, the Competent Person will send a copy of the report as soon as is possible to the relevant enforcing authority. In this case, an employer who has been notified of an imminent risk shall ensure that the lifting equipment is not used before the defect is rectified.

Notes:

Regulation 11 Keeping of Information

An employer obtaining lifting equipment shall:

- Keep the EC Declaration of Conformity for so long as they operate the lifting equipment
- Ensure that the information contained in every report is kept available for inspection

In the case of a thorough examination for lifting equipment:

- Until he ceases to use the lifting equipment

In the case of a thorough examination for lifting accessories:

- For two years after the report is made

LOLER and the Tester/Examiner

LOLER refers to 'Thorough Examination and Inspection' of which a test may be part.

A report of thorough examination to include details of any tests carried out.

The duties of the Competent Person include ensuring that:

- Lifting equipment has been thoroughly examined before it enters service
- Second-hand, hired or borrowed equipment has a current examination report before it is used

And, where safety of equipment depends upon installation:

  - That it has a thorough examination after it has been installed
  - That it has a thorough Examination after it has been assembled

Manual Handling Operations Regulations 1992

- Refers directly to lifting operations and adds to the employer's duties in section 2 of the HSWA

- Requires an assessment to be made of any operation where loads are handled manually, or where manual effort is necessary, with a view to reducing the number of injuries that result from such operations:

  - Task
  - Individual
  - Load
  - Environment

- Requires the introduction of lifting appliances where the risks are high or if the operation can be made safer by their introduction

Working at Height

The danger of people and materials falling affects not only those working at height, but also sometimes to a greater degree, those underneath.

Working at height is one of the biggest causes of fatalities and major injuries. Commonly, accidents are caused from falls from ladders and through fragile surfaces. Work at height means work in any place where, if there were no precautions in place, a person could fall a distance that could cause personal injury (for example a fall through a fragile roof).

Employers and those in control of work at height must first assess the risks.

Before working at height you must follow these simple steps:

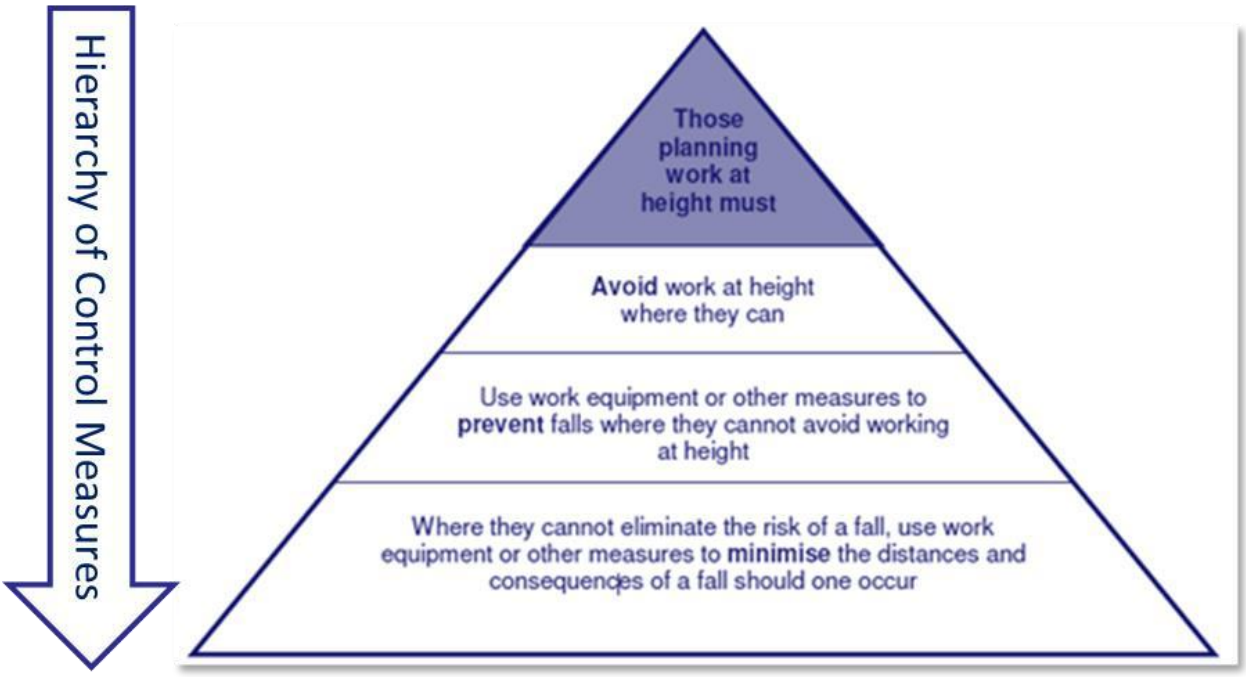
- Avoid work at height where it is reasonably practicable to do so
- Where work at height cannot be easily avoided, prevent falls using either an existing place of work that is already safe or the right type of equipment
- Minimise the distance and consequences of a fall, by using the right type of equipment where the risk cannot be eliminated

Working at Height Regulations (UK)

The work at height regulations 2005 have an influence on lifting practice.

They emphasise the need to **avoid working at height if possible** but, where it is necessary, they require the most suitable means of reducing and controlling the risk.

Consequently, this has affected the choice of equipment for some lifting operations.



Dos and Do Nots of Working at Height

Do:

- As much work as possible from the ground
- Ensure workers can get safely to and from where they work at height
- Ensure equipment is suitable, stable and strong enough for the job, maintained and checked regularly
- Take precautions when working on or near fragile surfaces
- Provide protection from falling objects
- Consider emergency evacuation and rescue procedures

Do not:

- Overload ladders; consider the equipment or materials workers are carrying before working at height. Check the pictogram or label on the ladder for information
- Overreach on ladders or stepladders
- Rest a ladder against weak upper surfaces, e.g. glazing or plastic gutters
- Use ladders or stepladders for strenuous or heavy tasks, only use them for light work of short duration (a maximum of 30 minutes at a time)
- Let anyone who is not competent (who doesn't have the skills, knowledge and experience to do the job) to work at height

Working at Height – A Brief Guide

For more information on this, please read the HSE document: "Working at Height – A Brief Guide", available at www.hse.gov.uk

Electricity at Work Regulations

The Electricity at Work Regulations apply to almost all places of work. The Regulations were enacted to impose duties to limit the risks involved with using electricity at work.
The following people are subject to the Regulations:

- Employers and the Self-Employed
- Employees

The duties under the Regulations are not just in relation to employers but also place a duty on employees in the following circumstances:

- To co-operate with his employer so far as is necessary to enable any duty placed on that employer by the provisions of these Regulations to be complied with
- To comply with the provisions of these Regulations in so far as they relate to matters which are within his control
- Many employees in the electrical trades and professions for example have responsibilities which are part of the duties of their employment of safety in relation to the installation of electrical equipment and systems

The definition of electrical equipment provided by the regulations includes anything used, intended to be used or installed for use, to generate, provide, transmit, transform, rectify, convert, conduct, distribute, control, store, measure or use electrical energy.

For further information, please read the HSE documents: “The Electricity at Work Regulations 1989 – Guidance on Regulations” and “Electricity at Work – Safe Working Practices” available at www.hse.gov.uk

The Electromagnetic Compatibility Directive

In order to facilitate a single European market for goods some 20 years ago the European Union began what is described as the 'New Approach'. A number of Directives were adopted with the aim of setting objectives for the harmonisation of technical rules, primarily but not exclusively, affecting the health and safety of new products by design and construction.

The principal aim of the 'New Approach' was to remove barriers to trade by requiring all products to meet common minimum health and safety objectives, which would be supported by agreed standards at the product level.

The Electromagnetic Compatibility Directive 2004/108/EC (EMC) will apply to equipment with an electrical aspect, primarily to prevent interference with other electrical equipment and its own immunity from such disturbance.

The Electromagnetic Compatibility Regulations

The EMC Directive is implemented in the UK by the Electromagnetic Compatibility Regulations which apply to electrical and electronic equipment liable to cause or be affected by electromagnetic disturbance.

The aim of the regulations is to ensure that electromagnetic disturbance generated by electrical or electronic equipment doesn’t reach levels which would prevent radio, telecommunications and other equipment from working properly. They also exist to ensure that such equipment itself has adequate immunity from electromagnetic disturbance.

The rules don’t deal with safety-related matters.

Whilst this is not a matter for the tester and examiner of lifting equipment, we should note that when the manufacturer affixes the CE mark to an item it implies that all the necessary directives have been complied with.

The EC Declaration of Conformity for electrically operated lifting equipment should therefore refer to both the **Machinery Directive** and the **Electromagnetic Compatibility Directive**.

Notes:

Revoked, Repealed and Amended Legislation

Prior to 5 December 1998, the Factories Act 1961 was the main legislation concerned with the use of lifting equipment and it was augmented several sets of industry specific regulations. The Provision and Use of Work Equipment Regulations 1998 and the Lifting Operations and Lifting Equipment Regulations 1998 together repeal, revoke or amend and replace the requirements for lifting equipment given in the following:

- The Factories Act 1961
- The Construction (Lifting Operations) Regulations 1961
- The Shipbuilding and Ship-repairing Regulations 1960
- The Docks Regulations 1988
- The Mines and Quarries Act 1954
- The Offshore Installations (Operational Safety, Health and Welfare) Regulations 1976
- The Lifting Plant and Equipment (Records of Test and Examination etc.) Regulations 1992

LEEA COPSULE – Methods of Operation

Whilst the LEEA COPSULE does not include operation of powered equipment, users should be reminded of the need for power systems to be installed, maintained and examined in accordance with the relevant regulations, e.g. The Electricity at Work Regulations, The Pressure Systems Safety Regulations etc., and their need to meet any obligations these regulations impose.

Power operated equipment has the advantages of quicker operation than with manually operated equipment, often operatives can be remote from the load and heavier loads can be handled conveniently without operative fatigue.

In summary, where no power source is available, light loads are to be lifted, infrequent operation is called for or precision placement of the load is required, manual operation may be considered. Where heavy loads are to be lifted, frequent operation is called for or a more rapid operation is necessary power operation should be considered.

Notes:

2. Lifting Media – Chain

Fine Tolerance – Short Link Chain

- **BS EN 818 – 7**, covers short link chain for lifting purposes — Safety — Part 7: This is fine tolerance chain used in hoists where precise dimensions are required to engage with the load wheel (as shown in the illustration below)
- Fine tolerance grades are: **(Types T, DAT and DT)**, from 4mm to 22mm diameter
- **ISO 3077** - Short-link chain for lifting purposes, - Grade T, (types T, DAT and DT), fine – tolerance hoist chain. This is the ISO alternative to BS EN 818-7

Chain Finishes

Fine tolerance chain can be recognised primarily by the Grade mark.

- Type DAT and type DT hoist chains possess a surface hardness greater than core hardness and are used for power driven chain hoists to offer greater resistance to wear
- Type DT hoist chain differs from DAT hoist chain in having higher surface hardness and/or greater case depth to optimise wear resistance

Fine Tolerance – Short Link Chain

- The chain is made to precise dimensions in order that it engages freely, and without jamming into pocketed load wheels
- The application of a tensile force at the final stages of manufacture (pulled to precise pitch) has the effect of work hardening the chain
- Fine tolerance chain is less ductile than chain used for general sling manufacture (medium tolerance)
- Fine Tolerance chain has better wear characteristics

Load chains must:

- Be strong
- Be reasonably resistant to corrosion
- Have good resistance to wear

These properties are partially achieved by material selection.

Further improved by case hardening and/or plated with corrosion resistant finishes at the time of manufacture

Fine Tolerance Chain

Guidance on the applications for which the different types of Grade T hoist chain shall be used is as follows:

- **Type T manually operated hoists,** or **power operated hoists with slow speeds,** where the working environment does not involve abrasive conditions
- **Type DAT power driven hoists** where **chain speeds are high** in combination with high working capacity and where wear resistance is required to give longer chain life
- **Type DT** power driven hoists used in **abrasive conditions**

Note: Case hardened chains are not suitable in portable manually operated hoists.

WLL Comparison of Chain Grades

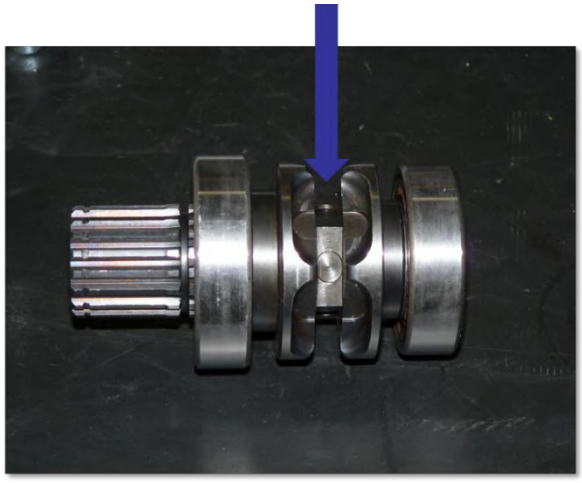
Nominal size d_n mm	Chain type T t	Chain type DAT t	Chain type DT t
4	0,5	0,4	0,25
5	0,8	0,63	0,4
6	1,1	0,9	0,56
7	1,5	1,2	0,75
8	2	1,6	1
9	2,5	2	1,25
10	3,2	2,5	1,6
11	3,8	3,	1,9
12	4,5	3,6	2,2
13	5,3	4,2	2,6
14	6	5	3
16	8	6,3	4
18	10	8	5
20	12,5	10	6,3
22	15	12,5	7,5
mean stress N/mm^2	200[1)]	160	100

[1)] Only for hand operated hoists. For power driven hoists: see annex B, Table B.1.

Fine Tolerance Chain

Dimensional incompatibility between the hoist chain and mating parts of the hoist (chain wheel, chain guide and loading device) may lead to premature failure of the chain.

BS EN 818-7 contains dimensional requirements for correct assembly and fit.



Key Points

- **Correct alignment** with the load wheel
  - Use of suitable chain guide
  - Hoist not to be used if direct entry to load wheel is prevented, **or:**
  - Where the chain is twisted

- Chain must be under tension to engage the load wheel correctly
  - A few links of load chain will be sufficient

- Chain **should not be corroded or covered in dirt** or **debris**

- **Chain stripper fitted** to ensure disengagement of slack load chain from the load wheel

- **Adequate** and **appropriate lubrication**
  - Lubricants should be able to withstand high bearing pressures
  - Colloidal graphite used in adverse working conditions such as foundries, **or:**
  - Where lubricant may contaminate (e.g., food or pharmaceutical industries)
  - Must be acid free

- Chain collector box or bag usually fitted
  - Adequate size and alignment
  - Provide a means of drainage
  - Slack chain should never pile too high in the bag/box – this will remove the tension from the slack end of the load chain
  - Could result in a twisted link entering the load wheel and cause disastrous consequences

- Load chain must always hang in a straight line
  - No twists
  - Load hooks fitted with a swivel to prevent live side of chain from twisting

- Load chains are never to be back hooked or choked
  - Separate sling attachments

Frequent Inspection

In addition to the requirements for statutory periodic examinations, hoist manufacturers will issue instructions for user inspections. The type and frequency of inspections depends basically on the working conditions of the hoist. General classifications are given for these inspections as ‘frequent' and ‘periodic'.

Frequent inspections are visual inspections carried out by the operator or other designated person, with or without a record being made, to determine if damage or deterioration has occurred in service.

The following inspection intervals are recommended when carrying out frequent inspections and are in addition to a daily pre-use check which should be made by the operator:

- Light service - every month
- Moderate service - every 2 weeks
- Heavy service - every week
- Very heavy service - every day

Periodic Inspection

Periodic inspections are more thorough inspections by appointed persons making records of the external conditions to provide a basis for a continuing evaluation. The following periodic inspection intervals are recommended:

- Light service - yearly
- Moderate service - six monthly
- Heavy service - quarterly
- Very heavy service - every six weeks

If at any of these user inspections external conditions indicate it necessary, the machine should be referred to a Competent Person for thorough examination.

Thorough Examination

Thorough examinations are made by a Competent Person, i.e. the tester and examiner. They are usually associated with statutory requirements calling for records to be made and certificates or reports issued which permit the hoist to enter or remain in service. This is far more thorough than the user inspection and will usually include disassembly of parts to permit detailed examination. Each of the regulations lays down a maximum time period between such examinations.

When carrying out thorough examinations the chain should be examined throughout its length to detect any evidence of wear, distortion or external damage. The block should then be operated under 'no load' and 'load' conditions in both directions to check for the smooth functioning of the chain and wheels. If the chain jumps, binds or is noisy after cleaning and lubrication then a more detailed examination must take place.

Competent Person – Thorough Examination

- Preparation for examination
    - Chains should be cleaned (no strong alkalis or acids as it could lead to hydrogen embrittlement)

- **Visually examine** chain throughout entire length, link by link

- **Operate hoist** under no-load and loaded conditions
    - Check for directional smoothness
    - Look for chain jumping in the pocket wheel
    - Listen for binding and noisy operation
    - If minor faults are not corrected by cleaning and lubrication, a detailed examination is necessary

- Link by link examination in adequate light. Check for NCCG, wear, elongation and other damage including build-up of debris
    - Wear and elongation to be measured in accordance with original equipment manufacturer (OEM) instructions

Stretch and Elongation

A common misunderstanding is that stretch in a load chain is the same as elongation. This is incorrect. Stretch in a load chain is not permitted as this is actually the chain having exceeded its elastic limit and now will have permanent set (it is now in the plastic deformation stage) and this should be withdrawn from service. Elongation is wear that has occurred due to articulation of the interlinking chain links at the intrados of the connection point.

Manufacturers may have different instructions for measurement and the acceptance/rejection criteria may vary.

Where there are no OEM instructions:

- 2% increase in length (due to wear) over a minimum length of 5 links should be used as a rejection value

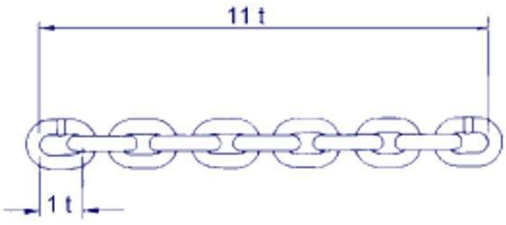
Note: This is less than 5% which is used for chain slings. This is because the load chain in a machine has to mate with the load wheel and therefore elongation would cause a poor fit and dangerous consequences.

Some hoist manufacturers issue a gauge for checking of elongation.

The example below is taken from a manufacturers maintenance manual and is typical for most brands of hoists:

Checking stretch

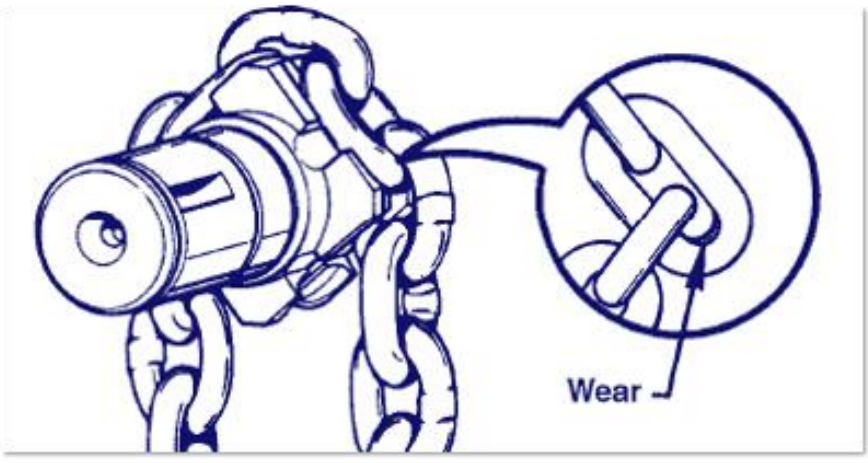
1. Using a Vernier gauge or similar, take measurements over eleven links at various points along the length of chain. Ensure the chain is within tolerance



1t = LENGTH OF ONE CHAIN PITCH
11t = DIMENSIONS TO BE MEASURED

Chain size	Length of 11 links (mm)	
	Nominal	Maximum
5x15	165	168
6x18	198	201
8 x 24	264	269

Chain Elongation due to Wear



Rejection Criteria

Load chains should be **rejected** if any of the following conditions are observed:

- Cracks
- Nicks or gouges
- Visible distortion
- Severe corrosion
- Deposits which cannot be removed
- Increase in length which exceeds the OEM recommendations or 2% over 5 links

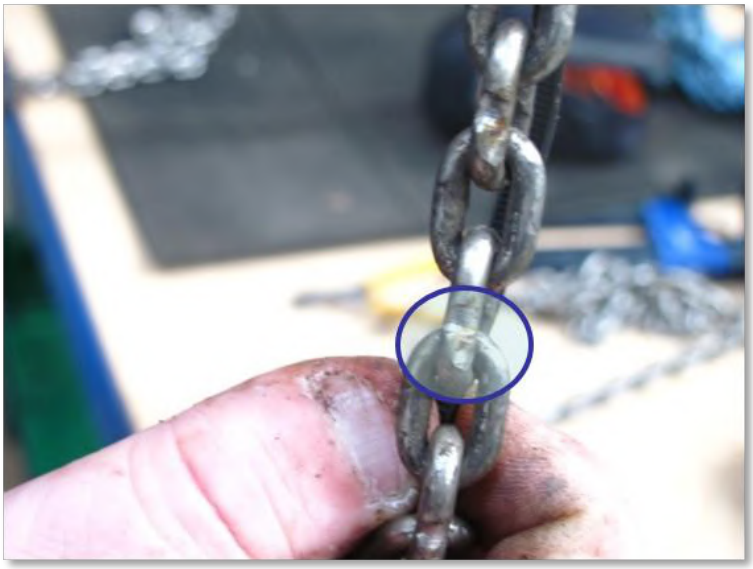
Wear

In the case of wear, rapid wear can lead to sudden failure of the chain. This is shown as a rough appearance of the mating surfaces. Such chains should be replaced even if they are within the original equipment manufacturers wear limits.

Chain Replacement

Calibrated chain for powered lifting hoists varies in dimensions, particularly pitch, for different manufacturers. For this reason, it is important that only chain specified by the hoist manufacturer should be used for replacement. Each manufacturer provides details on the best methods of chain replacement for their particular units and it is recommended that these be closely followed.

When replacing worn chain with new chain it is advisable to also replace the pocketed wheel(s) as the pockets will have worn with the chain.



Manufacturer's Certificate

The certificate of test and examination shall give at least the following information:

- The name and address of the manufacturer or his authorised representative, including date of issue of the certificate and authentication
- Number and parts of BS EN 818
- Quantity and description of the chain of which the test sample is representative
- Identification of the chain of which the test sample is representative
- Nominal size of chain in millimetres
- Manufacturing proof force in kilonewtons
- Breaking force, in kilonewtons (confirmation of whether this was met or exceeded)
- Total ultimate elongation at fracture, as a percentage (i.e. confirmation that the specified minimum total ultimate elongation has been met or exceeded)

3. Lifting Media – Wire Rope

Wire Rope and Wire Rope Examination

Wire Ropes for lifting Appliances

Wire ropes are generally regarded as an expendable component.

The load rope requires replacement when inspection shows that its condition has deteriorated and further use would not be suitable for safety reasons.

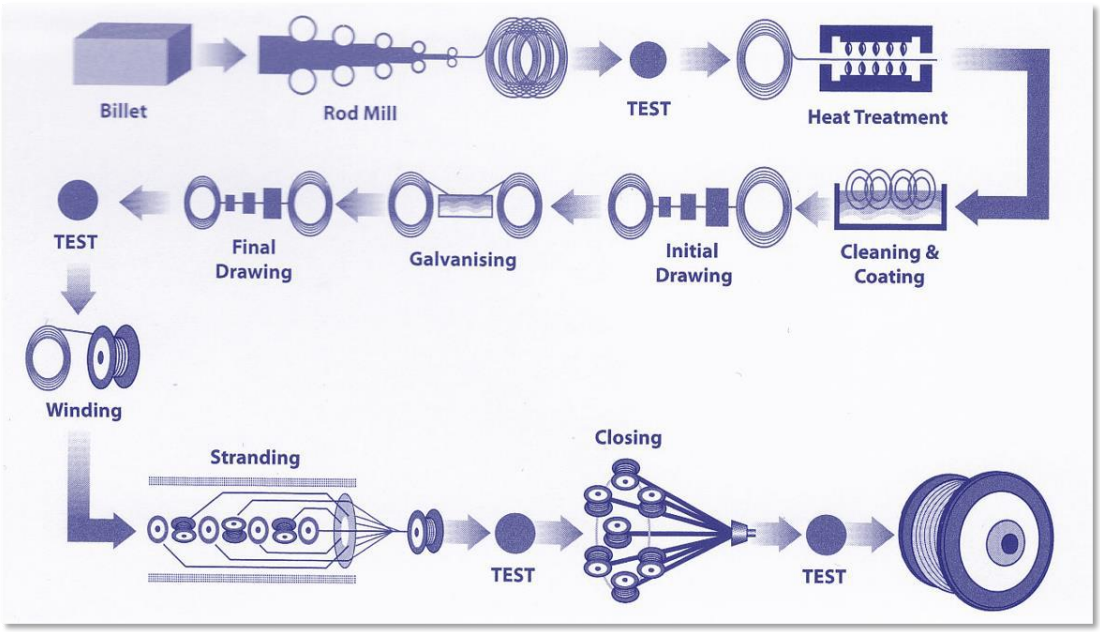
By following well-established principles, such as those detailed in various standards, LEEA COPSULE, and any additional specific instructions provided by the 'original equipment manufacturer' (OEM) of the crane or hoist and/or by the manufacturer of the rope, these criteria should never be exceeded.

When correctly applied, the discard criteria given in full in BS ISO 4309 are aimed at retaining an adequate safety margin.

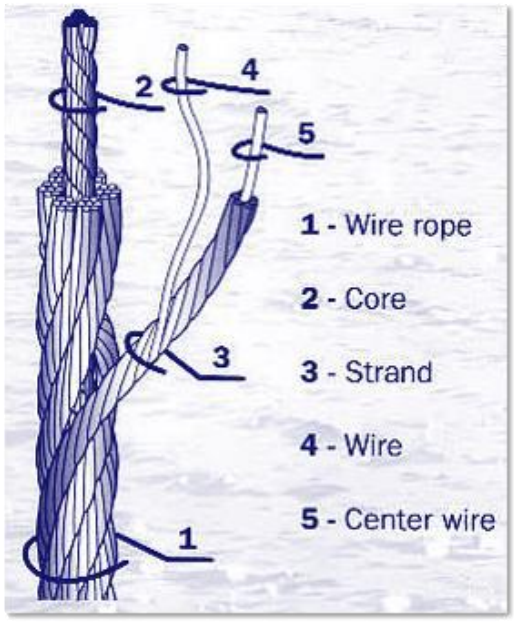
Failure to recognize them can be extremely harmful, dangerous and damaging.

Notes:

How Wire Rope is Made



Elements of a Wire Rope



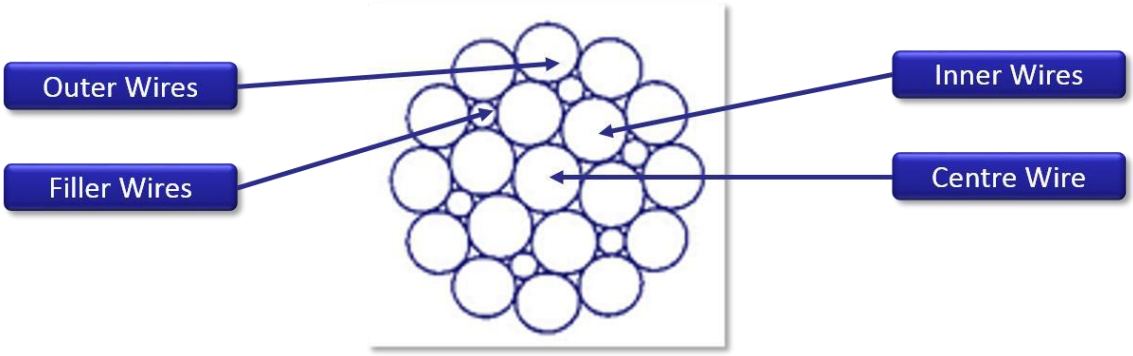
Definitions

Outer wires: all wires positioned in the outer layer of a spiral rope or in the outer layer of wires in the outer strands of a stranded rope.

Inner wires: all wires of intermediate layers positioned between the centre wire and outer layer of wires in a spiral rope or all other wires except centre, filler and outer wires in a stranded rope.

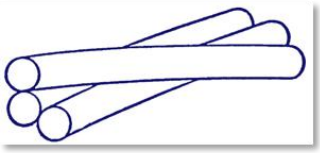
Filler wires: wires used in filler construction to fill up the gaps in between the layers.

Centre wires: wires positioned at the centre of a spiral rope or the centres of strands of a stranded rope.



Strand Construction

A single wire, known as a king wire (centre wire), is taken and then the remainder of the required number of wires are twisted around this to form a strand.



Cross Lay Rope

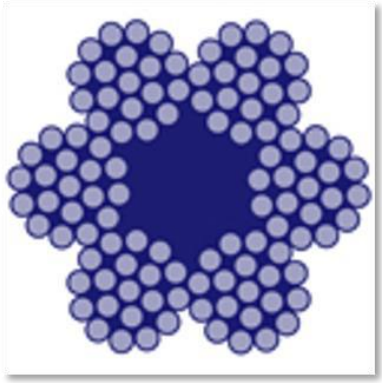
Equal Lay Rope (Parallel)

Wire sizes and the manner in which they are laid up can be adjusted to give varying performance characteristics to the rope for different service duties.

Most common for wire rope for sling manufacture is 6 x 19. However, 6 x 36 is also widely used and other constructions can be employed.

6 x 19 means that there are 6 strands each of 19 wires and 6 x 36 means that there are 6 strands each of 36 wires. Both of these are equal lay ropes.

This illustration shows a wire rope construction made of 6 outer strands with each outer strand made up of 19 wires.

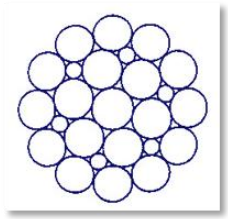


6 x 19 Construction

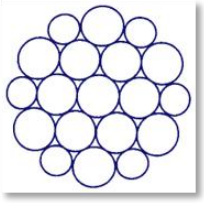
The three basic methods of laying up a **strand: -**

Seale Construction

Filler Construction



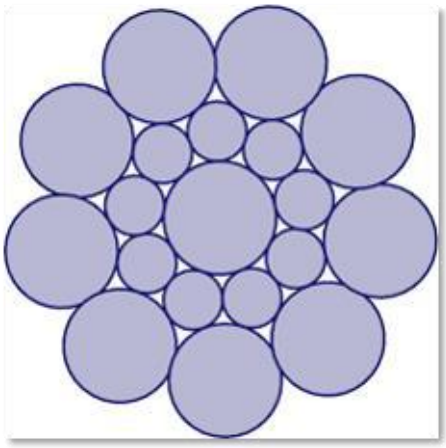
Warrington Construction



Seale Construction

This is a parallel lay strand with the same number of wires in both layers.

In the example shown below, the construction consists of 1 x centre wire, 9 x inner wires and 9 x outer wires:

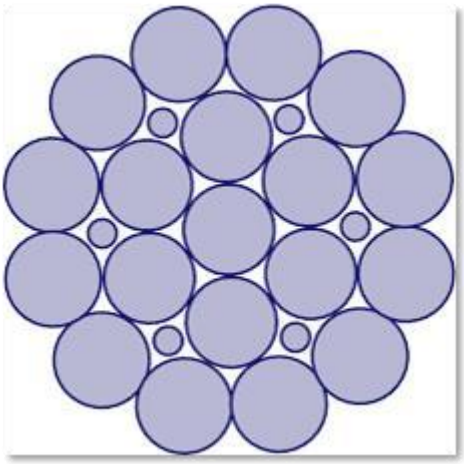


Notes:

Filler Construction

A parallel lay strand having an outer layer containing twice the number of wires than the inner layers with filler wires in the valleys between the layers.

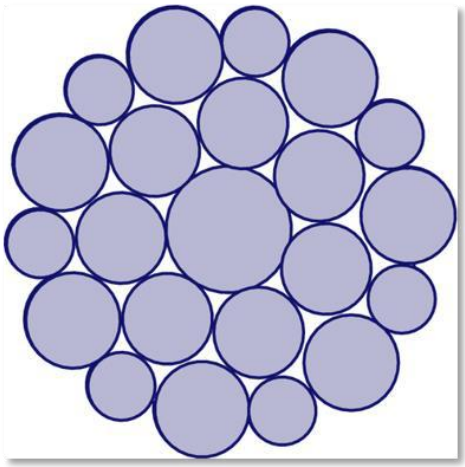
In the example shown below, the construction consists of 1 x centre wire, 6 x inner wires, 6 x filler wires and 12 x outer wires:



Warrington Construction

A parallel lay strand having an outer layer containing alternately large and small wires.

In the example shown below, the construction consists of 1 x centre wire, 7 x inner wires and 14 (7 large and 7 small) x outer wires:

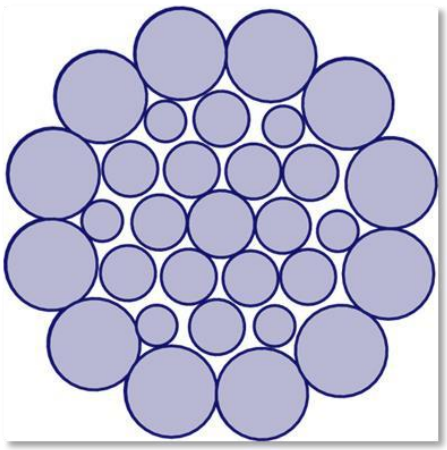


You may have noted that previous images of Warrington construction rope in this module show a 1/6/12 (6 large and 6 small outer wires) however, as long as the geometry of the outer wires remains the same, there may be alternative numbers of wires in a particular rope construction.

Notes:

Warrington Seale (Combined) Construction
A parallel lay strand having three or more layers laid in one operation and formed from a combination of the previous strand types.

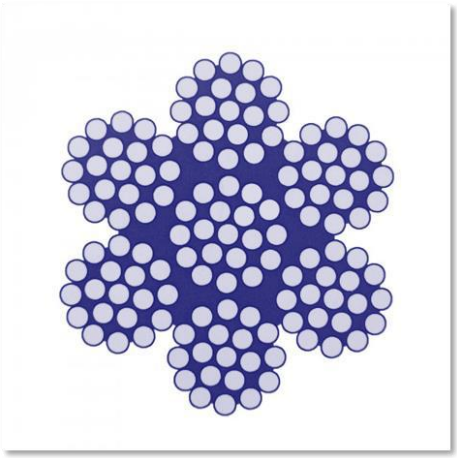
In the example shown below, the Warrington Seale construction consists of 1 x centre wire, 6 x inner wires, 12 Warrington wires and 12 x outer wires:



Types of Wire Rope Core

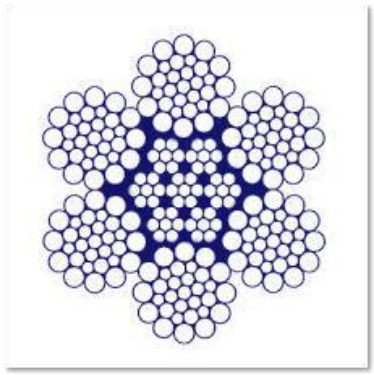
Fibre core (FC)
This type of core is made from either natural fibres or synthetic fibres.

Wire Stranded Core (WSC) This type of core can be either one single wire as the core or more typically the core construction the same as the outer strands.



Independent Wire Rope Core (IWRC)

This type of core is actually made up of a core and strands so is actually a rope that is utilised as the core. (Ropes over 12mm diameter shall have IWRC).



Grades of Wire Rope

Wire Tensile Strength/Grade

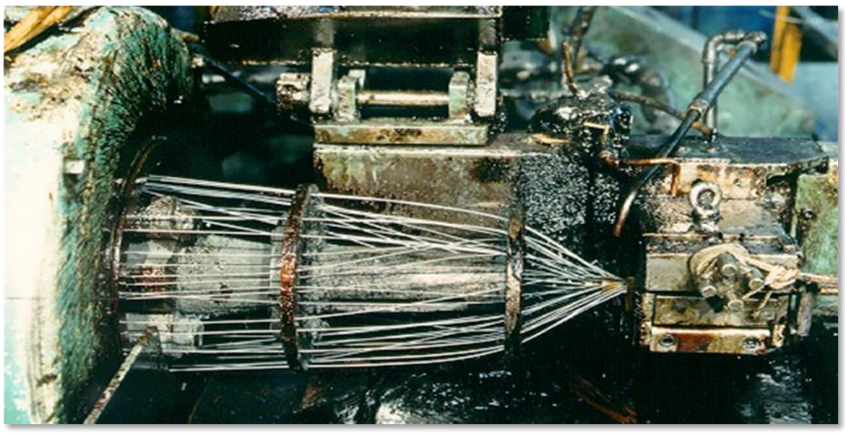
The grade of the wire rope based upon the tensile strength of the wires in N/mm².

Rope Grade	Wire Tensile Strength Grade	
	Minimum	Maximum
1770	1570	1960
1960	1770	2160
2160	1960	2160

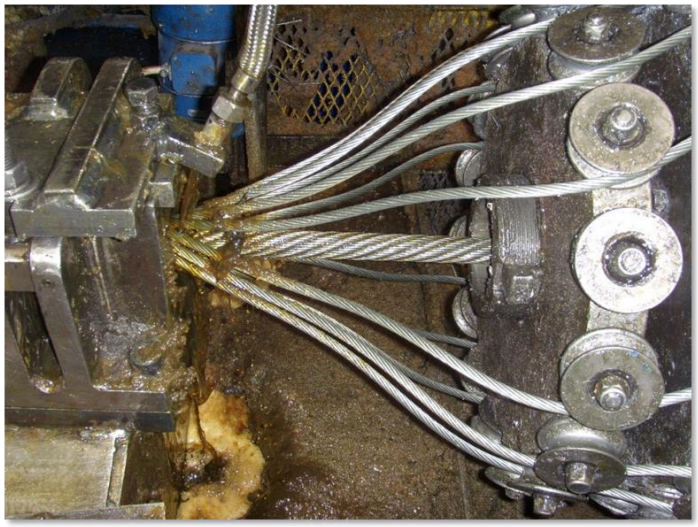
Note: Rope Grade 2160 is not covered by European Standards.

Stranding

The stranding operation takes place when all the wires are brought together at the forming point. Note that the wires during this and the closing operation are spun in to the correct helical shape, this process is called preforming. This reduces the internal stresses in the strands and the rope meaning that if the wires and strands are cut they do not spring out of the rope formation.



Pre-Forming
During this operation, the strands are now brought together at the forming point around the specified core to make the rope.



The individual wires in the strand are bent into the correct helix before being wound into position. The strands are then wound into the correct helix, generally the opposite direction.

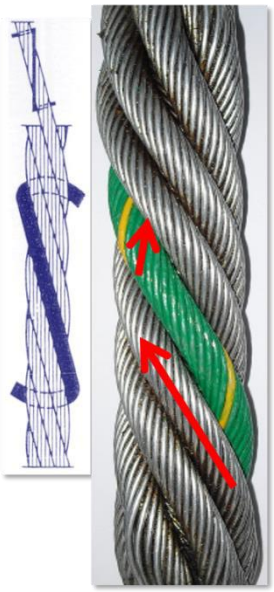
- Results in a relatively inert (dead) rope
- Resistant to kinking
- Easy to handle so when such a rope is cut:
    - Wires will stay in position
    - Broken wires do not stick out
    - Less dangerous to the user
- Rope is more flexible

Rope Lay

Rope lay refers to the way in which the wires are laid when forming the strands and the way in which the strands are laid when forming the rope.

There are 2 types of lay, ordinary (regular) lay and lang's lay:
Ordinary lay: the wires that make up the strand and the strands that make up the rope are laid in opposite directions. When formed, this gives the impression that the wires are running the length of the wire rope.

Lang's lay: the wires that make up the strand are laid in the same direction as the strands in the rope. When formed the wires quite clearly run across the diameter of the rope. Due to the tendency of the rope to unwind, lang's lay ropes are not suitable for wire rope slings.



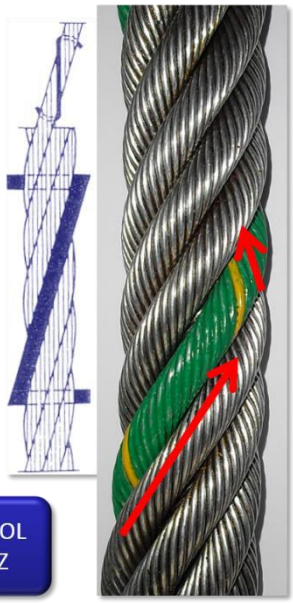
Ordinary Lay

Wires in the strands are laid in the opposite direction of lay to the strands in the rope.

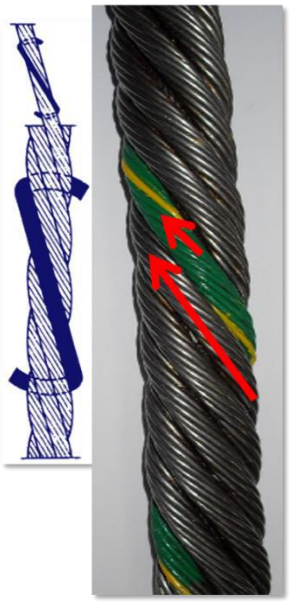
The lower case letter indicates the direction of the wires and the capital letter, the direction of the strands.

Note: Ordinary Lay ropes will be letter designated with different letters.

LHOL
zS



RHOL
sZ



Lang's lay

Wires in the strands are laid in the same direction of lay as the strands in the rope.

Not suitable for the manufacture of wire rope sling legs.

Note: Lang's Lay ropes will be letter designated with the same letters.

LHLL
sS

RHLL
zZ

Lang's Lay

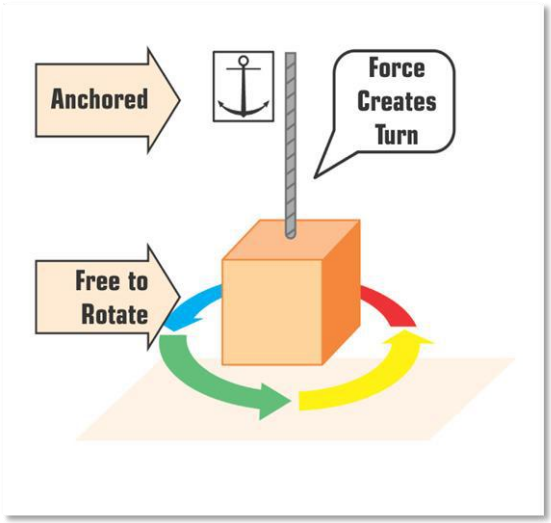
- The advantage of Lang's lay is that this construction offers a much better wearing surface than ordinary lay
- Lang's lay rope is more flexible than one of ordinary lay
- Its disadvantage is that it can only be used in applications where both ends of the rope are secured, such as a lift or multi-fall hoist. If suspended under load with one end free to turn, such as on a single fall powered hoist rope, it will un-lay itself
- Both ordinary lay and lang's lay ropes are usually supplied right-hand lay, but left-hand lay is available for special applications

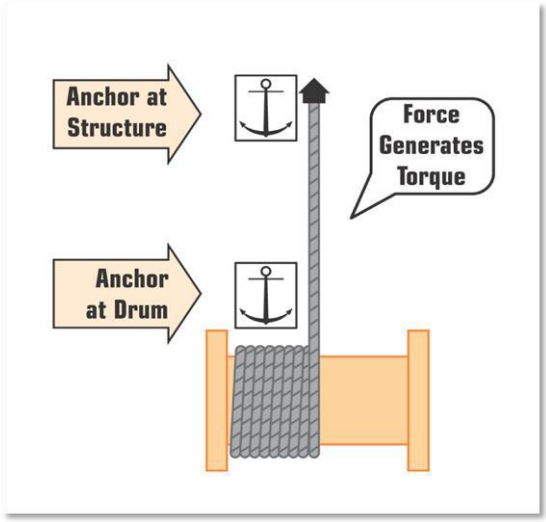
Low-Rotating Rope

Although the six strand rope is the most common, there are many exceptions, and the exception is most likely to be the low-rotating type usually used on cranes or on larger capacity hoists.

All six strand ropes tend to untwist when load is applied to them:

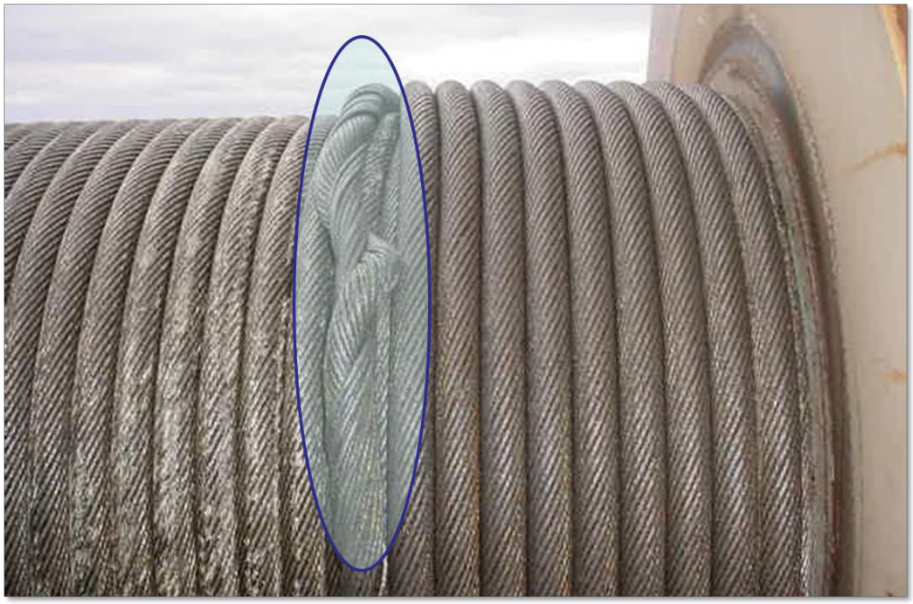
- An undesirable characteristic especially on long multi-fall hoist blocks where it can cause the bottom block to twist
- It may be overcome by using what is known as a multi-strand rope, which has low-rotating qualities by having two or three layers of 7 wire 1-6 strand laid in opposite directions



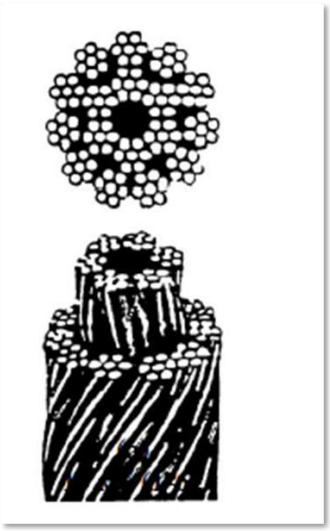


Notes:

Effect of Rope Rotation



Low-Rotating Rope



The most common type is the 17 x 7 (1-6), which has an outer layer of 11 strands laid over an inner layer of 6 strands, which in turn is laid over a core strand.

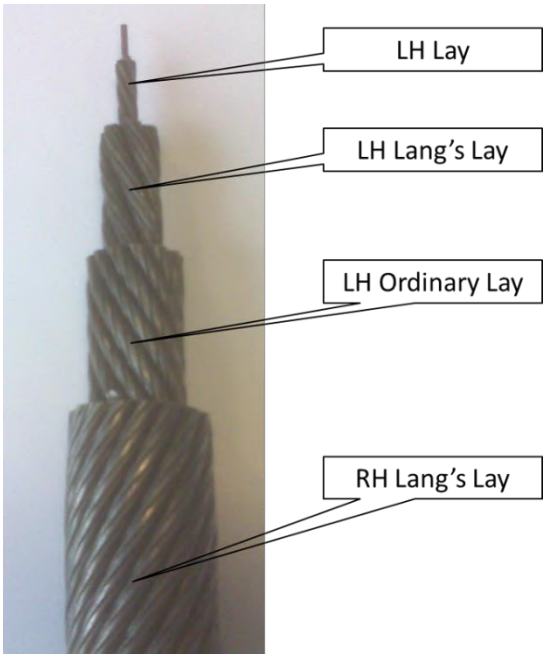
The construction is 11 strands/6 strands/1 strand all 7 wire 1-6.

The layers of strands are laid in opposing directions to prevent the rope from spinning under load.

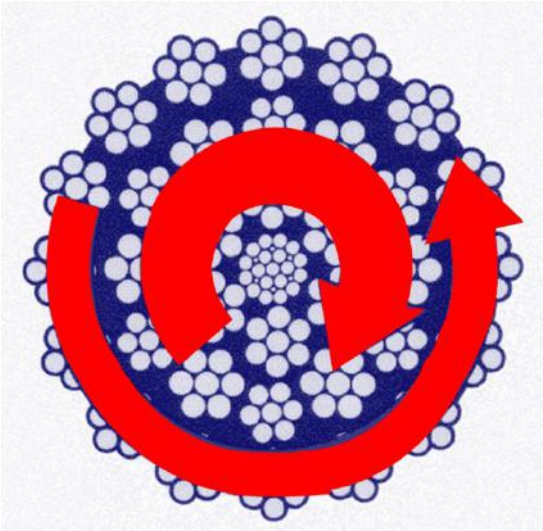
A more flexible version is the 34 x 7 (1-6), which is simply a 17 x 7 with an additional layer of seventeen strands laid around it.

The construction is 17 strands/11 strands/6 strands/1 strand all 7 wire 1-6.

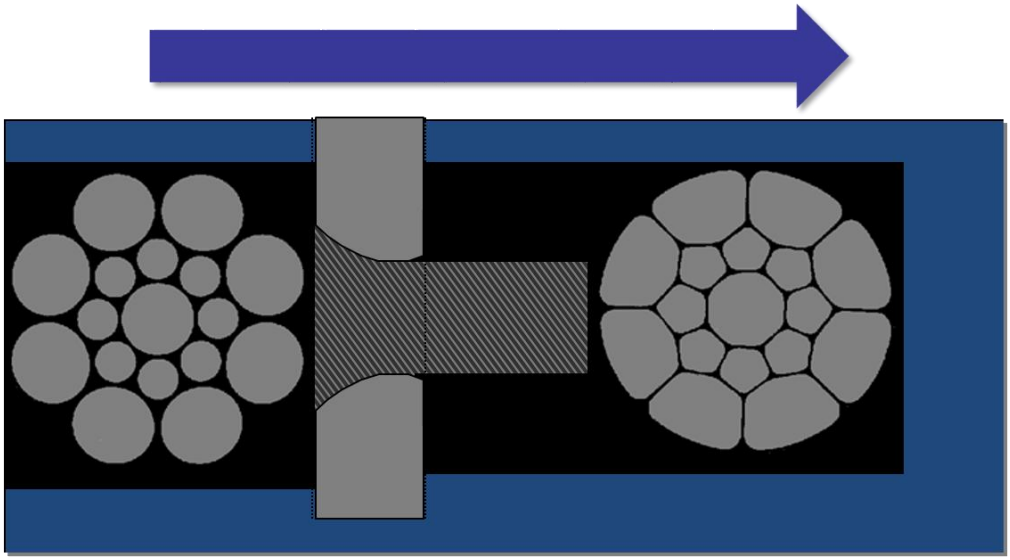
The layers of strands are laid in opposing directions to prevent the rope from spinning under load.



Rotation-Resistant Rope (Illustration is 35LS – Low-Rotating Rope)



Compacted Rope (K Designation)



Benefits of Compacted Rope

Increased steel area:

- Increase in strength
- Crush resistance
- Diameter stability
- Reduced stretch

Smooth surface:

- Increased fatigue life
- Lower contact pressures

Accurate diameter:

- Improved spooling
- Twin rope systems

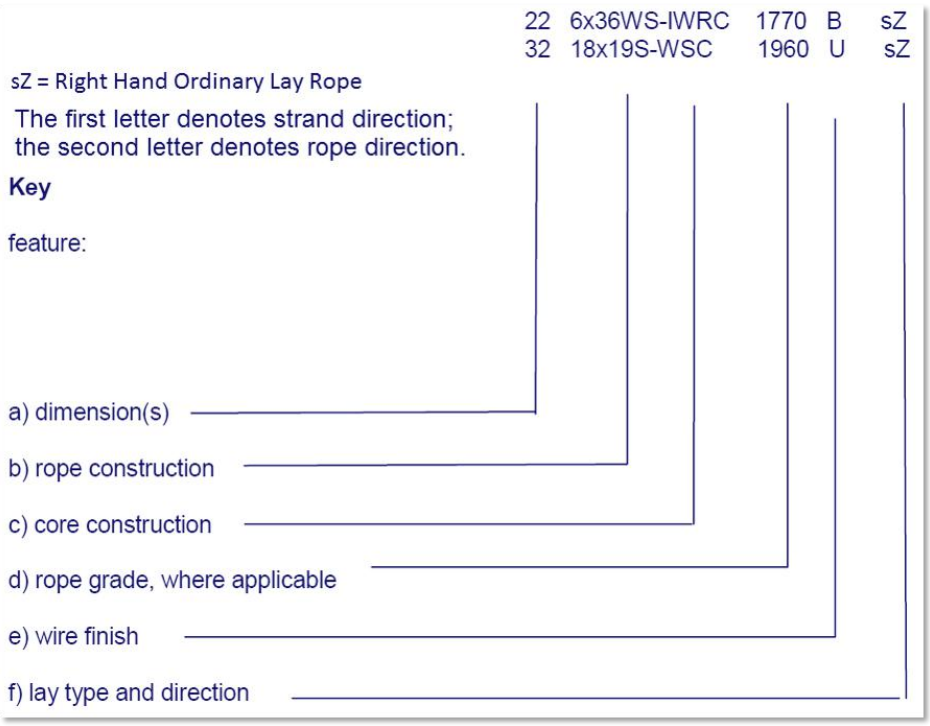
Rope Finish

BS EN 12385 uses the symbol 'U' to denote uncoated or bright finish.

For zinc finishes the symbol will depend on the class of the coated finish, e.g.

- **Class A zinc finish is designated 'A'**
- **Class B Zinc is designated 'B'**

Rope Details and Designation



Safe operation of manual lifting machines incorporating wire rope as the lifting medium depends, to a large extent, upon the level of detailed examination that is applied by the Competent Person during the thorough examination, not with standing that daily operator checks by the user also have a significant bearing on safety of the machine in use.

The Competent Person should firstly refer to instructions provided by the original equipment manufacturer. Local or application specific regulations should always be followed.

Wire Rope Examination

Rope should always be clean; if this is not possible, consider electromagnetic wire rope inspection method, where appropriate.

In the absence of original equipment manufacturer's criteria, BS ISO 4309 (to which BS EN 13157 refers) criteria may be used to determine the serviceability of the load rope fitted to a powered appliance.

BS EN 13411 series of standards should be referred to for terminations in steel wire ropes.

BS ISO 4309:2010 – Modes of Deterioration and Assessment Methods

Mode of Deterioration	Assessment Method
Number of visible broken wires (randomly distributed, localised groups, valley breaks and those that are in the vicinity of a termination point)	By counting
Decrease in rope diameter (resulting from external wear/abrasion, internal wear and core deterioration)	By measurement
Fracture of strand(s)	Visual
Corrosion (external, internal and fretting)	Visual
Deformation	Visual and by measurement (wave only)
Mechanical damage	Visual
Heat damage (including electric arcing)	Visual

BS ISO 4309 – Wire Rope Discard

Discard Criteria (General)

The safe use of wire rope is qualified by the following criteria:

- The nature and number of broken wires
- Broken wires at the termination
- Localised grouping of wire breaks
- The rate of increase of wire breaks
- The fracture of strands
- Reduction of rope diameter, including that resulting from core deterioration
- Decreased elasticity
- External and internal wear
- External and internal corrosion
- Deformation
- Damage due to heat or electric arcing
- Rate of increase of permanent elongation

Wire Rope Examination

The examination of wire ropes should be systematic and follow a logical order so that no part of the rope, or the accessories and attachments to which it connects are missed. In manual machines, particular attention is to be taken at the following locations:

- Rope drum anchorage
- Rope within the area of a termination point
- Sections of rope travelling through sheaves
- Sections of rope travelling through the hook block
- Sections of rope that spool onto the rope drum, especially in areas where the rope crosses over itself in multi-layer drums
- Any section of the rope that can be damaged by abrasion in contact with an external fixture such as a hatch opening
- Any part of the rope that is exposed to heat

Broken Wires

It is usually the number of broken wires developing in a wire rope, which causes its removal from service.

It is essential that the entire length of a wire rope be inspected frequently for broken wire(s), excessive wear, and lack of lubrication, with particular attention being paid to those areas adjacent to terminal fittings and where an accelerated rate of wear or corrosion is to be expected, e.g. where a rope passes around sheaves or pulleys, or is particularly exposed to the elements.

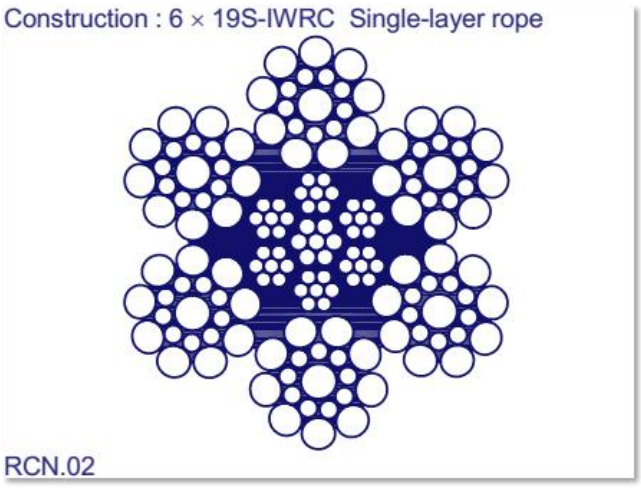
All examinations shall take into account these individual factors, recognising the particular criteria.

BS ISO 4309 details the discard criteria for the allowable amount of broken wires, depending upon the rope category number of the rope (RCN)

Example of BS ISO 4309 Rope Category Number

Before determining the discard criteria for load ropes under BS ISO 4309, it is necessary to identify the RCN of the rope.

By way of example, we are going to look at an RCN 02:



Rope category number RCN (see Annex G)	Total number of load-bearing wires in the outer layer of strands in the rope[a] n	Number of visible broken outer wires[b]					
		Sections of rope working in steel sheaves and/or spooling on a single-layer drum (wire breaks randomly distributed)				Sections of rope spooling on a multi-layer drum[c]	
		Classes M1 to M4 or class unknown[d]				All classes	
		Ordinary lay		Lang lay		Ordinary and Lang lay	
		Over a length of $6d$[e]	Over a length of $30d$[e]	Over a length of $6d$[e]	Over a length of $30d$[e]	Over a length of $6d$[e]	Over a length of $30d$[e]
01	$n \leqslant 50$	2	4	1	2	4	8
02	$51 \leqslant n \leqslant 75$	3	6	2	3	6	12

Viewing the example from BS ISO 4309 above, we can see that an ordinary-lay rope, categorised as an RCN 02 (single-layer or parallel-closed rope) may have a maximum of 6 broken wires over a length of 6 x its diameter, or 12 broken wires over a length of 30 x its diameter, in a machine such as a hand operated winch, utilising a multi-layer drum.

What if you do not know the RCN number?

If the RCN number of the load rope cannot be found in annex G of BS ISO 4309, the following method should be used for calculating the number of allowable broken wires:

- Determine the total number of load-bearing wires in the rope;
    - Simply add together all of the wires in the outer layer of strands except for any filler wires and read off the discard values for broken wires over a length of 6d and 30d for the appropriate conditions, in the tables provided.

Rope category number RCN (see Annex G)	Total number of load-bearing wires in the outer layer of strands in the rope[a] n	Number of visible broken outer wires[b]					
		Sections of rope working in steel sheaves and/or spooling on a single-layer drum (wire breaks randomly distributed)				Sections of rope spooling on a multi-layer drum[c]	
		Classes M1 to M4 or class unknown[d]				All classes	
		Ordinary lay		Lang lay		Ordinary and Lang lay	
		Over a length of $6d$[e]	Over a length of $30d$[e]	Over a length of $6d$[e]	Over a length of $30d$[e]	Over a length of $6d$[e]	Over a length of $30d$[e]
01	$n \leqslant 50$	2	4	1	2	4	8
02	$51 \leqslant n \leqslant 75$	3	6	2	3	6	12

Notes:

Definitions

In the case of 6 and 8-strand ropes, broken wires usually occur at the external surface.

In the case of rotation-resistant ropes, there is a probability that the majority of broken wires will occur internally and are “non-visible” fractures.

Note: Students are reminded that access to relevant standards, such as BS ISO 4309, is necessary in order to carry out thorough examinations correctly.

Wire Rope Examination

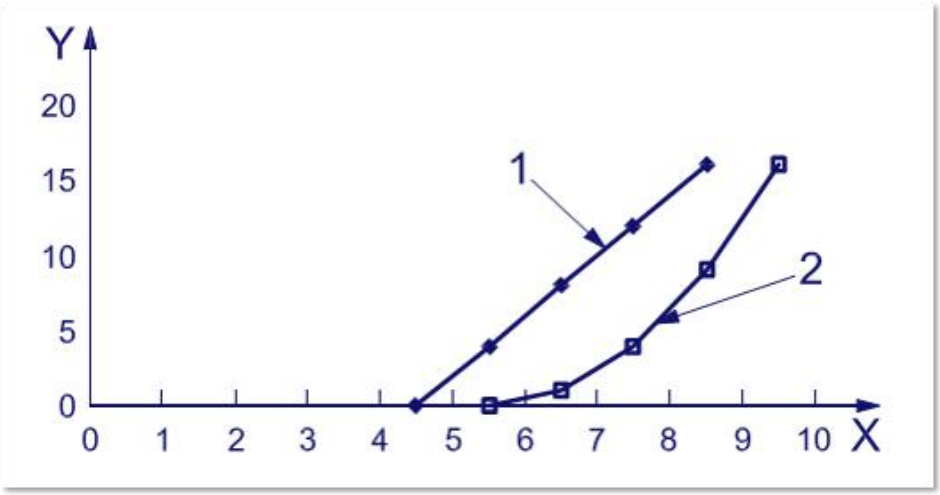
The Competent Person can find it prudent to initiate or recommend more frequent periodic inspections than those required by legislation.

This decision can be influenced by the type and frequency of operation.

Also, depending on the condition of the rope at any time and/or whether there is any change in circumstances, such as an incident or change in operating conditions, the Competent Person can deem it necessary to reduce or recommend the reduction of the interval between periodic inspections.

Examples of Rate of Increase for Broken Wires in 2 Different Ropes

Generally, ropes develop broken wires at a greater rate later on in the life of a rope than in the early stages. Have a look at the following graph which shows two examples of this.



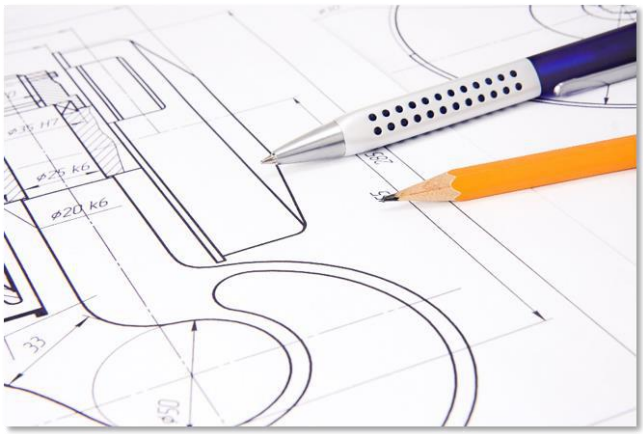
Key:
X = time, in cycles
Y = number of randomly distributed broken wires per unit length

4. Load Hooks and Sheave Blocks

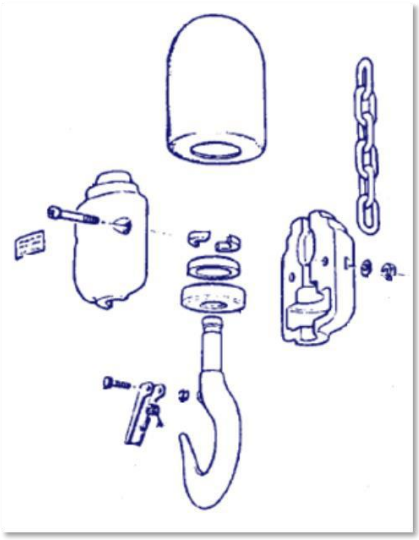
Load Hooks and Sheave Blocks

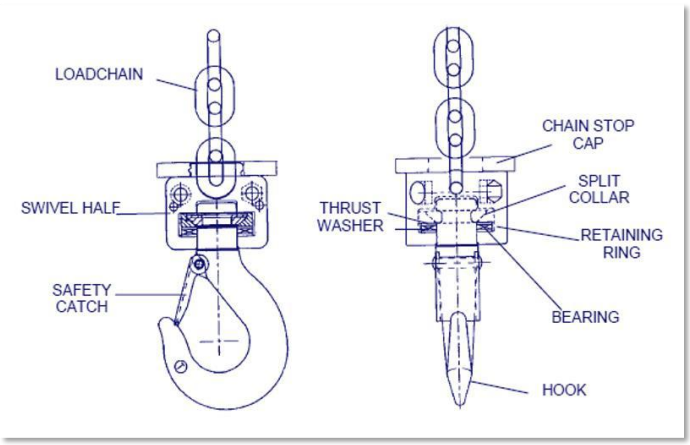
Most manufacturers design their own hooks and bottom blocks and these are usually alloy steel to a particular standard. However, the requirements for examination and the acceptance/rejection criteria are the same. Revision of your earlier studies is therefore advised. Here we will discuss bottom blocks and therefore hooks will be considered with and as a part of the block.

A bottom block is the unit at the load end of the hoisting medium and usually includes a swivel hook from which the load is slung. They will vary in size and construction depending on the make, type and capacity of the hoist to which it is fitted.



Single Fall Bottom Block

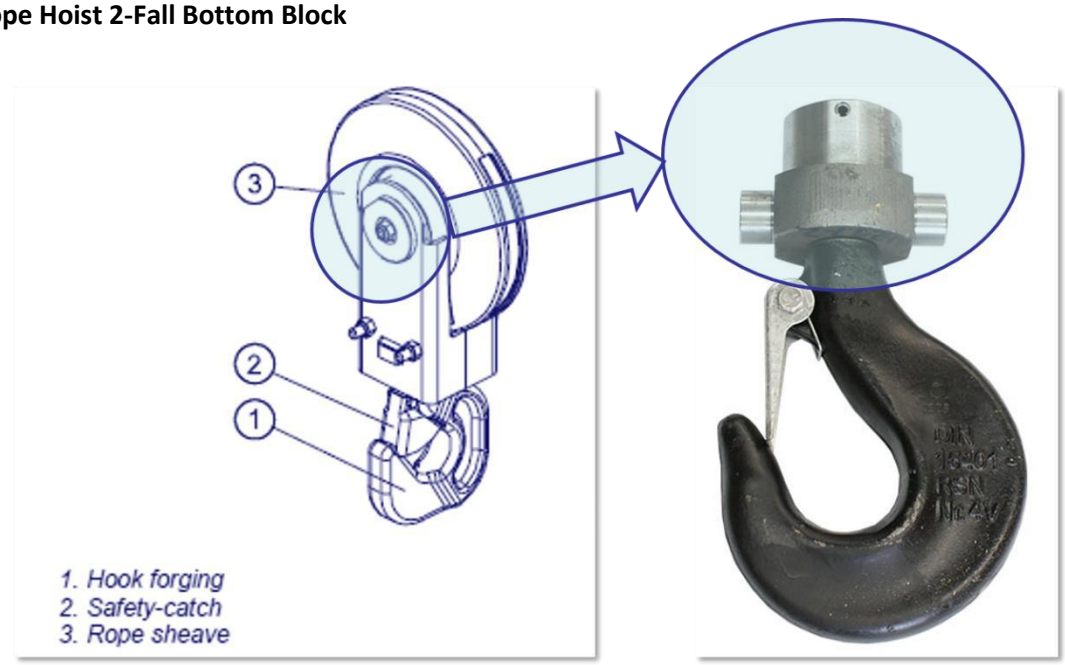




Notes:

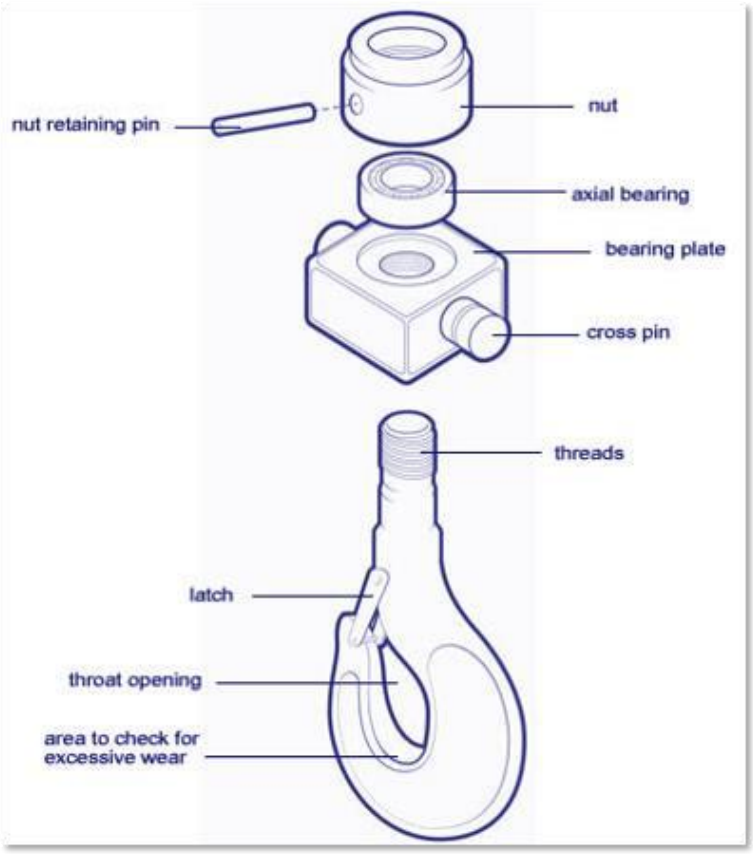
2-Fall Bottom Block Swivel Hook Thrust Bearing

Wire Rope Hoist 2-Fall Bottom Block



Notes:

Bottom Hook



Examination

For thorough examination, the bottom block should be dismantled as wear in many critical parts cannot otherwise be seen. The parts should be de-greased and then carefully inspected for wear or damage. Special attention should be paid to the mating surfaces such as:

- Sheave bore or bushes
- Sheave pin
- Holes in side plates and straps
- Crosshead trunnions
- Bearing face of crosshead
- Hook shank and nut (especially corrosion on the threads)
- Thrust bearing
- Hook seat
- Safety latch

The hook, sheave pin and crosshead should be examined carefully for evidence of cracks, particularly at changes of section in the hook shank, root of thread, hook seat etc. If for any reason the bottom block cannot be fully dismantled, the following features should be examined:

- Hooks - for evidence of distortion
- Hook set - for evidence of grooving, cracks etc. Hooks worn in the seat must not be built up by welding
- Hook bearing - for ease of swivelling in the crosshead

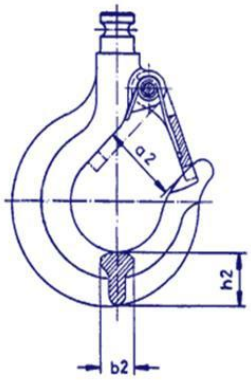
- Crosshead trunnions and/or sheave pin - for evidence of wear in the side plates or sheaves. If damage and distortion to any of the following parts is noted this will almost certainly be due to overloading or other excessive strain:
    - Sheave pin
    - Side straps and plates
    - Crosshead
    - Hook
    - Nut
    - Thrust bearing

The parts should therefore be replaced. This may also be the economic answer, and a more detailed examination of the machine may be necessary.

It is important that bottom hooks swivel freely, particularly in the case of hooks attached to a single falls of wire rope. The shank of the hook must also line up with the bearing point. This must be checked by allowing a load to swivel.

Bottom Hook Wear Tolerances

The following example of allowable wear tolerances is provided by a specific manufacturer; however, the examiner should be aware of the individual requirements of other original equipment manufacturers when considering rejection criteria.



Inspect	Dim.	Capacity			
		2 to 3 tonnes		3.2 to 5 tonnes	
		Nominal value (mm)	Wear limit (mm)	Nominal value (mm)	Wear limit (mm)
Hook saddle	b2	24	22.8	29.5	28
Hook saddle	h2	35	33.2	44.5	42.3
Hook opening	a2	43	47.3	54	59.4

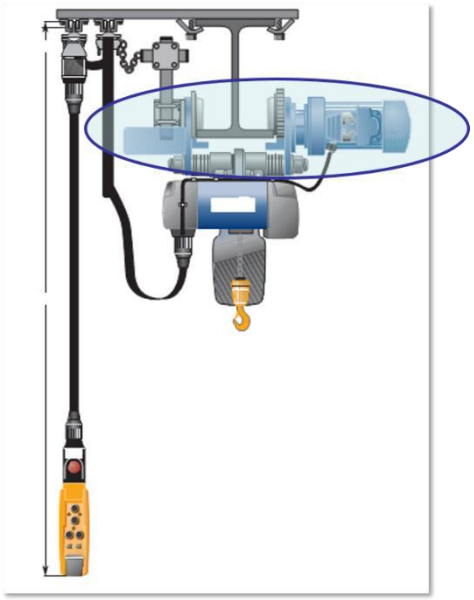
Testing

Replacement hooks should receive the full proof load required by the standard to which they are made, e.g. 2 x WLL up to 25 tonnes, 1.22 x WLL + 20t for larger capacity hooks.

However, when hoists are manufactured, bottom hooks and blocks are often fitted in an untested condition by the manufacturer. They are then considered to be a component of the hoist and that the test made to the hoist, i.e. 1.25 x WLL, is sufficient to test the hook.

5. Suspension and Trolleys

Introduction



In conjunction with this unit reference should be made to Section 7 of the LEEA COPSULE (Code of Practice for the Safe Use of Lifting Equipment) and manufacturers' manuals.

This module covers the types of suspension and travelling trolleys used with power hoists. We shall also consider their construction, examination and requirements for safe use.

A range of suspension and travelling trolley options are available for powered lifting appliances.

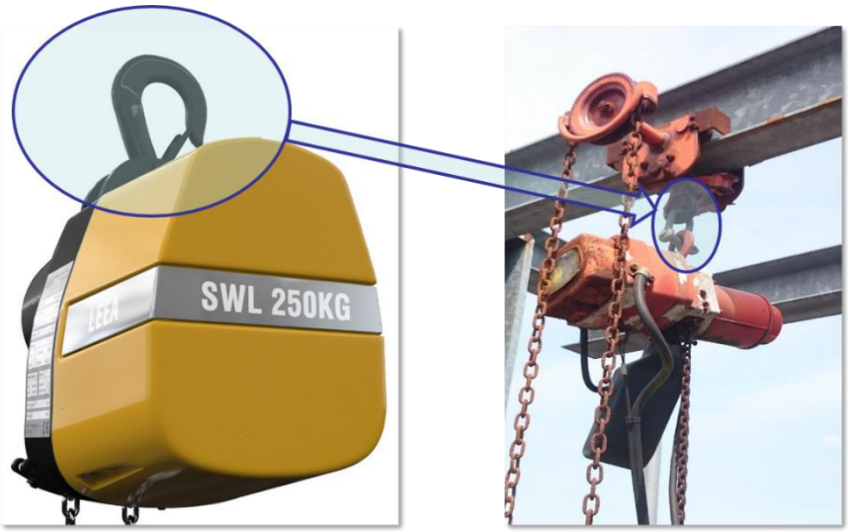
Hook/eye suspension, push-travel and powered runway beam trolley options are available for the underslung hoist applications; hand chain driven and powered trolley options are available for 'crab' units mounted to the top running cross-traverse rails of overhead cranes, although this subject will be covered in the LEEA Overhead Travelling Cranes Advanced Programme.

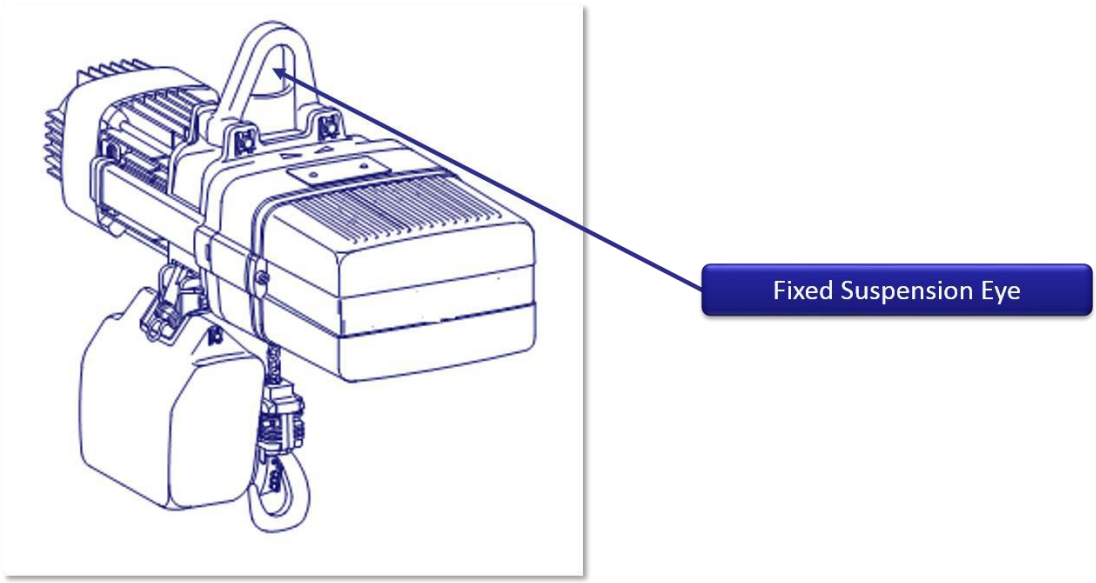
For this module, we will concentrate on the suspended (underslung) options:

- Hook/eye suspension
- Combined trolley fixed suspension
- Manual push-travel trolley
- Light crane system trolley
- Hand geared trolley
- Powered travel trolley

Hook/Eye Suspension

The hook suspension hoist can be suspended from a fixed anchor point, or alternatively to the load suspension bar of a manual or powered travelling trolley.





Combined Hoist and Trolley

The combined hoist and trolley combination is where the hook or eye suspension is removed from the hoist and alternatively, the hoist is attached directly and securely to the trolley.

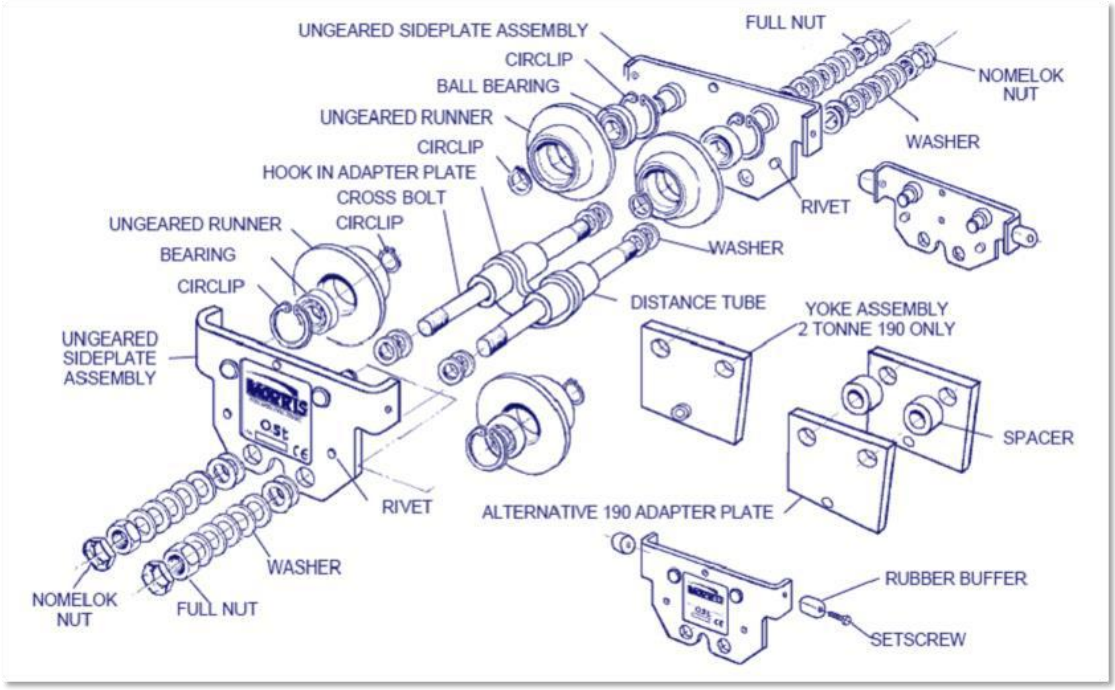
Manual Push-Travel Trolley

A simple, easy to install trolley option.

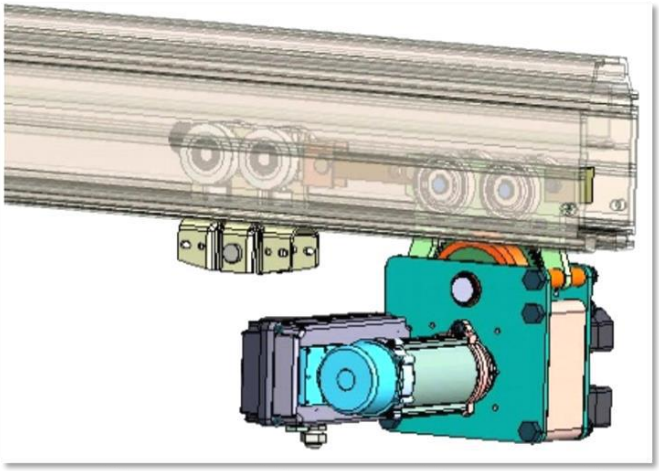
Hoist suspension directly to the trolley load bar.

Notes:

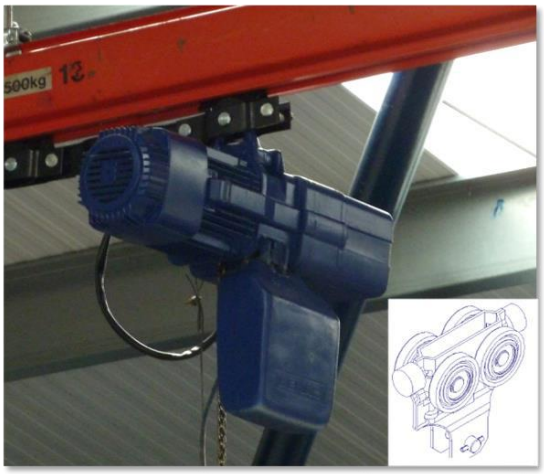
Typical Components of a Push Travel Trolley



Light Crane System Trolley



Powered Trolley

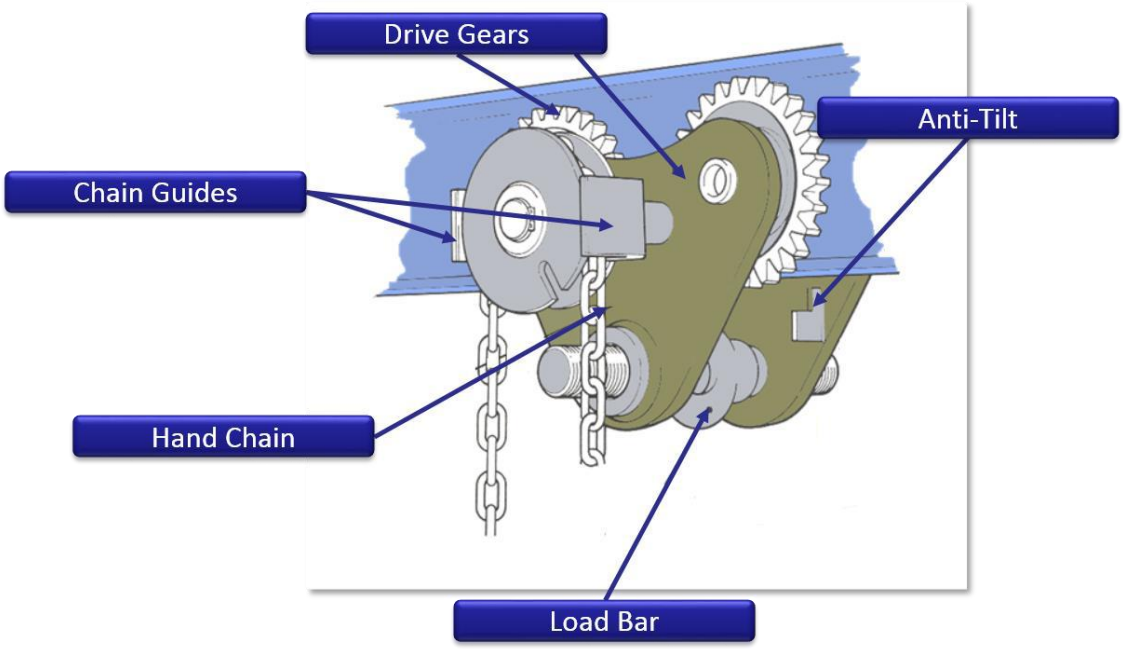


Push-Travel Trolley

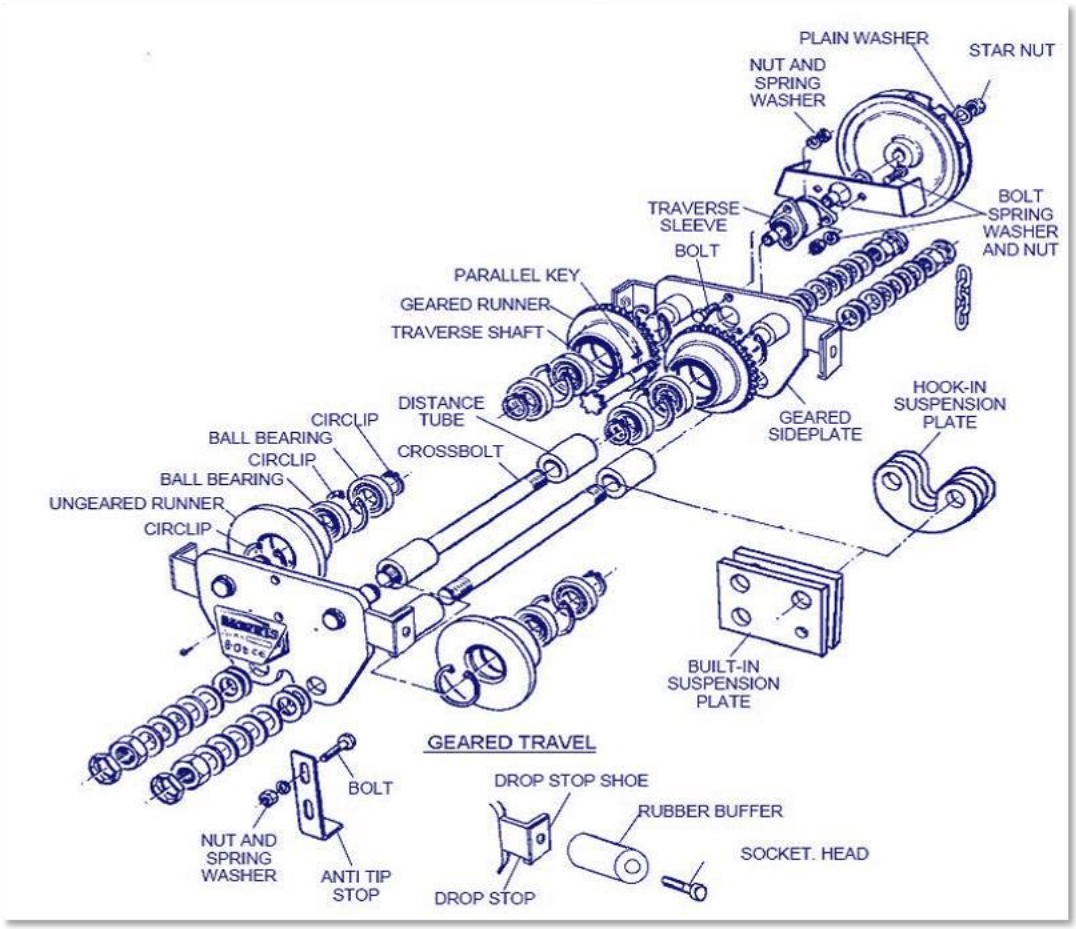
Notes:

Hand Geared Trolley

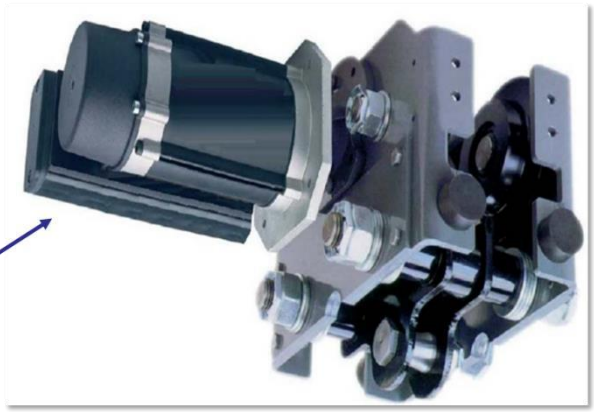
This is a manual trolley with a hand chain, allowing the operator to manually traverse the trolley into position. The hand chain wheel drives two geared runner wheels on the drive side of the trolley via a drive pinion gear.



Typical Component of a Hand Geared Trolley

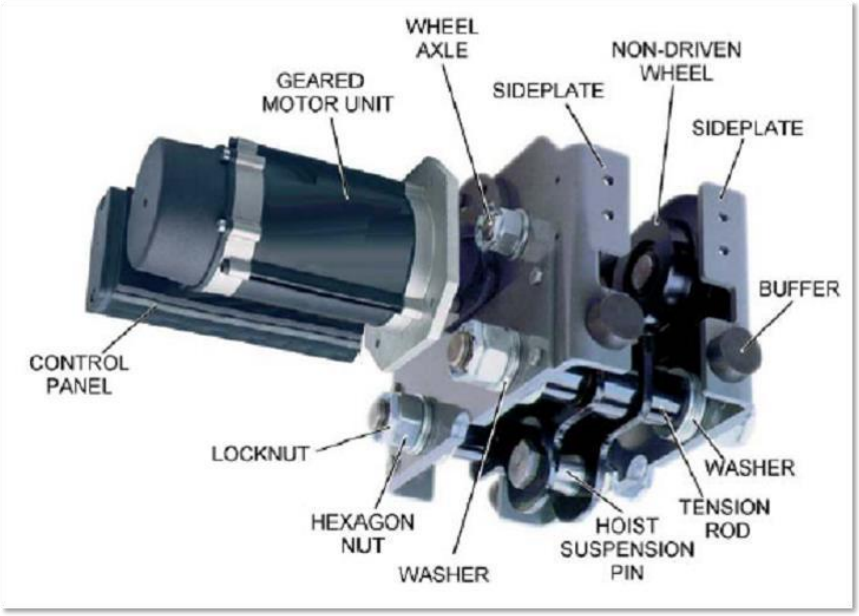


Powered Travel Trolley



The trolley is fitted with an electrical/hydraulic/pneumatic motor drive (whichever option is chosen) to power the traverse motion.
A brake will be fitted to the motor to arrest traversing operation.

Typical Components of a Powered Trolley



Notes:

Runway Beams and Travelling Trolleys

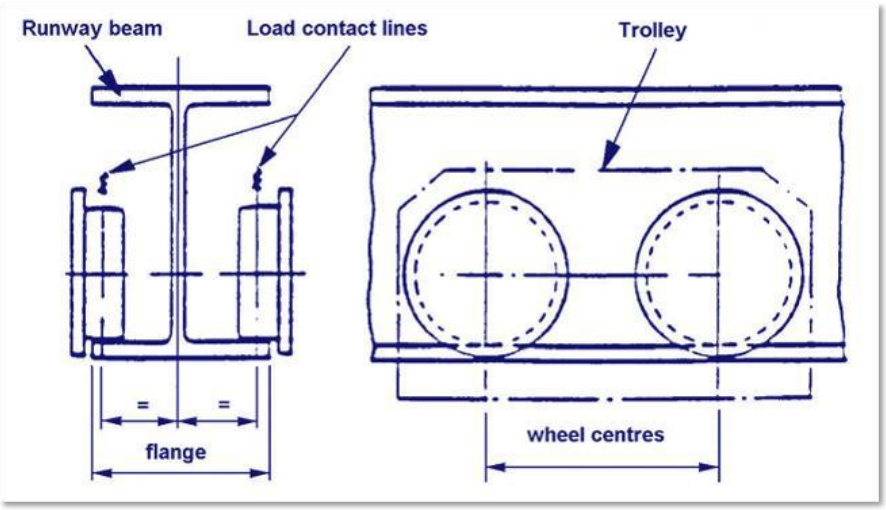
Runway beams are usually constructed in accordance with British Standard 2853: 1957. Most modern runway systems utilise the universal beam section (UB). On older installations the runway may be of the od rolled steel joist section (RSJ).

BS 2853 is intended to apply to runway beams manufactured from standard rolled steel sections. It does not apply to special sections or proprietary track systems.

Runway Beam Flange Bending

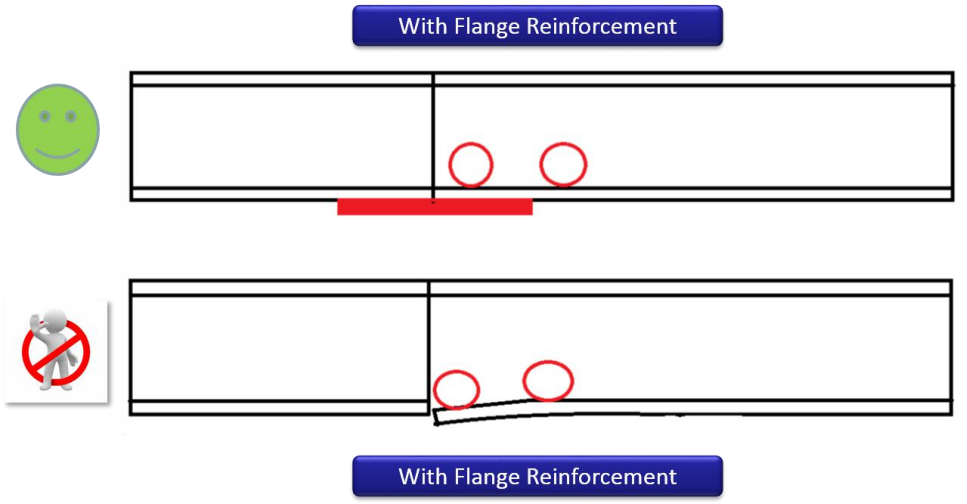
The effect of a trolley suspended from the lower flange of a runway is to create localised bending of this flange (see illustration below). The amount of bending can be affected in two ways:

1) The amount of set in of trolley wheels
2) The distance apart of the trolley wheel centres



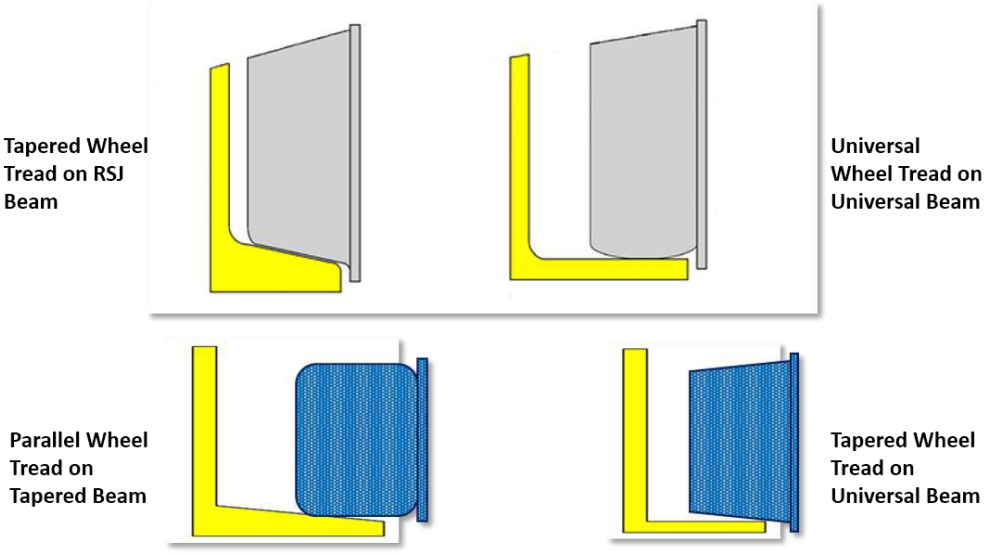
Notes:

Note: If a runway is joined and has no reinforcing of the lower flange at the join then the flange is considerably weakened and could cause local permanent set at the joint.



Trolley Wheel Profiles

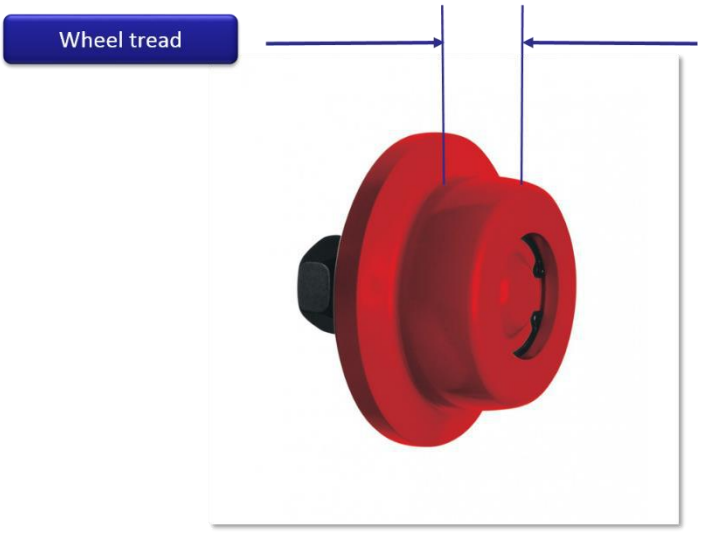
It is important when examining a runway beam system to check that trolley runners are compatible with the flange taper, especially if the equipment is old or has been re-sited. A taper roller suitable for an RSJ profile will only run on the edges of the flange of a UB causing rapid wear to both the wheel and the flange. This can lead to possible overloading and distortion of the flange as well as to the trolley side plates and wheel axles.



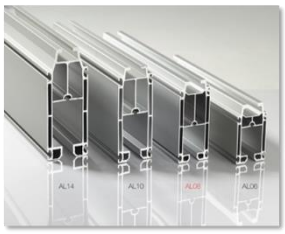
Notes:

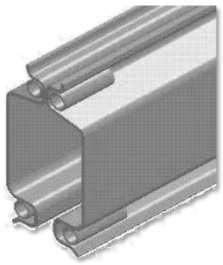
Runway Beams and Travelling Trolleys

The modern trolley runner has a radius end profile (wheel tread), although small, allowing it to sit correctly on either type of flange.



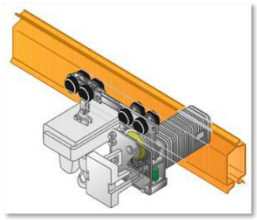
Light Duty Runways and Crane Section





Light Duty Runway Systems

Light duty installations, developed using a form rolled section.

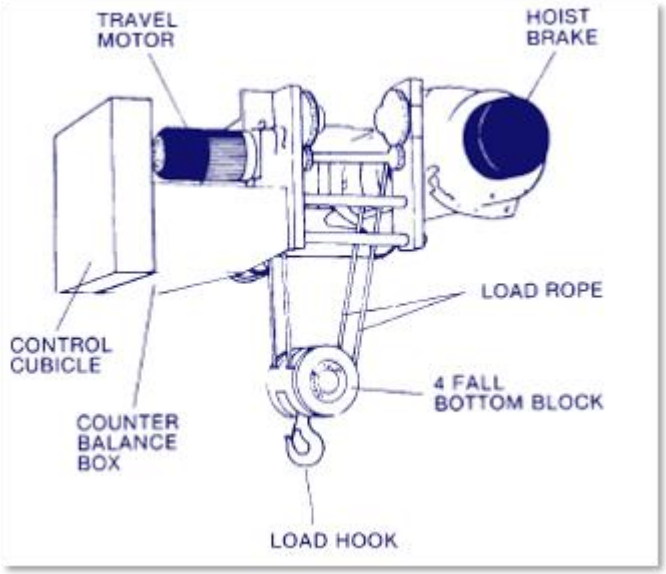


Trolleys are supplied with either a load bar or suspension plate for `hook in' arrangements or the trolley is built in as part of the permanent structure of the hoist block.

Latest range of track is available in aluminium.

Travelling Trolleys (Fleet Angle)

Most electric traverse trolleys are of the four-runner type driving on two runners on the same side of a runway beam. Where headroom is a problem the hoist may be mounted on one side of the runway beam with a counter balance on the other. This is known as a "low headroom" hoist.
In this arrangement the ropes fall at an angle. It is very important that the hoist limit is correctly set. As the bottom block approaches the trolley the angle between the rope falls from the drum and compensating sheave increases. This increases the load in each rope which may eventually exceed the breaking strength of the rope.
The same limitation would be true of any multi-fall hoist where the rope or chain falls at an angle to meet the bottom block.

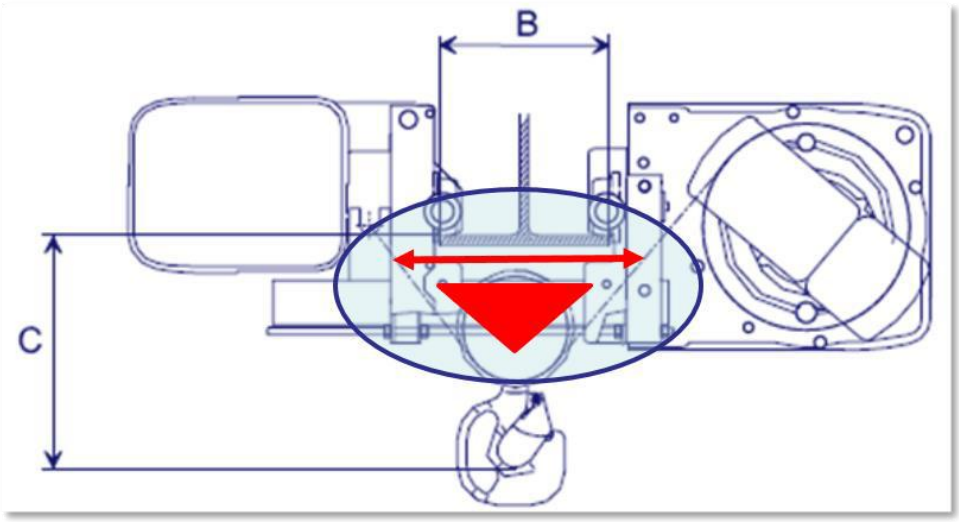


Rope Fleet Angles

In 'Low Headroom' models, the C-dimension depends on the wheel-gauge of the trolley.

When the B-dimension increases, the fleet angle of the ropes with the hook in the upmost position changes accordingly.

To avoid overloading the ropes, overload device, return sheaves and other structures, the minimum C-dimension may not be smaller than recommended by the hoist manufacturer.



In this arrangement the ropes fall at an angle.

When using such a hoist it is very important that the overwind limit is correctly set. This is because, as the bottom block approaches near to the trolley, the angle between the rope falls from the drum and compensating sheave increases.

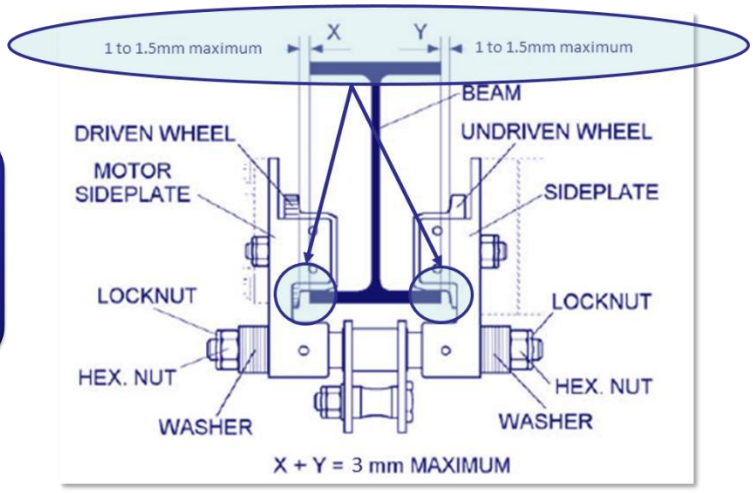
This increases the load in each rope, which may eventually exceed the breaking strength of the rope. The same limitation would be true of any multi-fall hoist where the rope or chain falls at an angle to meet the bottom block.

Trolley Adjustments

Typical trolley adjustment

X + Y = 2-3mm maximum

Always follow manufacturers recommendations



Adjustment

There are several different methods of adjusting the trolley to suit the width of girder flange on which they are to run and some are made to a fixed width.

- It is important that the load suspension point is always central to the beam and trolley
- Spacer bars and washers is one common method of setting the beam width
- It is important that the correct number and size of spacers are placed each side of the load suspension point

Another, increasingly popular, method of adjustment is the use of a load bar which is threaded left and right hand into the side plates.

- Caution is needed to ensure that one side plate has not been turned on the screw more than the other

Rigid and Articulated Trolleys

The most common forms of four-wheeled trolley have the wheels arranged on fixed side-plates and are known as rigid trolleys. They are suitable for use on straight runway beams or those with a generous radius.

Articulated trolleys are also available. These have four or more wheels and are designed so that each pair or set of wheels is free to pivot relative to the others in plan view.

Marking

The following information should be permanently and legibly marked on a suitable part of the trolley:

- Distinguishing mark. This should be unique to the trolley and identify it with the Certificate
- SWL
- An indication that it is suitable for power operated lifting appliances
- The width of the runway beam for which the trolley is designed or in the case of an adjustable trolley the range of widths

The marking should be either by means of a suitable metal tab permanently attached or by stamping provided that no mechanical property of the trolley is impaired.

Notes:

In-Service Inspection

This inspection should be carried out by a Responsible Person on a regular basis to ensure that the equipment is properly maintained and in working order at all times.

The frequency of inspections should be determined according to the conditions of service. If any of the following defects are found the trolley should be withdrawn from service and referred to the Competent Person for thorough examination:

- Appreciable wear of the trolley wheel treads and bearings or damage to flanges
- Insecurity of the wheels and axle pins
- Distortion, particularly in the side plates and load bar
- Wear on the bearing points
- Cracked or defective welding
- Incorrectly substituted components
- Worn, corroded or damaged hand-chain, particularly on the bearing surface on the inside of the links but also the outside of the links. Bear in mind possible damage to the operatives' hands
- Illegible SWL/WLL or other markings

Thorough Examination

When examining a hoist with trolley mounted on a runway the runway must also form a part of the examination:

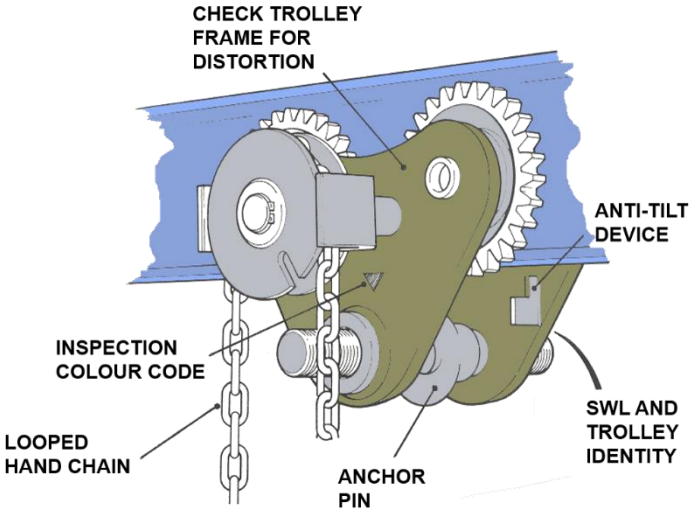
- Check the runway has a valid test certificate
- The runway beam or girder should be of the proper size, adequate strength, with an even running surface and should be packed level at suspension points. In any 2 metres the runway should not deviate by more than 2mm and the maximum total deviation over the whole runway should not exceed 10mm
- Ensure adequate stops are fitted to the runway
- Remove the trolley from the runway, disassemble and clean
- Check the markings on the trolley (i.e. SWL/WLL, distinguishing number, manufacturer's name) against the test certificate
- Check cross bolts, side plates, assemblies and bearing stubs for deformation
- Check bearings for evidence of wear. If debris or water is able to penetrate the seals rapid wear and seizure can take place
- Check runners (wheels) for free running and the outside diameters for wear

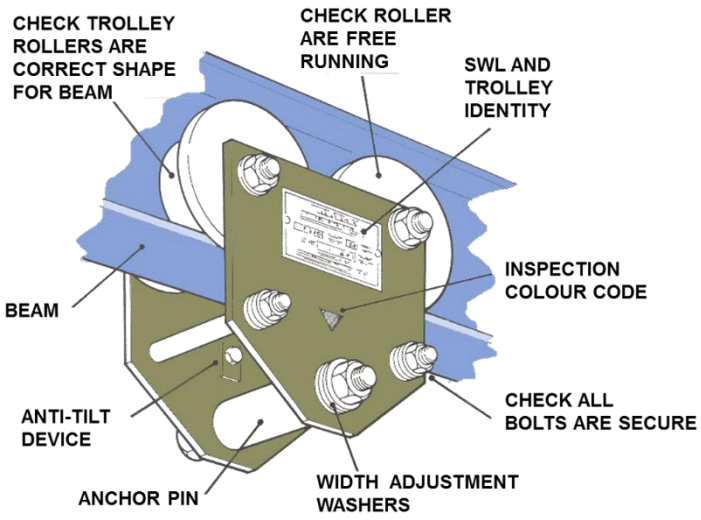
In addition-for hand geared trolleys:

- Check chain for wear (8% of link diameter), kinks and overstretching
- Check hand chain wheel for wear and deformation; ensure the guard fits closely around the hand chain wheel
- Check gears for evidence of wear, broken or deformed teeth. After examination advise client to lubricate bushes and shafts with a suitable grease

And for electric traverse trolleys:

- Check the motor brake for wear and loss of efficiency
- Check the electric motor for security to side plate
- Check the electric motor for wear in the bearings
- Check the cables for integrity and insulation
- Check the pinion and gears for wear, broken teeth alignment and correct engagement





In addition, for trolleys in situ, if any of the following defects are found the examiner should recommend the following action:

"This equipment is to be removed from service until the following work is carried out:“

- Incorrect size of trolley for the runway beam
  - Action: replace with correct size of trolley
- Wrongly adjusted trolley
  - Action: re-adjust to correct side clearance between the wheel flanges and the toes of beam, usually 2 to 3 mm total clearance. Also ensure that the trolley is correctly aligned centrally with the flange of the runway
- Incorrect or wrongly fitted hoist block
  - Action: remove and replace or refit as required
- Trolley wheels or runway contaminated with lubricant or other fluid that could cause wheel slip
  - Action: clean wheels and beam
- Wrongly adjusted anti-tilt device
  - Action: re-adjust
- Distortion or appreciable wear of the runway beam on which the trolley is fitted. End stops missing or ineffective
  - Action: remove from service

Testing (as Part of the Thorough Examination)

The Competent Person shall decide whether a test is required as part of the thorough examination.

- Manual lifting machines are tested with an overload of SWL +50%. Lifting machines power are tested to SWL +25%
- If a trolley is of the detachable or hook in type it should therefore be tested to SWL/WLL +50%
- If a trolley is built in a hoist unit as a part of the appliance, the trolley would be tested with the hoist. If it were power operated the proof on test load would be SWL/WLL +25%

Note: Overload testing is usually only required upon installation, after major repair or modification, on moving to a different location (disassembled and reassembled) or following an exceptional circumstance.

Training

Whilst the tester and examiner is not called upon to train operatives he must be aware of the training requirements so that he is able to advise the owner/user should he become aware of bad practices whilst he is on site.

Operatives should be instructed in the specific use for which the trolley is intended.

Operatives whose job it is to erect trolleys should be trained in the correct method of assembly and fitting of the trolley. They should also be made aware of which part of the structures available are suitable for use as runways and what they are capable of supporting.

Notes:

6. Principles of Electrical Machines

Introduction

It should also be noted that this module is written in a simplistic form that is intended to establish only some basic principles. The aim is to give those with little or no knowledge of the subject a basic understanding and to provide the basis for further self-development.

This module will help examiners/inspectors whom have dealings with electrically powered lifting equipment to understand the principles, recognise the layout and individual items, and be aware of associated dangers.

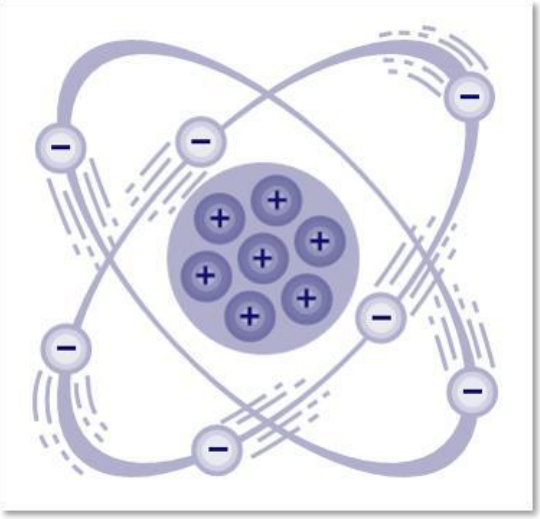
It is in no way intended to provide competence to deal with electrical matters, which must always be dealt with by a suitably qualified person.

Basics of Electricity

The Atom

All matter is made up atoms. Atoms have a nucleus with electrons that are moving around it. The nucleus is composed of protons and neutrons. Electrons have a negative charge '-'. Protons have a positive charge '+'. Neutrons are neutral.

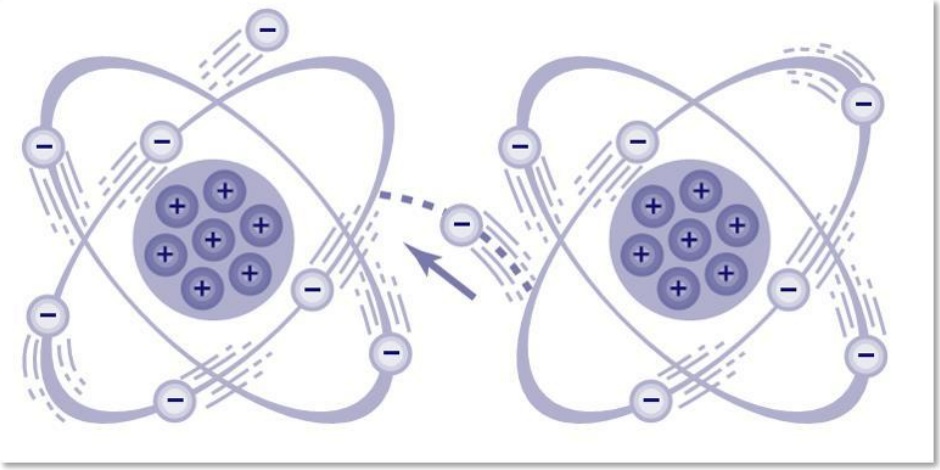
In the normal state of an atom, the number of electrons is equal to the number of protons and the negative charge of the electrons is balanced by the positive charge of the protons.



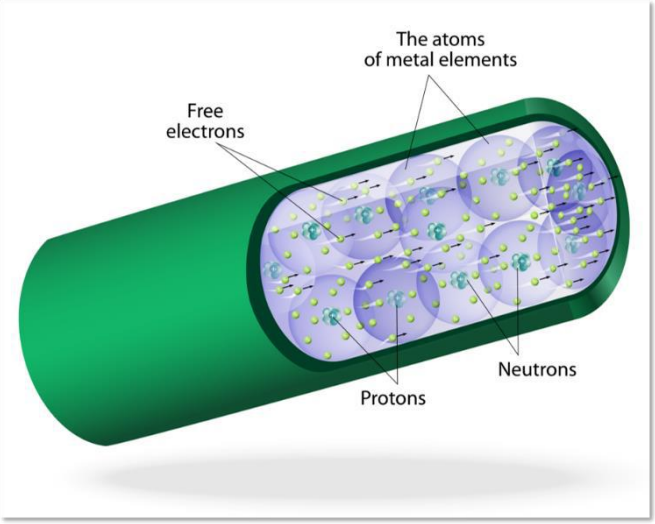
Electrons

Electrons move about the nucleus at different distances. The closer to the nucleus, the more tightly bound the electrons are to the atom. Electrons in the outer band can be easily force out of the atom by the application of some external force such as a magnetic field, friction, or chemical action.

Electrons forced from atoms are sometimes called free electrons. A free electron leaves a void which can be filled by an electron forced out of another atom.



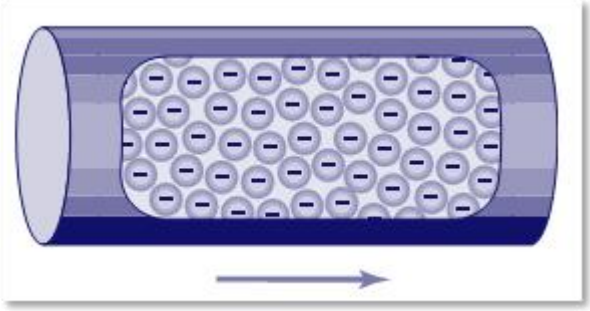
Electrical Current



Conductors

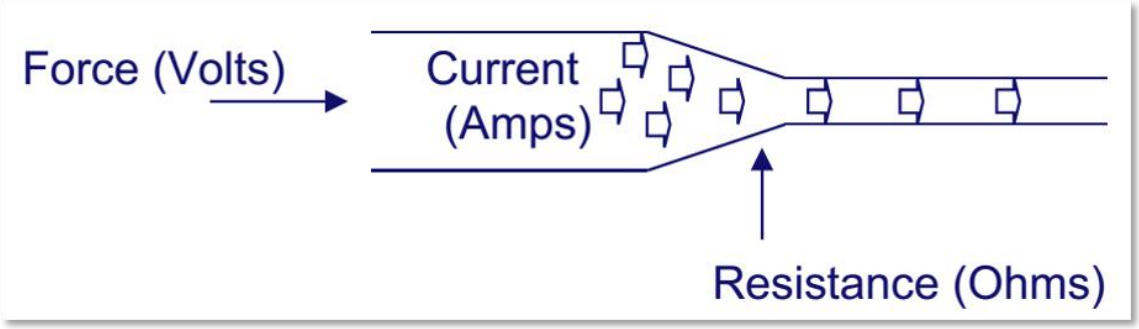
In any electrical circuit electrons are flowing through conductors much like water is pumped through pipes, or blood is pumped through veins.

The force that causes the current to flow is called electromotive force 'EMF' or Voltage. Sometimes voltage is also known as electromotive potential difference. The SI unit used to measure voltage is the volt (V).



An electric current is produced when free electrons move from atom to atom in a material. Materials that permit many electrons to move freely are called conductors. Steel, silver, copper, aluminium, zinc, gold, brass, and iron are considered good conductors.

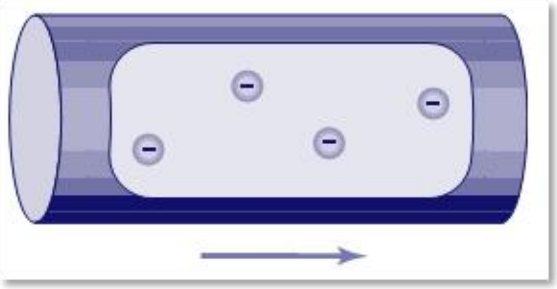
A simplistic way of describing electric circuits to non-electrical people is to compare them to water flow in a pipe.



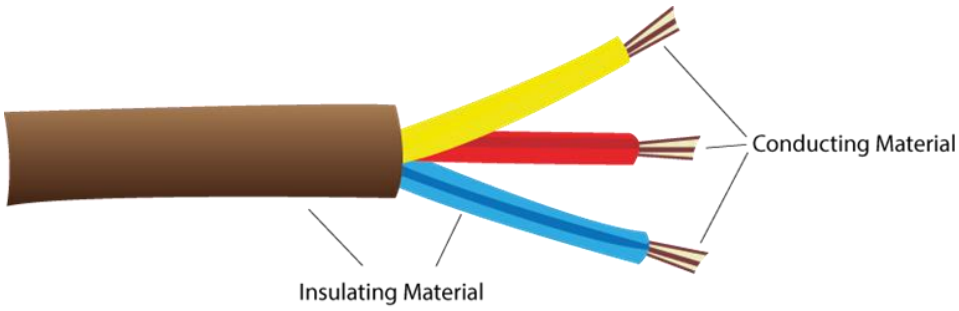
- The force pushing the water is the 'Voltage'
- The amount of water is the current or 'Amps'
- The reduction of the pipe's diameter is the resistance or 'Ohms'

Insulators

Materials that allow few free electrons are called insulators. Materials such as glass, rubber, glass and plastic are good insulators.



An electric cable is one example of how conductors and insulators are used. Electrons flow along a conductor to provide energy to an electric device such as a TV, computer, or a hoist motor. An insulator around the outside of the copper conductor is provided to keep electrons in the conductor.

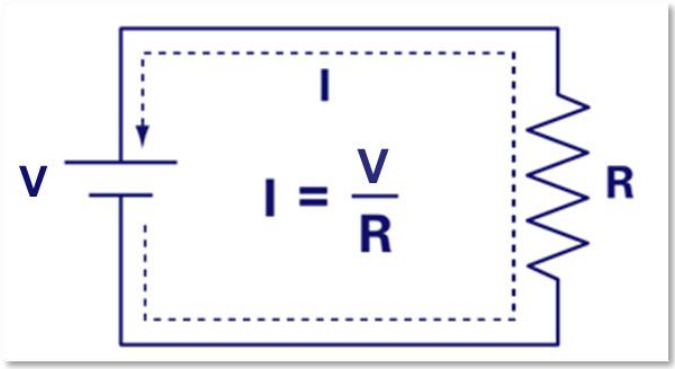


Electrical Circuits

A simple electric circuit consists of a voltage source, some type of load, and conductors to allow electrons to flow between the voltage source and the load.

Ohm's Law

Ohm's law shows that current varies directly with voltage and inversely with resistance.



Current (I) is measured in amperes (amps)

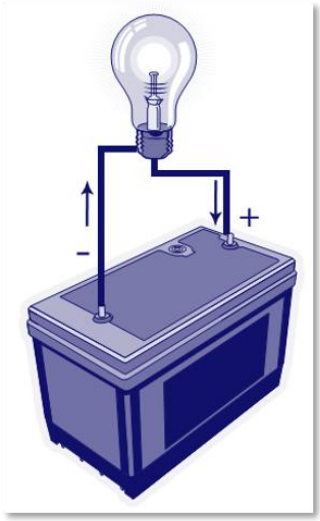
Voltage (V) is measured in volts

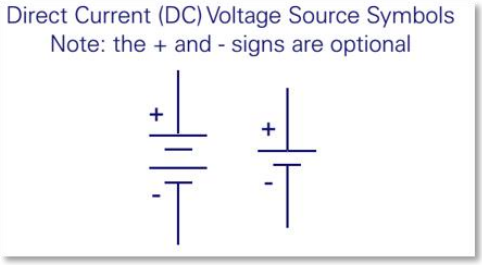
Resistance (R) is measured in ohms (Ω)

Current, Voltage and Resistance

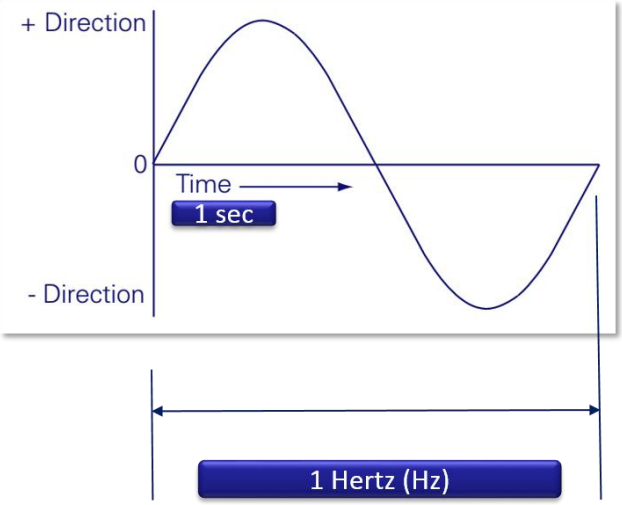
The flow of electrons in a circuit is called current. The System International (SI) unit used to measure quantity of current is called an Ampere (A). The device that provides the electromotive force is called a source. This can be a generator or a battery.

Some sources produce a constant voltage. The current from such a source is constant in value and in one direction for a given load. This kind of current is called direct current (DC). Batteries produce direct current.





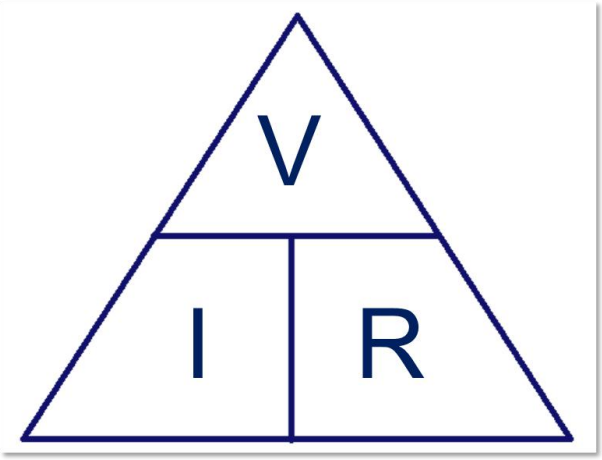
Sources such as generators produce electromotive force (Voltage) that continuously alternates in value and direction. This kind of force is called alternating current (AC) because the alterations repeat themselves in cycles. The number of cycles made by the AC current in one unit of time is called 'frequency' and is measured in Hertz (Hz). The unit of time is 1 second. Therefore, an AC current at 50 Hz means 50 cycles occur every 1 second.



Notes:

Ohm's law

OHMS LAW states that current in a circuit is proportional to the voltage and inversely proportional to the resistance. A simple way to remember which formula to use is achieved by using a triangle as shown below:



There are three ways to state Ohm's law:

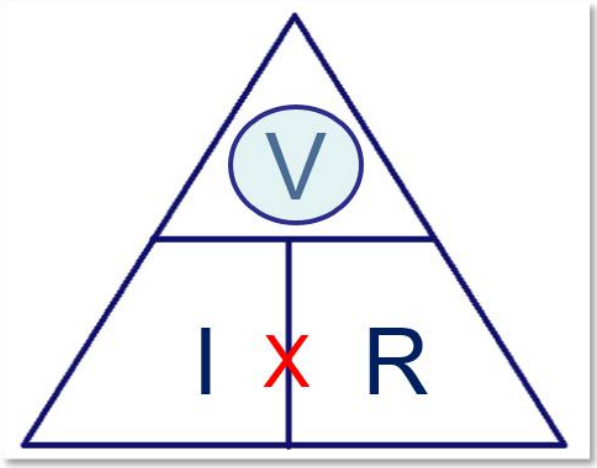
V = I x R

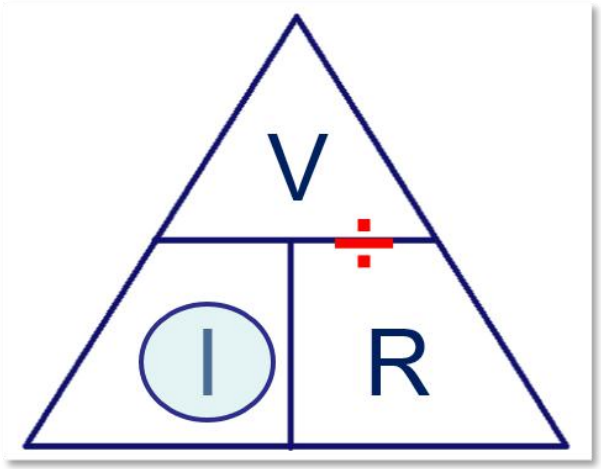
I = V ÷ R

R = V ÷ I

Using the triangle, you simply cover the value that you wish to calculate and you have the formula to use. The following examples show how this is achieved.

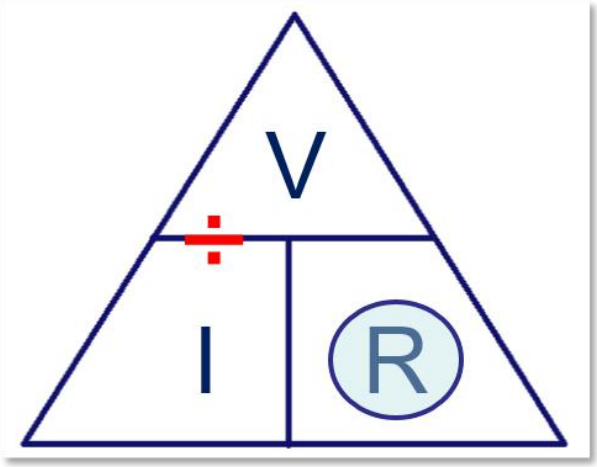
Example 1: If you need to calculate voltage, and you know the current and resistance, cover the voltage and you are left with current x resistance:





Using the triangle, you simply cover the value that you wish to calculate and you have the formula to use. The following examples show how this is achieved.

Example 2: If you need to calculate current, and you know the voltage and resistance, cover the current and you are left with voltage ÷ resistance:

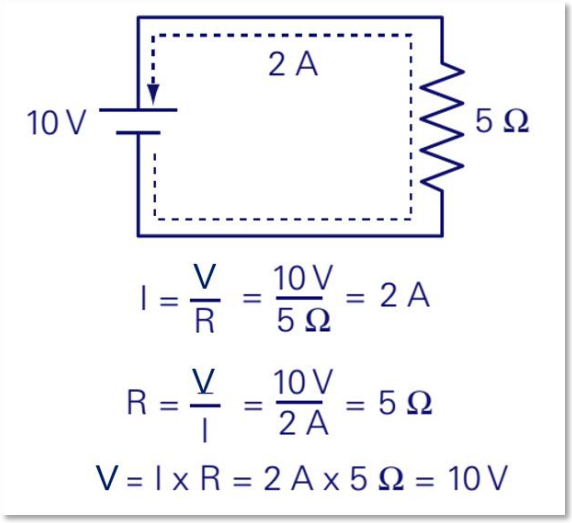


Using the triangle, you simply cover the value that you wish to calculate and you have the formula to use. The following examples show how this is achieved.

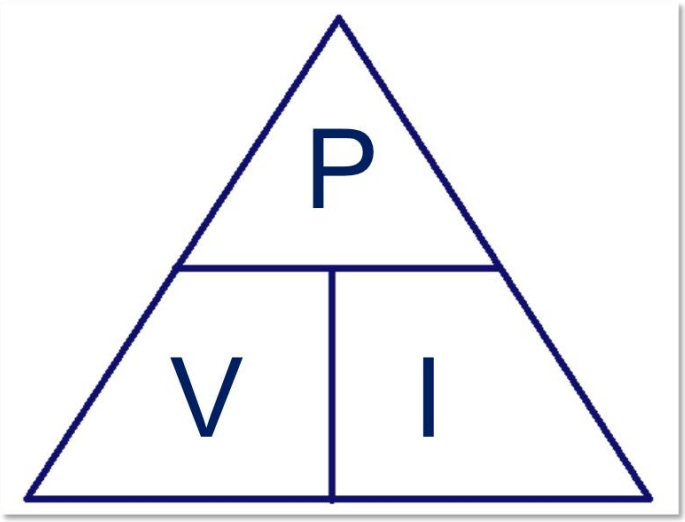
Example 3: If you need to calculate resistance, and you know the voltage and current, cover the resistance and you are left with voltage ÷ current:

Current, Voltage and Resistance

As we have shown in the previous Ohm's Law examples, if you know any two values, you can use Ohm's Law to calculate the missing value. Using the illustration below, it is easy to see how this is achieved.



The Law of Power



Power is the rate at which work is done and is represented by the symbol 'P'. All electrical loads need a certain power to run.

E.g. a lamp bulb needs power to give light, an electrical motor needs power to run etc.

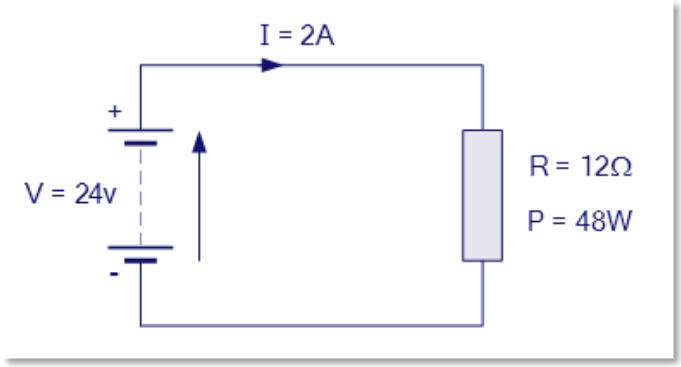
Power within an electrical circuit is only present when both voltage (V) and current (I) are present and is measured in watts (W). Note that 1000 watts is usually expressed as 1kW.

For example, in an open-circuit condition, voltage is present but there is no current flow I = zero, therefore V x zero is zero, so the power dissipated within the circuit must also be zero. Likewise, if we have a short-circuit condition, current flow is present but there is no voltage V = zero, therefore zero x I = zero, so again the power dissipated within the circuit is zero.

As electrical power is the product of V x I, the power dissipated in a circuit is the same whether the circuit contains high voltage and low current or low voltage and high current flow. Generally, electrical power is dissipated in the form of heat (heaters), mechanical work such as motors, and energy in the form of radiated energy (lights) or as stored energy (batteries).

Notes:

In the following illustration, we can see how voltage, current, resistance and power may be calculated:



Voltage: (V= I x R) = 2 x 12Ω = 24V
Current: (I = V ÷ R) = 24 ÷ 12Ω = 2A
Resistance: (R = V ÷ I) = 24 ÷ 2 = 12Ω
Power: (P = V x I) = 24 x 2 = 48W

Electric Motors

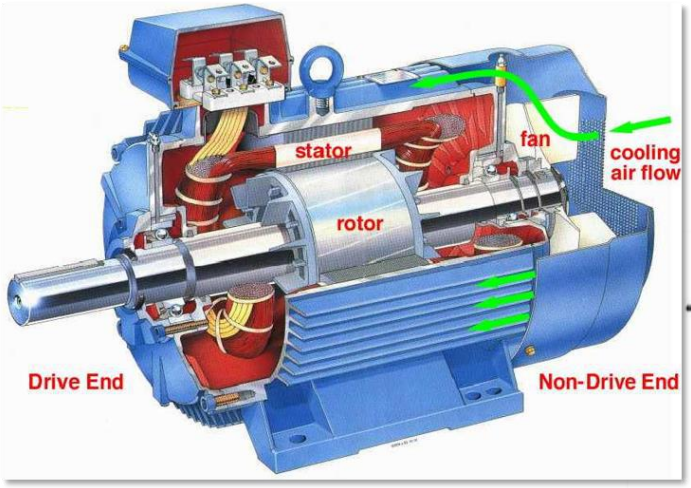
Electric motors are the most common motive source used with lifting equipment. They therefore form an important part of the study of power operated lifting equipment. Not only are they used to provide the motive force to raise and lower loads, as in hoists and winches, but also to move them, as in travelling hoists and cranes.

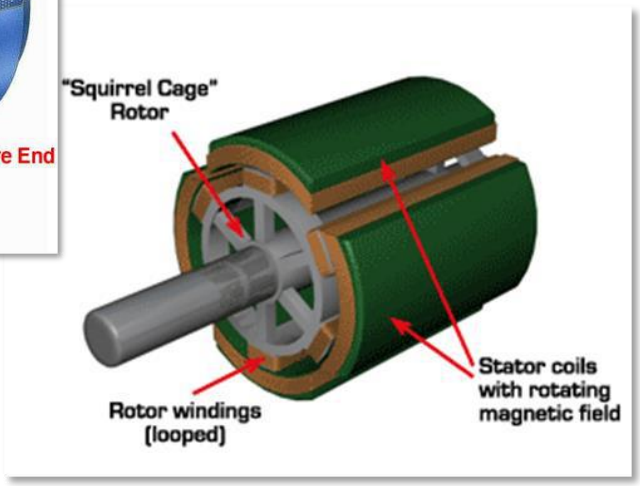
These different duties call for the motors used for the various functions to have differing characteristics.

In this unit we will consider how electric motors work:

- We will briefly look at how AC motors work
- We will consider motor duty rating factors

AC Motors

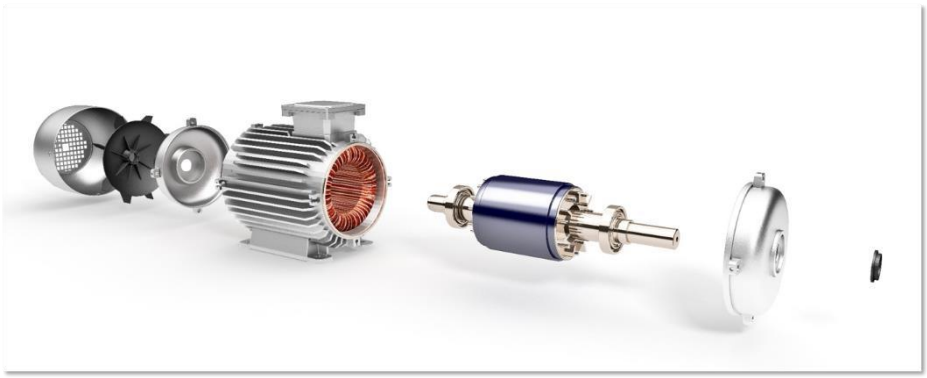




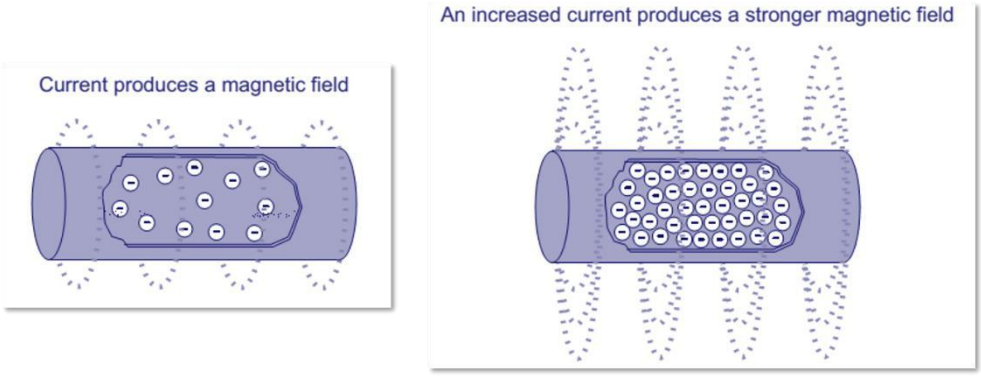
3 – phase AC induction motors are used extensively in lifting appliances.

There are 3 main parts to the motor:
Enclosure (frame)
Stator
Rotor

Electric Motors



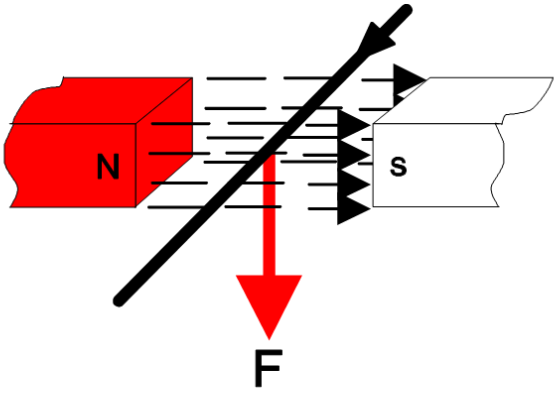
When current flows through a conductor, it produces a magnetic field around the conductor. The strength of the magnetic field is proportional to the amount of current.



Notes:

Electrical Motors

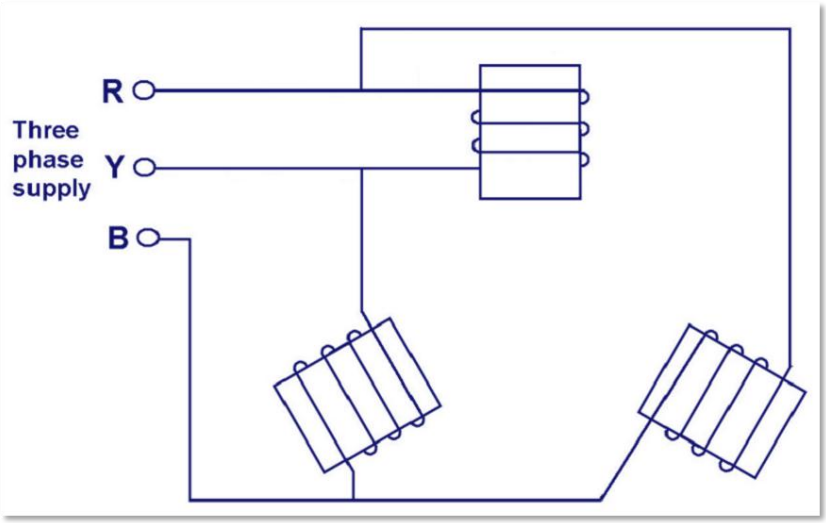
An electrical motor converts electrical energy to mechanical movement.



A wire that is put through a magnetic field creates a force. If the wire is moving, the force will move in the same direction.

Squirrel Cage AC Motor

In squirrel cage motors only the stator has copper coils. The rotor package is a short circuited aluminum or copper cage that is filled with some conductive material, usually cast aluminum. The rotor bars are slightly angled to increase the efficiency.

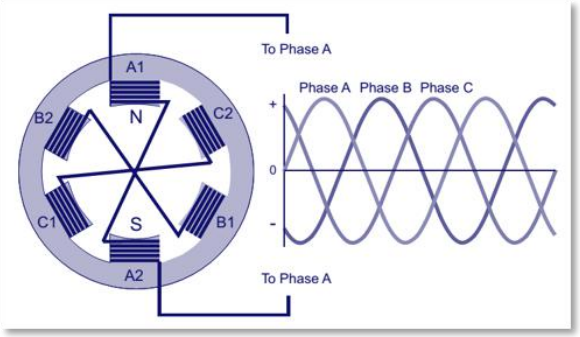


Cylindrical rotor squirrel cage motors require an auxiliary brake. The brake is mounted on the free end of the motor on the motor shaft.

- Hoist motors use 3 phases; the principle works as illustrated below
- An AC motor creates the revolutions on the rotor

Each leg of the 3 phases going to a motor are 120 degrees out of phase with each other, so what happens is the supply, due to the changing of polarity of the supply creates a rotating magnetic field inside the rotor.

Remember that when we put current into a wire the wire creates a magnetic field around the wire, if you constantly change the polarity of the current being applied to the wire (AC current) and then you have three phases which are 120 degrees out of phase with each other, you get a rotating magnetic field inside the stator, which is what we call the flux.



Motor Insulation

The stator core and windings are insulated. The type of insulator depends on the operating temperature of the motor.

Most motors have type E or F insulation. Class E insulation allows a temperature rise of 70°C whilst Class F permits a rise of 95°C above ambient temperature for totally enclosed motors.

Squirrel Cage Motor – Overheating

- There are no mechanically wearing parts in squirrel cage motors
- Usually the only thing that burns a motor is overheating
- A motor burns out when the insulation material around the stator coils heat up too much and melts
- This causes short circuits, and the motor is no longer functional
- A burnt motor is either changed or the stator is rewound. The rotor may also be destroyed from overheating.
- Other factors that cause motors to overheat include:
    - Too many starts (inching) – operator activates high speed first before starting in slow speed
    - Lifting beyond ED% rating of motor (heavy loads plus lifting time)
    - Environmental temperature

Cooked!

Requirements of BS EN 60204

Standard, BS EN 60204-32 Safety of machinery – Electrical equipment of machines states:

Clause 7.3 Protection of motors against overheating

- Protection of motors against overheating shall be provided for each motor rated at more than 2kW

This can be achieved by:

- Overload protection
- Over temperature protection
- Current limiting protection

Automatic restarting of any motor after the operation of protection against overheating is to be prevented if it can cause a hazardous situation or damage to the machine or work in progress.

We will look at hoist overload protection and safety devices later in this course.

Motor Ingress Protection (IP) Rating

IP ratings are used to define levels of sealing effectiveness of electrical enclosures against intrusion from foreign bodies (tools, dirt etc.) and moisture.

The table opposite explains the meaning of the IP rating, using the first and second numbers for reference, e.g.

IP 40 = 4 – Protected against solid objects over 1mm and 0 = No protection against ingress of liquids.

BS EN 60204 requires a minimum of IP23 for all motors. In dusty environments, BS EN 14492-2 requires a minimum IP protection of IP 44, and outdoor motors to have a minimum of IP 54 protection.

Ingress Protection Rating			
First Number Solids	Protection Provided	Second Number Liquids	Protection Provided
0	No Protection	0	No Protection
1	Protected against solid objects up to 50mm e.g. accidental touch by hands	1	Protected against vertically falling drops of water e.g. condensation, dripping water
2	Protected against solid objects up to 12mm e.g. fingers	2	Protected against direct sprays of water up to 15 deg from the normal position
3	Protected against solid objects over 2.5mm e.g. tools, screws	3	Protected against direct sprays of water up to 60 deg from the vertical
4	Protected against solid objects over 1mm e.g. wires	4	Protected against water sprayed from all directions – limited ingress permitted
5	Protected against dust – limited ingress permitted but no harmful deposits allowed	5	Protected against low pressure jets of water (6.3mm nozzle) from all directions. Limited ingress is permitted
6	Dust tight – totally protected against dust, Complete protection against human contact	6	Protected against strong jets of water (e.g. for use on ship decks) – limited ingress permitted
		7	Protected against the effects of immersion at a depth of 1m
		8	Protected against long periods of immersion under pressure (beyond 1m) – depth specific by the manufacturer

ED Rating

Electrical motors are not only rated according to the power they can generate, but also according to their heat resistance. This is called Efficient Duty.

- Every motor that is running gets hot due to electrical resistance in the motor
- The temperature of the motor must not increase above specified values
- Motors require rest periods to cool down

Hoist duty classification specifies the duty factor (ED % = Efficient Duty in percent) and starting frequency (maximum starts per hour) of hoisting motors according to the table below:

Hoist group	M3 (1Bm)	M4 (1Am)	M5 (2m)	M6 (3m)	M7 (4m)	M8 (5m)
Duty factor	25 % ED	30 % ED	40 % ED	50 % ED	60 % ED	70 % ED
Max starts / hour	= 150 / h	= 180 / h	= 240 / h	= 300 / h	= 360 / h	= 420 / h

More starts per hour increases the ED% as well as how much lifting the hoist will do in its work cycles.

- The ED% is calculated from how much the hoist will lift per each lift and how long each lift will take
- The ED% is based on a 10-minute period of time
- An ED rating of 40% means the motor can be operated for an average of 4 minutes in any 10-minute period whilst resting 6 minutes of that period
- Be aware that after 4 minutes of lifting the motor requires a 6 minute cooling down period

Another general way of explaining ED% is the maximum number of continuous minutes a motor can be used to lift nominal load in a 10-minute period without overheating the motor.

Duty Classification

Safe and effective operation of the hoist is dependent on correct classification of the hoist's operating group.

Hoists shall be classified in groups of mechanism in accordance with ISO 4301-1 according to the operational requirements and conditions of application.

Hoists shall be designed in accordance with FEM 1.001, booklets 1, 2, 3, 4, 5, 8 and 9 and FEM 9.901.

We will consider duty classification in the specific hoist modules during this course.

Requirements of BS EN 14492 Parts 1 & 2

BS EN 14492 is the current harmonised standard for Cranes – Power driven winches and hoists:

- Part 1 – Winches
- Part 2 – Hoists

The standard applies to the design, information and use, maintenance and testing of power driven hoists with or without travelling trolleys for which the prime mover is either an electric, hydraulic or pneumatic motor.

Annex J of the standard details the requirements for selection of motors in 3 ways:

1. General determinations for the selection of motors and dimensioning of motors according to thermal aspects, usually applying on all sorts of drives in intermittent service
2. Special determinations to dimension motors according to the maximum torque required to lifting motions and according to data on stress occurring during the use of these drives
3. As 2) but details requirements for horizontal drive motors (e.g. travel and traverse motions)

Notes:

Inspection/Examination

It is recommended that the following points are checked during the inspection/examination of an electrically powered lifting appliance:

- **Overheating** - check cleanliness and correct venting of the motor
    - Look for signs of burning or paint discolouration on the motor body/housing
- **Vibration**
    - Ensure mountings and fixing bolts are secure
    - Check that the motor shaft is incorrectly aligned
    - Check for excessive play in the coupling between motor and transmission equipment
    - Electrical imbalance, e.g. one phase burnt-out etc. (Only qualified personnel to check)
- **Running Sound** - this will be mainly due to bearings
    - If they are suspected they should be checked with a listening rod. A perfect bearing gives a whirling sound, whereas a damaged bearing gives a rattle
- **Lubrication** - ensure the motor bearings and attachments are adequately and properly lubricated
- **Attachments** - check connecting shafts and gears etc. for play and damage which could adversely affect the running of the motor

Important Reminder

It should also be noted that the initial section of the unit is written in a simplistic form that is intended to establish only some basic principles. The aim is to give those with little or no knowledge of the subject a basic understanding and to provide the basis for further study.

This module will help examiners/inspectors whom have dealings with electrically powered lifting equipment to understand the principles, recognise the layout and individual items, and be aware of associated dangers.

It is in no way intended to provide competence to deal with electrical matters, which must always be dealt with by a suitably qualified person.

Training

It is of paramount importance that **lifting equipment inspectors or examiners do not work on live electrical equipment.** Lock-out/Tag-out routines should always be considered as part of your risk assessment.
Under no circumstances should inspectors/examiners whom are not suitably and sufficiently qualified (as required by local legislation) attempt to work on live electrical equipment; this should not be required as part of a thorough examination as the equipment should be isolated following the initial operational/functional checks.

7. Principles of Pneumatic Machines

Introduction

It should also be noted that this module is written in a simplistic form that is intended to establish only some basic principles. The aim is to give those with little or no knowledge of the subject a basic understanding and to provide the basis for further self-development.

This module will help examiners/inspectors whom have dealings with pneumatically powered lifting equipment to understand the principles, recognise the layout and individual items, and be aware of associated dangers.

Pneumatic Machines

The use of pneumatic powered lifting equipment has many safety features over electric powered equipment.

One of the main safety features when compared to electricity is that the equipment is usually fail-safe.

When the air supply fails and the brake is open, or if the brake fails, the motor will not stop the load from dropping but will usually lower it in a controlled manner.

Another, related feature is that it is impossible to overload the motor. The motor will only turn if the air pressure is sufficient. If the air supply is at the correct pressure an air hoist can only lift its design load. If the pressure is lower than intended, or if too great a load is applied, the motor will stall and this will not damage the motor, unlike an electric motor that would burn out.

Air hoists cannot therefore be overloaded under correct air supply conditions.

The speed of air driven motors is infinitely variable:

- The amount of compressed air provided, i.e. the delivery rate, governs the speed
- By control of the valve, the operator can regulate the air flow and therefore control the speed of the hoist
- If the delivery rate of the air supply is below that intended, but at the correct pressure, the hoist will operate at a slower than intended speed
- If the delivery rate is correct, but the pressure is too low the hoist will still operate but at a reduced load

Pneumatic equipment is by nature spark proof; it can therefore be used in hazardous atmospheres.

- Air motors are self-purging, that is to say any moisture or small particles that are present in the air supply will be expelled with the exhausting air. They also employ the minimum of moving parts
- These features minimise maintenance and cleaning requirements. However, this does have an associated disadvantage, exhausting air is noisy
- Although silencers/baffles can be used to lessen the sound, icing can then be a problem
    - Section 5.10.2.1 of BS EN 14492-2 states that pneumatic motors “shall not create additional hazards by heating up nor by icing up”

- Exhaust air creates a high noise level if the air is allowed to exhaust freely into the atmosphere. The noise from an air motor consists of both mechanical noise and a pulsating noise from the air flowing out of the outlet
    - Various types of exhaust silencers are used to reduce noise level. The most common type screws directly onto the exhaust port of the motor

Despite the advantages, the utilisation of pneumatic lifting equipment is only small when compared to electricity. It would for example, be extremely expensive to install an air compressor solely for running a hoist.

The Vane Motor

Pneumatic vane motors have the advantage of being very compact, having only one moving part, and being easily maintained. As a result, very neat lightweight hoists with low headroom are easily produced. They are hard wearing and require the minimum of maintenance.

Vane motors consist of a rotor which revolves in an eccentrically offset perforation of the rotor cylinder.

The vanes form working chambers, the volume of which increases in the turn direction.

As the compressed air expands, the pressure energy transforms into kinetic energy, producing the rotary motion.

The vane motor has a cylinder casing of high grade nodular cast iron to give excellent abrasion resistance. The vanes are usually made from a fabric-based Bakelite material which is strong, light, quiet and has good sealing properties.

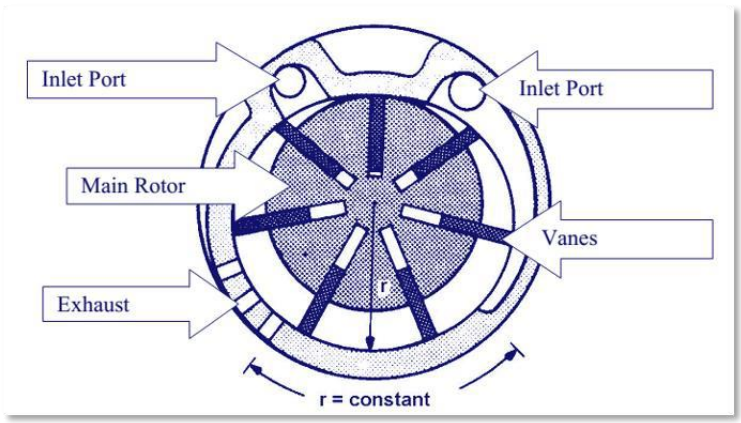
The vanes will wear in preference to the casing and will need to be replaced from time to time. This can be done at minimal expense. The rotor and shaft are made from alloy steel.

A Selection of Motor Vanes

The rotor is mounted towards the top of the casing cylinder so that the arrangement has an eccentric contour.

This means that when a vane is working under pressure across the lower section, i.e. when it is transmitting maximum torque to the rotor, it is working at a constant force on the projected area of the vane and eliminates the risk of air leakage.

In operation the vanes are forced against the cylinder wall to achieve a good seal. Some motors use spring loaded vanes but most now use air loaded vanes.



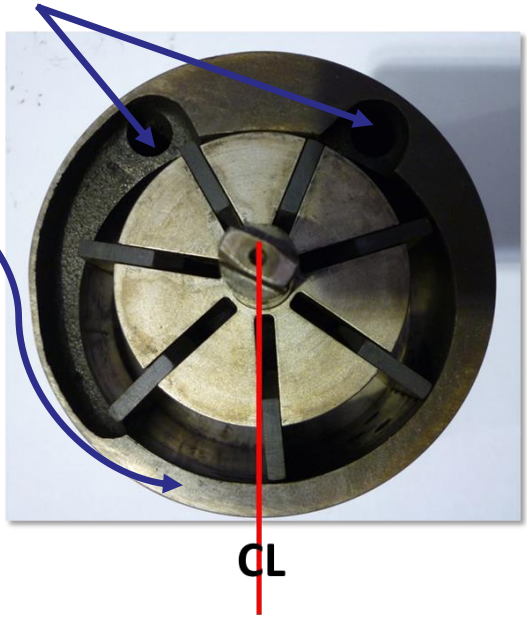
When air is initially supplied through one of the two ports at the top of the cylinder a small amount is directed under the vanes forcing them against the cylinder wall.

When a predetermined pressure is achieved the air is then directed into the cylinder to drive the motor.

The direction of the motor is governed by the air **entry port** selected.

One port acts as the inlet whilst the other remains closed, the air **exhausts** from the bottom of the cylinder to one side of the centre on the clockwise rotation of the motor (i.e. the lift side).

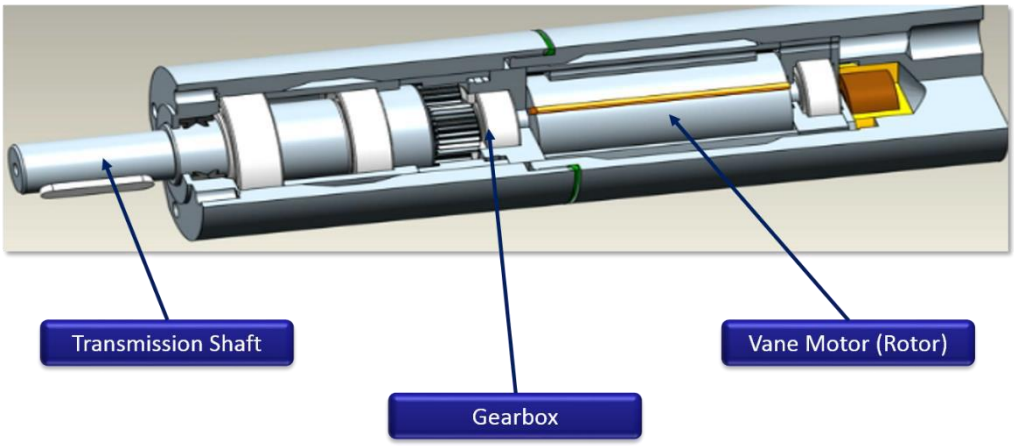
The motor is then reversed by changing supply ports so that now the air exhausts before the **centre line** of the cylinder. This has the advantage of giving air motors an important safety feature. If the air supply should fail whilst the brake is open, or if the brake fails, the motor will try to turn due to the downward action of the load, but this causes it to act as a compressor. It will then build a resisting pressure in the motor casing which in turn prevents further movement of the motor.



Notes:

Due to loss of pressure through leakage the motor may in fact continue to turn and lower the load but the motion will be extremely slow so, although not strictly true, air motors can be considered to be fail-safe.

The drive from the motor is transmitted to the gearbox by a transmission shaft.



Requirements of BS EN 14492

BS EN 14492 is the current harmonised standard for Cranes – Power driven winches and hoists:

- Part 1 – Winches
- Part 2 – Hoists

The standard applies to the design, information and use, maintenance and testing of power driven hoists with or without travelling trolleys for which the prime mover is either an electric, hydraulic or pneumatic motor.

- All components and materials of equipment shall be compatible and suitable for the anticipated ambient conditions
- Sufficient air pressure shall be available for all operating modes at any point of the equipment in order to fulfil all functions. A loss in pressure shall not result in hazards
- System reaction times as a function of control line lengths shall be reduced to a minimum
- Triggering of machine movements by venting control lines is not permissible
- Control equipment for starting pneumatically operated hoists shall automatically return to the neutral position after being released
- Power valves shall have sufficient venting cross sections in their neutral position, to prevent malfunction of the brake

Note: Due to the pneumatic drive characteristics, significant differences of lowering and lifting speed may exist.

Notes:

Inspection/Examination

- Check that the control mechanism works easily and that a distinct 'OFF' position can be obtained
- Check that the air supply is clean and lubricated in accordance with the manufacturer's instructions. Dirty or unlubricated air can lead to wear of the motor and valves and possible seizure
- Check the transmission system for smooth running
- Check the motor for leaks and free running
- Check main valve for leakage and smooth operation
- Check the valves for leakage and the integrity of the sintered bronze filter in the housing

It is of paramount importance that **lifting equipment inspectors or examiners do not work on live pneumatic equipment.** Lock-out/Tag-out routines should always be considered as part of your risk assessment.

Notes:

8. Power Supply Systems

Introduction to Power Feed Systems

Electric Power Operation

Electricity is the most common form of power used with lifting appliances. It is used on blocks, winches, trolleys and cranes to provide power for both lifting and travelling or slewing motions.

Although examples of DC supply appliances still exist, AC supply is considered to be the norm. Most types of electric power operated lifting appliances are available for three phase operation. Single phase and low voltage hoists and winches are available in the lower capacities and some types of vehicle winches are available for battery operation.

Pneumatic Power Operation

Pneumatic power operation is used on hoists, trolleys, winches and some cranes. It is less efficient and more difficult to carry to the appliance than electricity. For this reason, it is less common in general use than electricity, but it has many advantages making it more suitable for certain applications.

Hydraulic Power Operation

Hydraulic power is the least common form of power operation associated with lifting appliances, usually being restricted to special purpose equipment and to some types of winch.

Electrical Supply Systems

The use of electricity is highly developed throughout industry. It has the advantage over other forms of power of being more readily available and is easily carried from the power source to the appliance by cable or bus-bar conductor systems.

As a result, electricity is the most common form of power associated with general purpose lifting appliances.

The dangers associated with electricity are well known and there is much experience in protection to guard against them and in overcoming them. It is necessary to protect the operative from the dangers of electric shocks, either by insulation or by the use of low voltages.

Single phase and low voltage drives are less common in lifting appliances and are restricted to the lower capacity items due to the difficulties associated in providing motors of adequate capacities and ratings. It is therefore more normal to protect the operative by the use of low voltage control circuits as it is in this area that the main danger to the operative exists.

The current supply should include a means of isolating the equipment from the power source. In practice, switch fuses and isolators are used to fulfil this requirement. The isolator, which is considered to be part of the supply system, should be positioned at the start of the conductor system so that the system will be isolated from the power source as well as the appliance.

Electricity has the disadvantage of requiring special protection in certain environments, e.g. explosive atmospheres, and steps are necessary to contain the danger within the appliance. Such appliances and their power feed systems are far more expensive than standard equipment. They tend to be heavy and bulky and armoured cable offers little flexibility making travel difficult.

Various types of conductor systems may be used to carry the supply to travelling hoists and cranes.

The main factory supply is taken to a point adjacent to the equipment and terminated with a switch fuse/isolator. The power feed to the actual hoist or crane is then taken from this in one of several ways.

There are five basic power feed systems that are commonly used for electrically powered hoists:

1. Coiled cable
2. Cable reeling drum
3. Festoon cables
4. Insulated conductors
5. Energy chain cable carriers

In the past, bare copper conductors were used to provide a power supply for overhead travelling cranes. They are no longer considered suitable in all cases and are not used for new power supply installations. We will consider these systems and the limitations/dangers they present.

Bare Copper Conductors

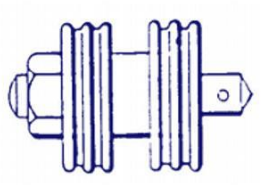
Although this system is considered unsuitable for new installations nowadays, it was widely used in the past on all types of installations. Many of these old installations may still be found in service.

The general advice is to review the installation;

- It may be that the bare wires present a possible danger to people working in the area
    - In this case the advice must be given to change this for a more suitable supply system
- On the other hand, it may be considered that the system is safe by virtue of its position
    - In this case it may be left in service

The owner has a responsibility under section 2 of the Health and Safety at Work Act to provide safe systems of work and it is his responsibility to change this if it is considered necessary.

In this system copper wires are stretched parallel to the beam by means of strainer screws with insulators. A collector bracket is fitted to the hoist on which are mounted the collectors.

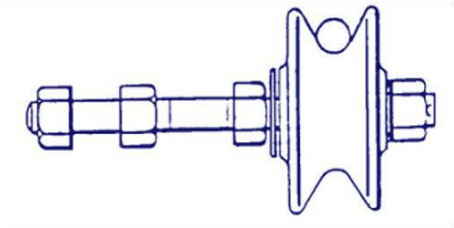


Insulating Conductor Bracket

The most common form of collector is the bronze roller, graphite bushed, thus providing good electrical contact and bearing surfaces. Each collection shaft is insulated from the collector bracket.

For long runs the wires are supported on porcelain reels, the collectors lifting the wires off the reels as they pass over them.

As bare copper wires are not generally recommended they have been superseded by safer and more efficient systems.

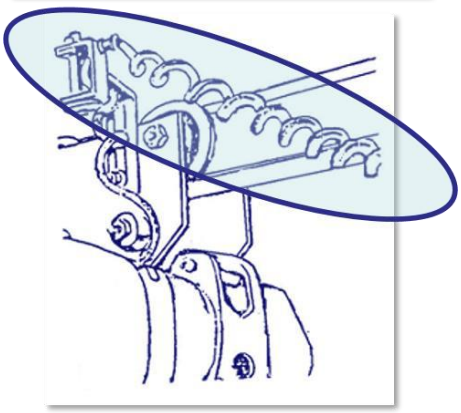


Wheel Type Collector

Coiled Cable

In the coiled cable the conductors are contained in a PVC compound insulate which is coiled in a similar manner to a tension spring. The cable is fixed to a swivelling bracket on the side plate of the trolley with the supply end fixed at a convenient point adjacent to the runway.

As the hoist is moved along the runway so the cable expands, when the hoist is moved back so the cable contracts. This type of cable is suitable where only short travel distances are required due to the sag in the cable. The normal extension ratio of such a cable is 3 to 1 with a nominal 3 metres extended length.



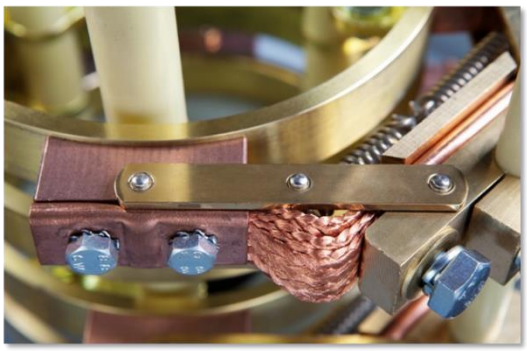
Cable Reeling Drum

The cable reeling drum provides a means of power on control using a flexible cable wound onto a drum which can be played out and then recovered. At the heavy end of the range reeling drums can be very large and equipped with geared motors actuated by torque sensing for cable recovery. This unit deals only with the more common spring operated type.

Construction is very simple, comprising a steel drum mounted on to a fixed shaft and rotating on sealed bearings. The power feed cable is clamped to the drum; the wire ends being connected back to carbon brush gear which rotates with the drum. The power feed to the drum passes through the fixed shaft to the slip rings which are fixed.

Slip Rings

Slip Ring Assembly



Slip Ring Brushes

Cable Reeling Drum

Since a reeling drum spiral wound spring does not provide a constant torque, spring selection is very important.

The cable should not be overloaded by too great a tension or have too much slack, nor should the appliance run back (a possible hazard with coiled cables and reeling drums if used in association with light weight push/pull trolleys).

Before a drum can be selected the cable size must be determined taking a number of factors into account:

- **Voltage Drop** - Unless it is otherwise stated it is usual to work to IEE Regulations which state that voltage drop shall not exceed 5% of the rated voltage based on the normal operating current, subject to confirmation from the manufacturers of both drum and cable
- **Temperature Correction** - Generally for ambient temperatures above 30°C the continuous rated current capacities should be eliminated
- **Reeling Configurations** - Rated cable capacities should be further de-rated according to the configuration of the reel to be chosen
- **Short Time Rated Motors** - In many cases the motors on a lifting appliance may be short time rated thus allowing cable carrying capacities to be increased

Note: Although not expected to design electrical power supply systems the Tester and Examiner would be expected to understand the fundamental requirements of a system to enable him for example to identify the reason for a performance deficiency of a hoist under test.

Cable Selection

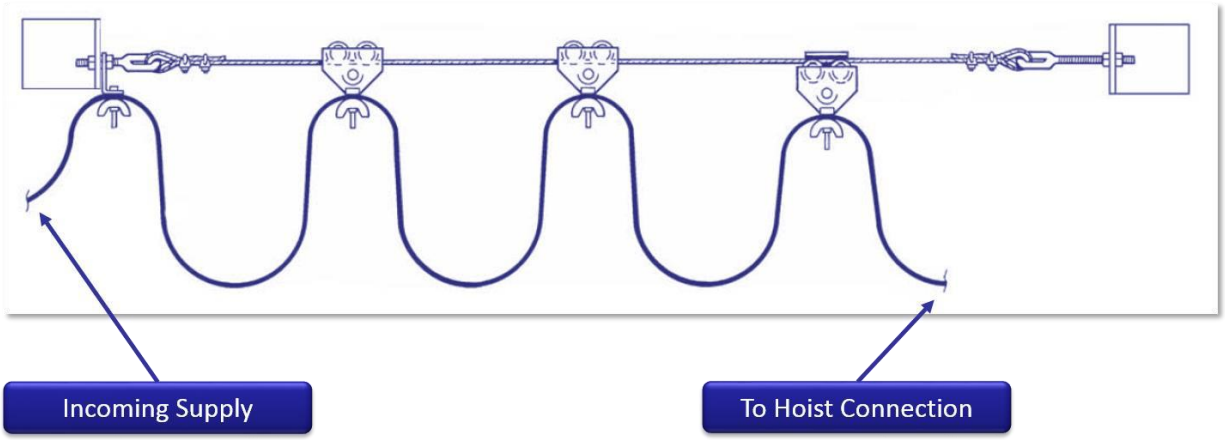
In practice the cable would be selected based on the criteria discussed against technical data provided for a particular product.

An example of cable selection will be discussed in the next section (Festoon Cable Systems) since it could apply to both systems.

Festoon Cables

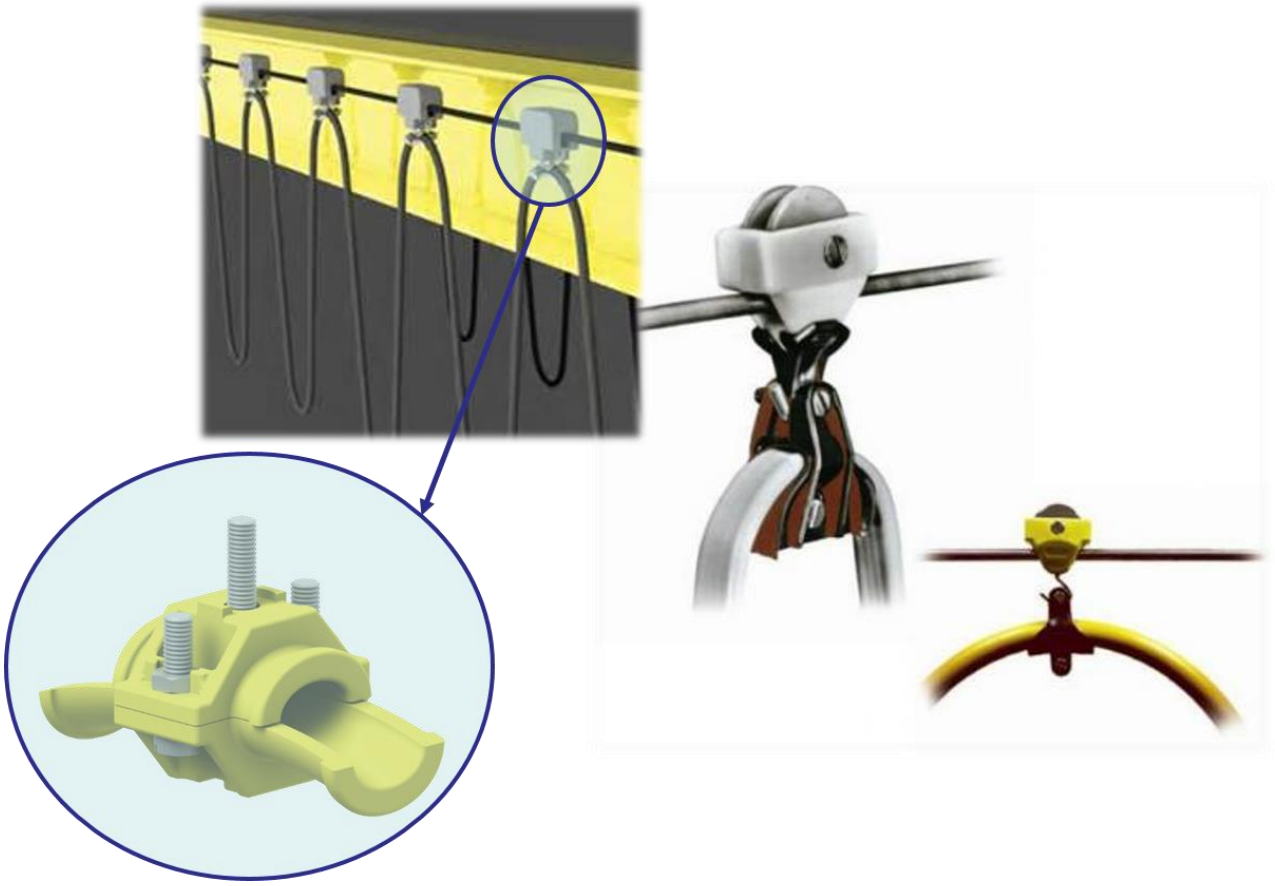
Taut Wire

The taut wire system is suitable for light duties over lengths not exceeding 30 metres and is simple and economical to install. The strainer wire is made taut by means of straining screws whilst the cable is carried on trolleys.



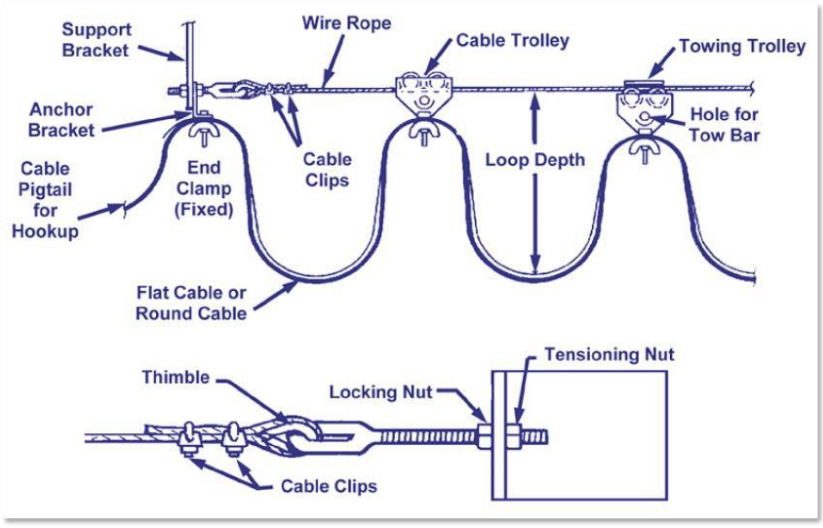
Notes:

Festoon Trolleys



Festoon Cables

Typical taut wire system:



Notes:

Tracked Cable Systems

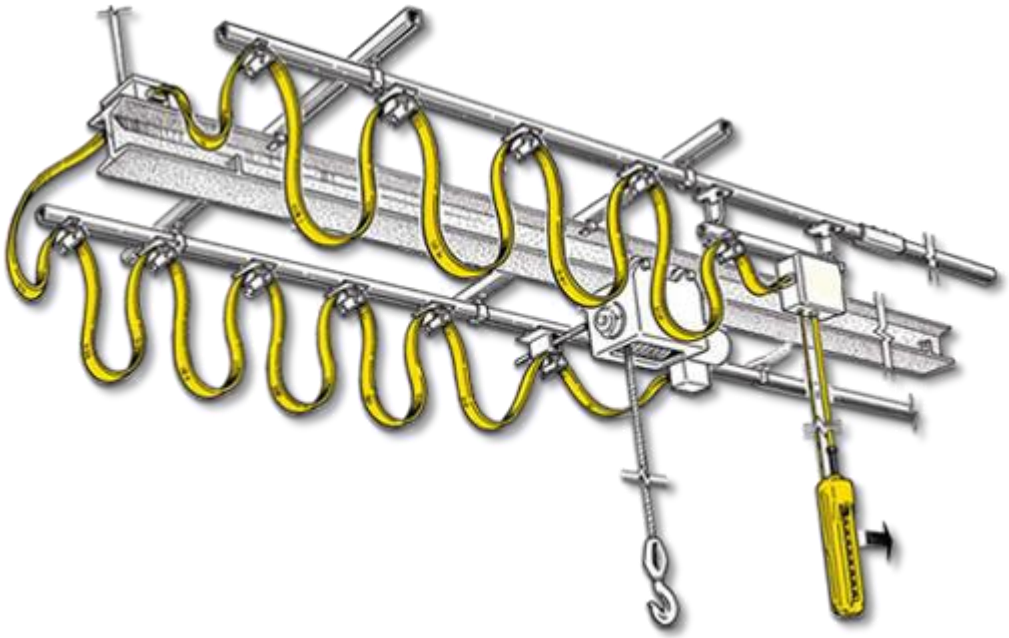
The tracked system is a development of the taut wire system. It can support greater loads and is suitable for higher speeds. Most systems incorporate an inverted `U‘ or ‘C’ section track, the cable support trolleys running on the two inner ledges.

The manufacturers of these systems offer a range of profile sections for most loading conditions from light to heavy duty.

The tracked festoon systems are very safe with perfect insulation hence no loss of energy or voltage drop where current has to pass from conductor to collector. Also on long track installations the size of cables would need to be increased to limit voltage drop hence requiring a heavier track system to support them.

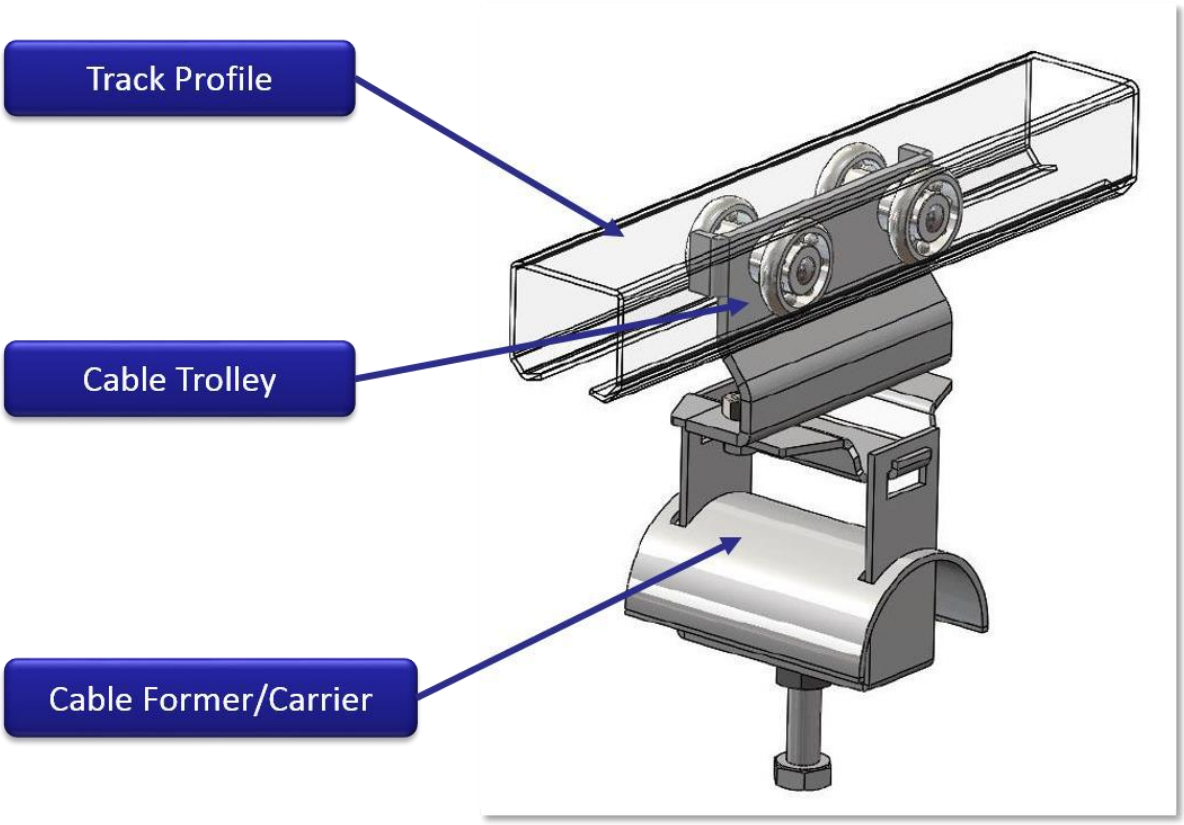
In many cases a lifting appliance will have two festoon tracks one to carry power to the hoist the other providing a mobile pendant push button box, e.g. on the bridge of the crane.

When a mobile pendant push button box is fitted the festoon cable will terminate in the pendant control box from which is suspended the push button box by means of the pendant cable.

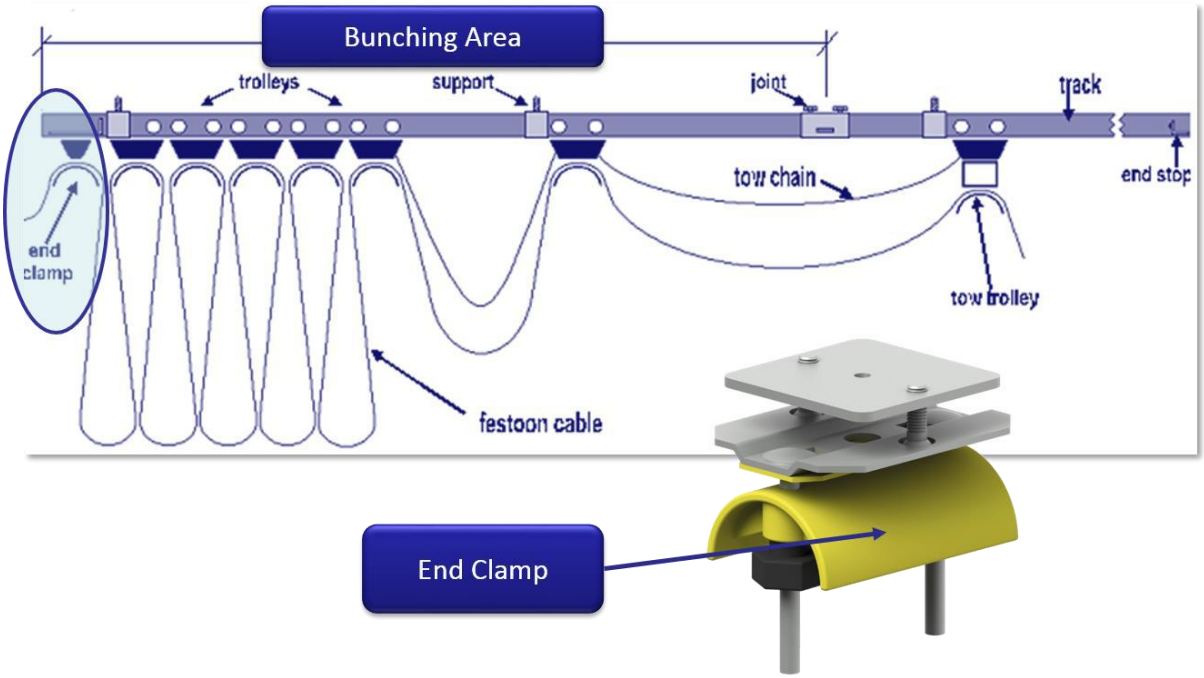


Notes:

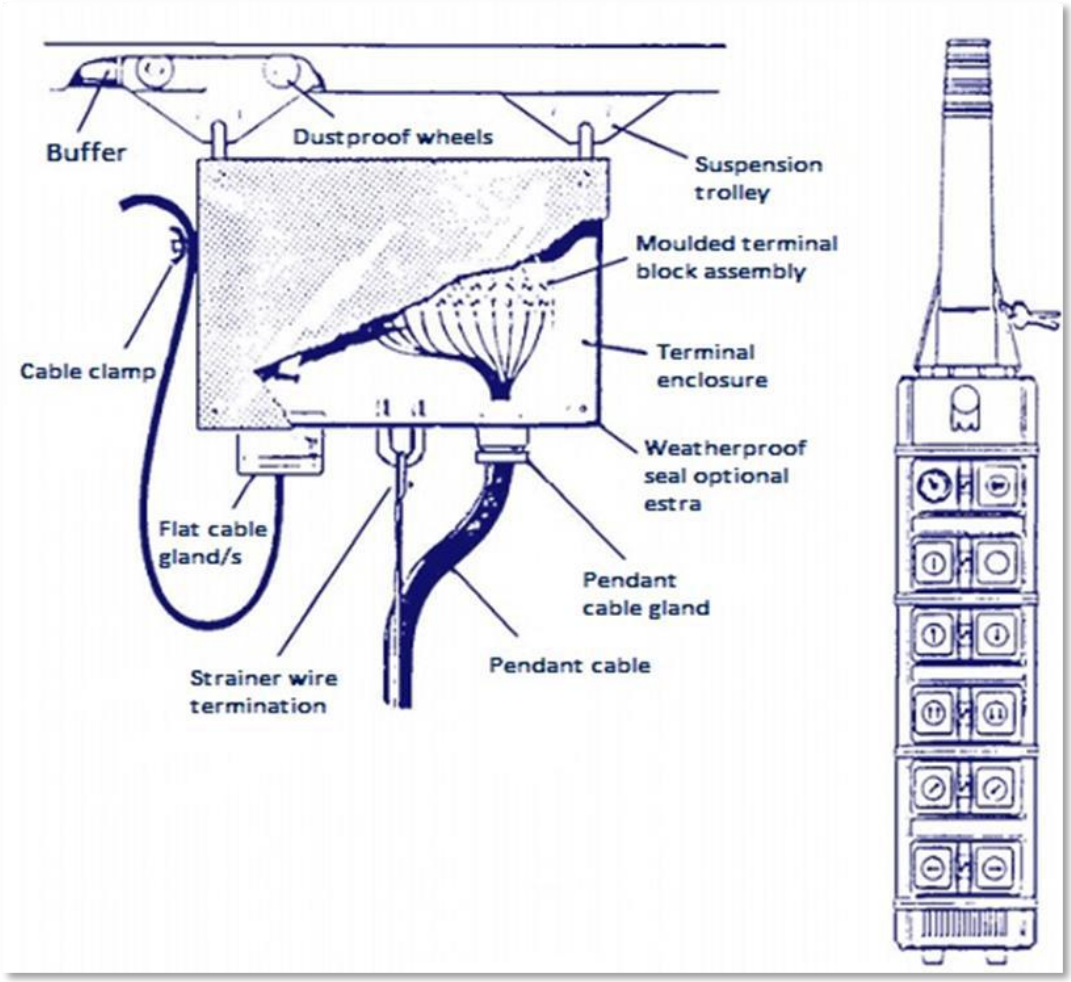
Typical components of a tracked festoon cable supply:



A limiting factor of the festoon system could be loss of travel of the hoist unit due to bunching of the trolleys especially on long track applications.



Typical mobile pendant push button box assembly and connection to the pendant connection box on the festoon:

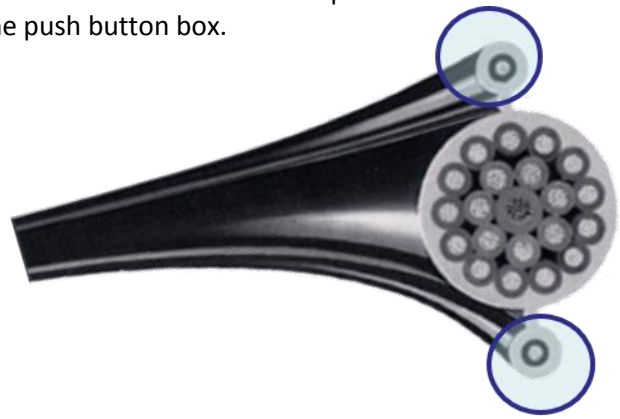


Hoist Control

With the majority of electric hoists, the contactor panel is mounted on the main frame and therefore travels with the hoist. It is recommended practice that control voltages should not exceed 115 volts which is achieved by transforming down from a single phase of the three phase supply. The low voltage control signals are transmitted via the push button box and multicore pendant cable to the hoist contactor panel.

Pendant Cables

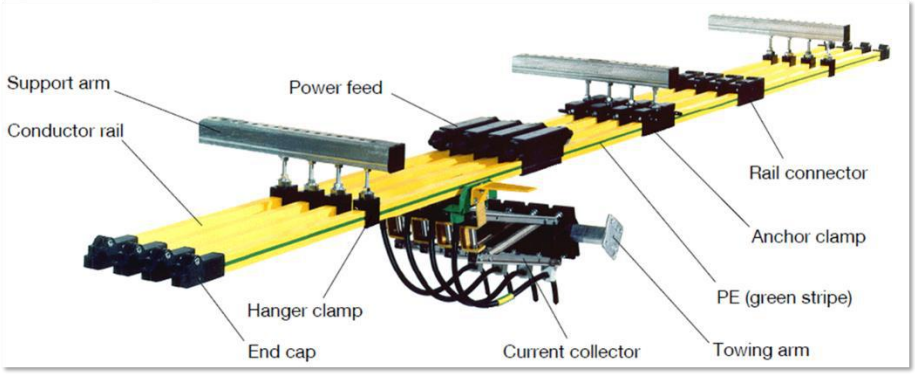
Pendant cables may have as many as 25 separate cores depending on the number of push buttons/motions required. The modern pendant cable has two independent strainer wires built in to support itself and the weight of the push button box.



Insulated Conductors

Shrouded Conductor Systems
Shrouded conductor systems are of various cross sections and the conductor bar is sufficiently shrouded with a PVC cover to ensure finger safety yet provide access for a collector shoe to pick up the current.

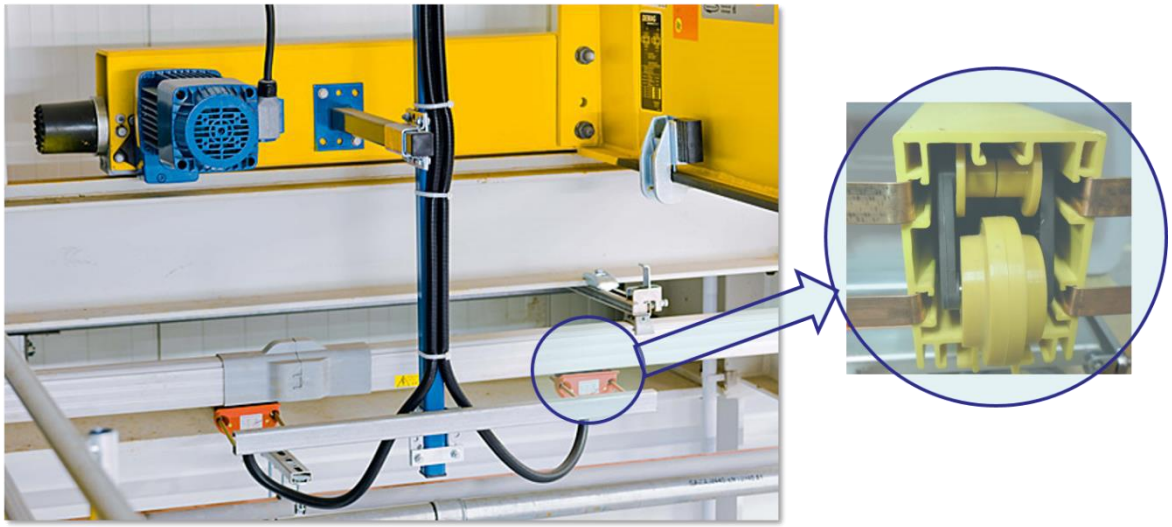
Typical components of a 4-bar (3 x phase and 1 x Earth conductor) shrouded system:



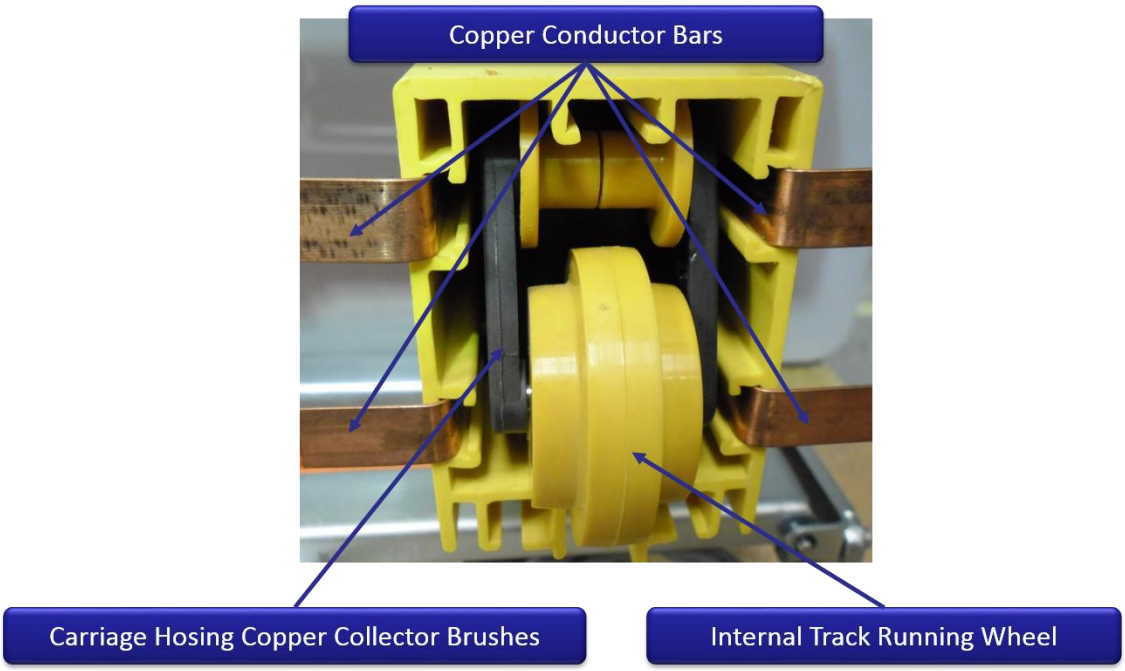
The collection assembly is spring loaded to ensure good contact with the conductor bar and articulated to enable the contact shoe to follow the track without binding.

Totally Enclosed Conductor Systems

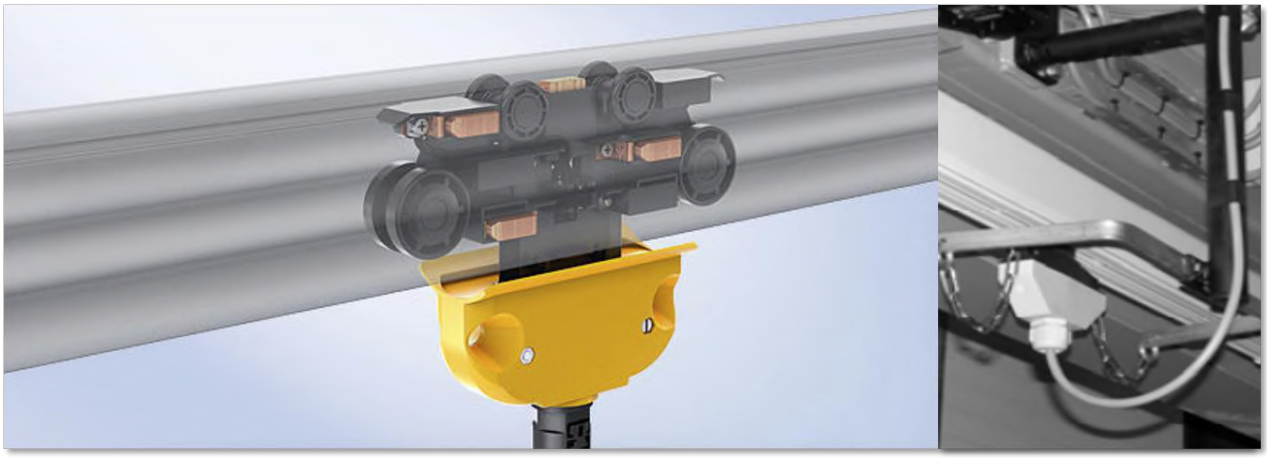
A totally enclosed conductor system is used where multiple conductors are required in one housing. It is a rigid and compact system. They are commonly used in overhead crane applications but also for traveling hoists.



Notes:



The illustration below shows how the fully enclosed conductor head collects the power from the enclosed bus-bars and feeds this direct to the hoist.



The merits of shrouded conductor systems are a much greater protection against accidental contact and a suitability for long runs since intermediate feeders can be added.

These systems are available up to 300 amps. They are however unsuitable for flame proof or similar applications.

Higher operating temperatures can be achieved by using polycarbonate covers (-40°C to 121°C) or laminated fibre glass (-45°C to 149°C).

Expansion

With any rigid system particular attention must be paid to expansion and expansion couplings fitted, in accordance with manufacturers recommendations, if problems are to be avoided.

Shrouded Conduction Systems

With the shrouded conduction system, the power feed need not be connected to one end. By connecting in the centre rather than to one end voltage drop is halved and by connecting a power feed to each end the voltage drop is halved again.

Energy Chain Systems

Most energy chain cable carriers have a rectangular cross section, inside which the cables lie.

Cross bars along the length of the carrier can be opened from the outside, so that cables can be easily inserted and plugs connected.
Internal separators in the carrier separate the cables. Cables can also be held in place with an integrated strain relief.
Mounting brackets fix the ends of the carrier to the machine.

Besides only bending in one plane due to the rigid jointed structure, cable carriers also often only permit bending in one direction.

In combination with rigid mounting of the ends of the carrier, this can prevent the enclosed cables from flopping in undesired directions and becoming tangled or crushed.

Cable carriers are used anywhere on cranes where moving components require power, control and communication power feeds in a flexible media.

Energy chain cable carriers are quiet in operation, lightweight and provide covered cable design and that can be quickly opened. They can be used in extreme conditions such as heat-resistant or clean room environments.

Compressed Air Supply Systems

The production of a clean, dry supply of compressed air suitable for pneumatic power operated lifting appliances is expensive and it is less easily carried from the power source to the appliance than electricity.

Due to these reasons, its use is more limited than that of electricity.

Although electric power operated lifting appliances are the usual choice for general purposes, pneumatic power operated appliances have advantages for certain applications as most of the dangers associated with electricity do not exist with compressed air.

Standard pneumatic equipment is flame proof.

It can therefore be used in atmospheres where electric equipment would require special insulation and protection to contain the danger.

With pneumatic equipment, this danger does not exist.

Pneumatic motors offer variable speeds of operation.

Air flow rate to the motor is controlled by the operative via a supply valve. By careful manipulation the operative can control the air delivery rate, the motor speed being governed by the volume of air supplied. At normal working pressure it is impossible to overload a pneumatic motor.

Once the load increases beyond the design load of the motor, it will stall and, unlike an electric motor, it will not be harmed by this

Although pneumatic motors are robust in design, capacity for capacity they tend to be smaller and lighter than equivalent electric motors. They will withstand a high degree of heat and moisture. Due to the internal pressure whilst in operation, the motor is self-purging.

This makes standard pneumatic equipment suitable for use in steamy atmospheres, such as paper mills and laundries, and in dusty conditions, such as flour mills without any special steps being taken, unlike electrical equipment which requires enclosures to protect the equipment from their effects.

Compressed air is less efficient than electricity. It contains a high proportion of moisture which has to be removed.

Whilst motors will purge and expel this moisture when in operation, condensation will occur when the motor is idle. This will lead to corrosion and contamination of residual lubricants unless steps are taken to prevent this.

Pneumatic appliances usually exhaust spent air to atmosphere direct from the motor. Although compressed air is generally considered to be less dangerous than electricity, some dangers do exist. Small leaks are usually harmless, though expensive. However, in dusty environments exhausting air and leaks can cause particles to be propelled through the air and be a hazard to eyes etc.

Inspection/Examination (Ensure Lock Out Tag Out Isolation)

Following total isolation of the power supply using a lock-out/tag-out routine:

Bare Copper Wires

Assess if the system is safe, if it is the following checks should be made. Check wires for burns due to arcing, replace if burns exceed 25% of diameter. Check collector shoes for burns and if roller collectors check for burns, loss of metal and wear of graphite bearings.

Most burns are caused by vibrations or defective collector mechanisms. Wires must not be greased as this will cause arcing.

Coiled Cable

Check PVC cover for cracks in the insulation especially at terminations. Replace if cracked or damaged. Check security of terminations, cable glands etc.

Cable Reeling Drum

Check drum for smooth running. If movement is erratic bearings should be checked. Check slip rings, carbon brushes and pressure springs. Check cable tension with drum fully wound, check cable tension with cable fully extended, i.e. the hoist at the opposite end. Check spare rotation capacity of drum and for a minimum of two remaining turns of cable on the drum. Check cable for cracks and damage.

Festoon Systems

Check taut wire anchors and runners for free movement. If a track system, inspect each joint section is tight and properly closed up. Inspect cable for cracking, check for loose trolley clamps. Additionally, in the case of festoon control systems, check pendant control box is running freely, festoon and pendant connections are secure. Check pendant secure to push button box. Check operation of buttons including any emergency stop and key switch etc.

Shrouded Conductor Systems

Check for tightness of joints, signs of burning and that covers are in place. Check shoes for wear and alignment. Check spring tension and general operation.

General

All power feeds must terminate at a fused, lockable isolator. This should have good access from the shop floor and be clearly identified. The isolator is considered to be part of the power feed system and should also be carefully examined for correct operation.

When examining a supply system, hoist or crane, the isolator should be locked off with an approved locking mechanism for safety.

It is of paramount importance that lifting equipment inspectors or examiners do not work on live equipment. Lock-out/Tag-out routines should always be considered as part of your risk assessment and equipment must be checked by a Competent Person to confirm power supplies are isolated before work commences.

Notes:

9. Electric Chain Hoists

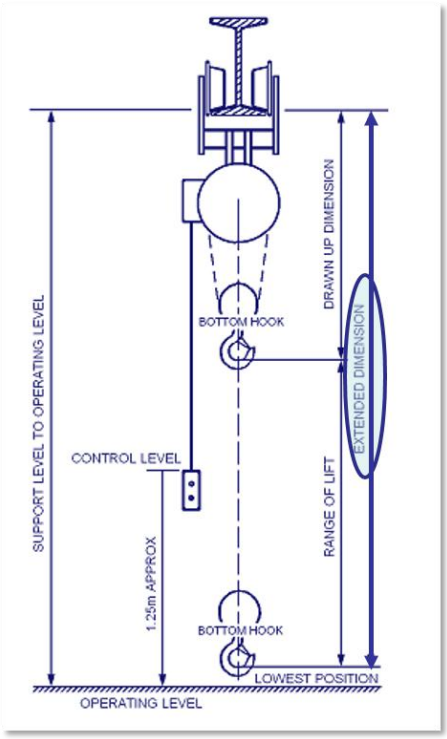
Introduction to Electric Chain Hoist

The electric chain hoist, similar to the wire rope hoist, has become a much more compact unit with the passage of time.

Power operated hoists are ideal for heavier or repetitive lifting applications as they offer the following advantages over manually operated chain hoists:

- Speed of operation
- Less fatigue for operatives, particularly on long lifts
- Operatives may be remote/away from the load

Most manufacturers and suppliers offer a range of accessories such as power feed systems, slack chain collecting boxes, weatherproof covers and remote control units.



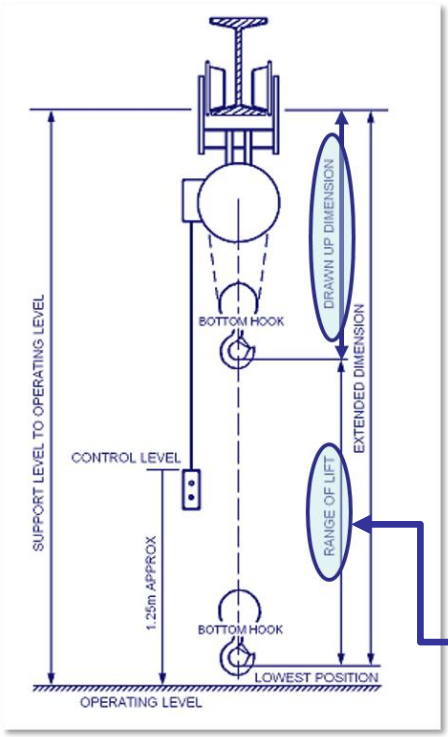
Definitions and Terminology

Hoist or Block?

The electric chain 'hoist' was previously known as the electric chain 'block'. This is because in older legislation, the term 'hoist' had a different legal meaning. As this no longer applies, we now refer to the unit as a 'hoist'.

Extended Dimension

The extended dimension is the distance between the support level and the bottom hook seat in the extended position, as shown opposite:



Drawn up Dimension

The drawn up dimension is the distance between the support level and the bottom hook seat when the bottom hook is in the raised position.

This is sometimes referred to as the 'headroom' as it is the effective headroom taken up by the hoist. However, the term headroom has not been used as it is sometimes used in everyday language to have other meanings.

Range of Lift

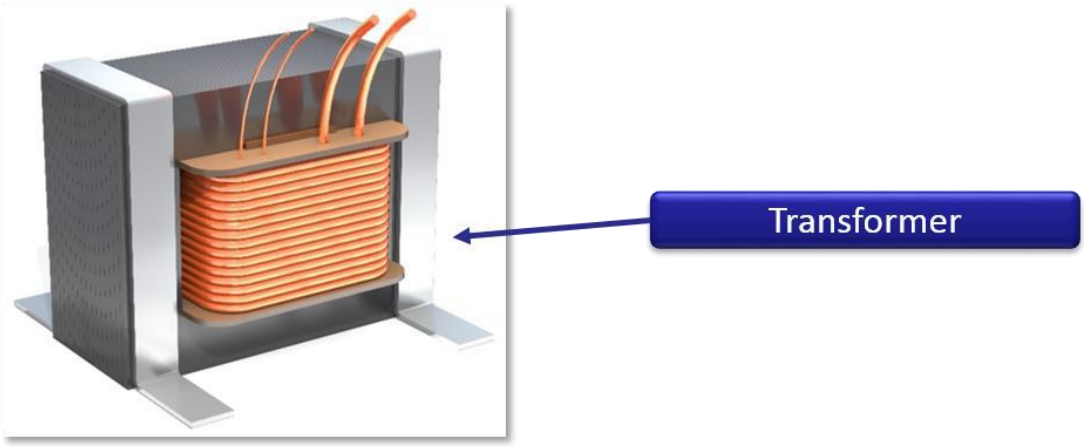
The range of lift is the vertical distance which the bottom hook travels between the extended and drawn up positions

Electrical Supply

Electric chain hoists usually require a 3 phase AC supply current. Some of the lower capacity models are available with single phase or low voltage motors.

Low Voltage (LV) Control

Modern electric chain hoists are normally fitted with low voltage control which is derived internally within the unit by transformer. This is usually in the range of 24 to 50 volts AC or DC and is often known as 'Extra Low Voltage'. Older hoists and special purpose hoists may not have LV control. It should also be noted that it is common in many European countries to use mains voltage control.



General Operation

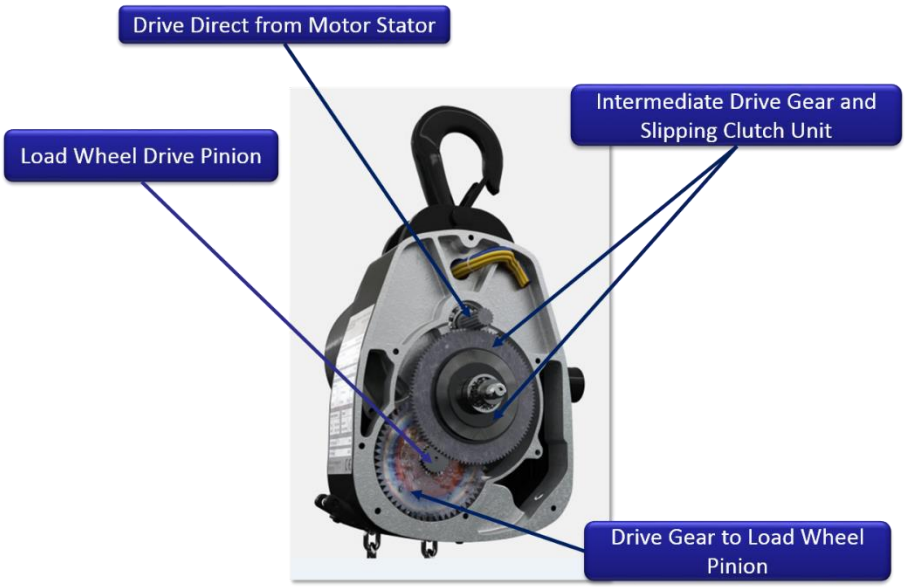
The electric chain hoist, similar to the wire rope hoist, has become a much more compact unit with the passage of time. Although safety is of paramount importance cost has obviously played a major part in this development.

An older type hoist of which is still found in service is shown below. Whilst the configuration is different to that of a modern hoist, the general operating principles are similar.

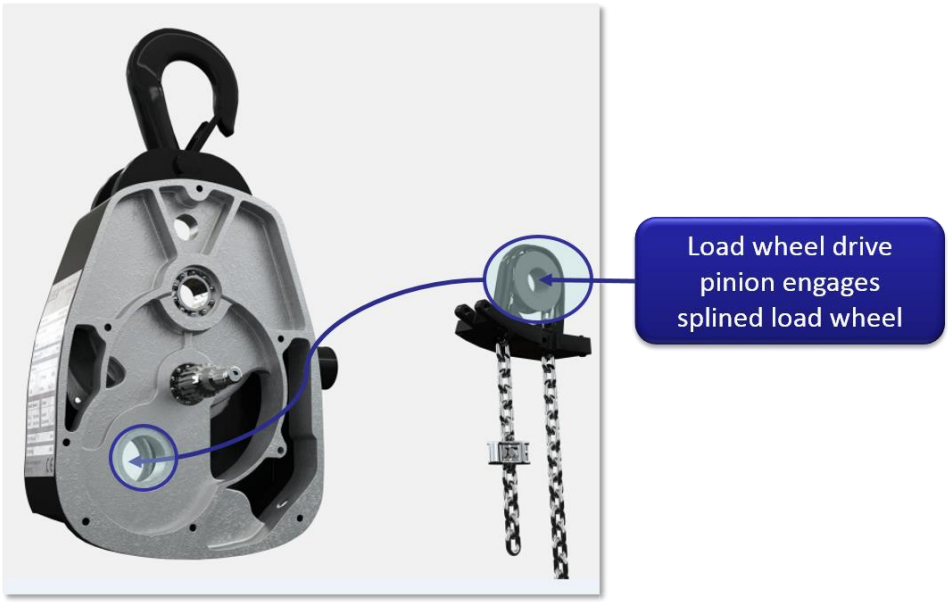
In the model shown opposite, upper and lower limit protection is only provided by means of a slipping clutch.

The following illustration identifies the parts of the hoist and its operation.

Notes:

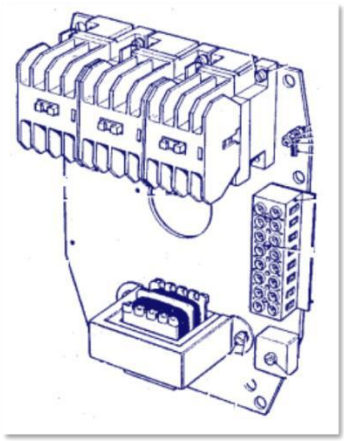


Removing the load wheel and chain guide assembly, it is easy to see how the load wheel is driven by the splined drive shaft from the gearbox.



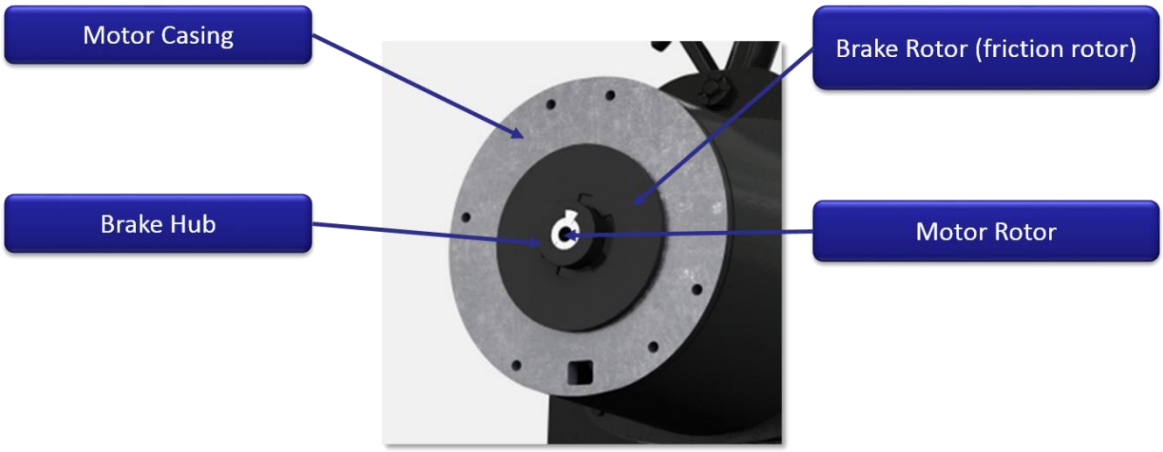
The hoist brake is located on the back of the motor. The brake hub which drives the brake rotor (a rotor with friction linings embossed onto both faces) is keyed onto the motor rotor shaft. Power to the DC electromagnetic brake is provided by cables from the control panel which is mounted to the gearbox cover.

Hoist Brake

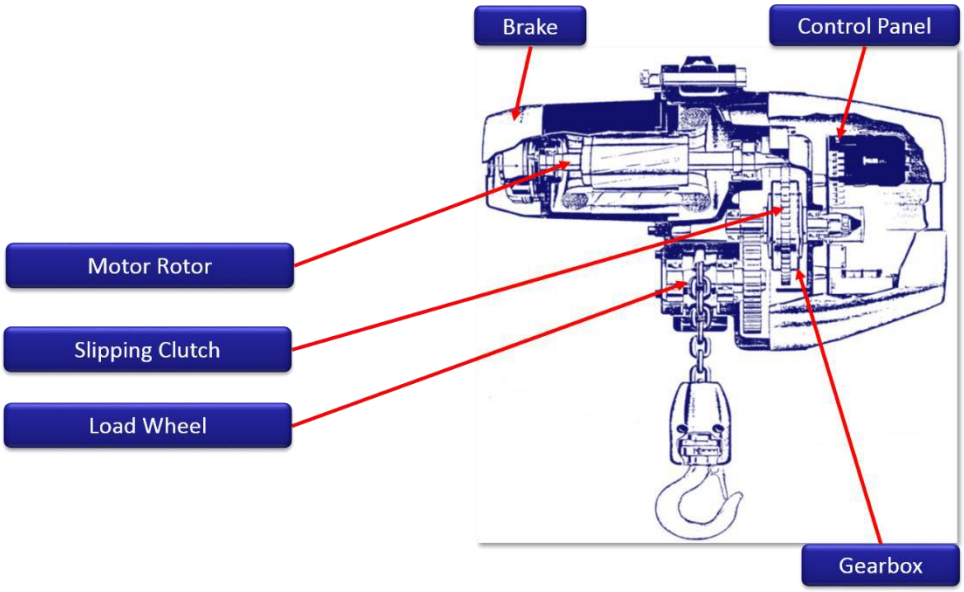


Typical Control Panel

The image below shows the brake hub attached to the motor rotor and the brake rotor (friction rotor).



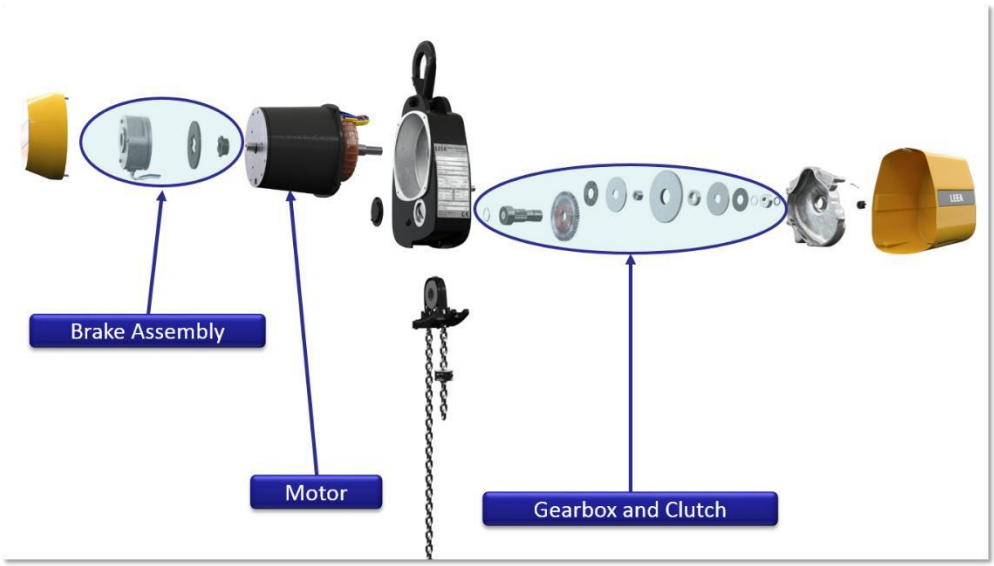
With the DC electromagnetic disc brake, (covered in Module 13 of this course) when the power to the motor is ON, the brake will be OFF, allowing the motor rotor to turn, engaging with the gearbox, through the slipping clutch and providing drive to the chain load wheel.



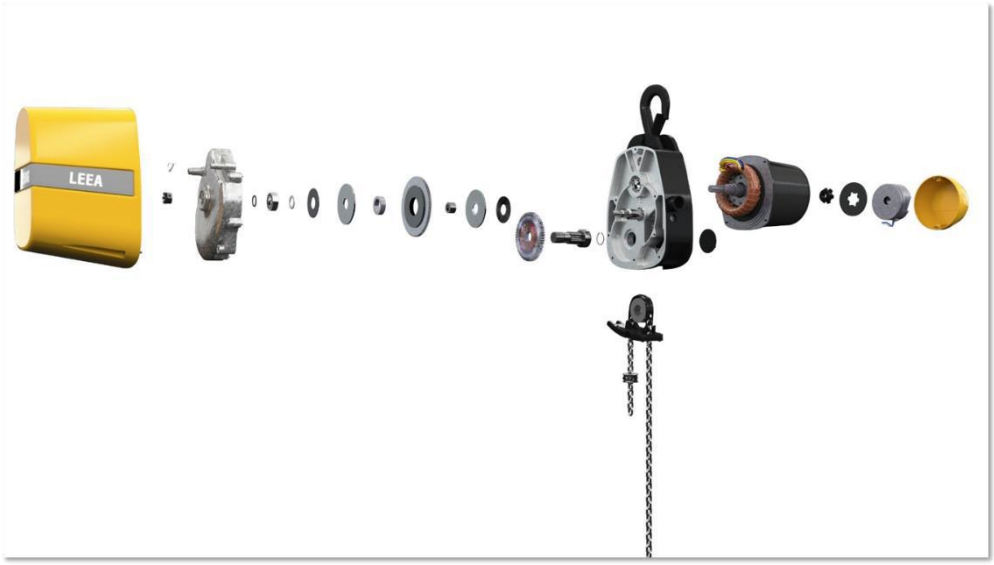
When power to the motor is OFF, the disc brake will be de-energised and the brake will be ON. This will stop the motor rotor from turning and in turn, the drive to the load wheel.

Notes:

Exploded View



Exploded View (Reverse)

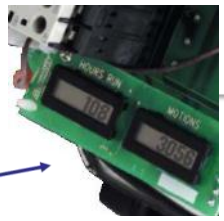


General Operation

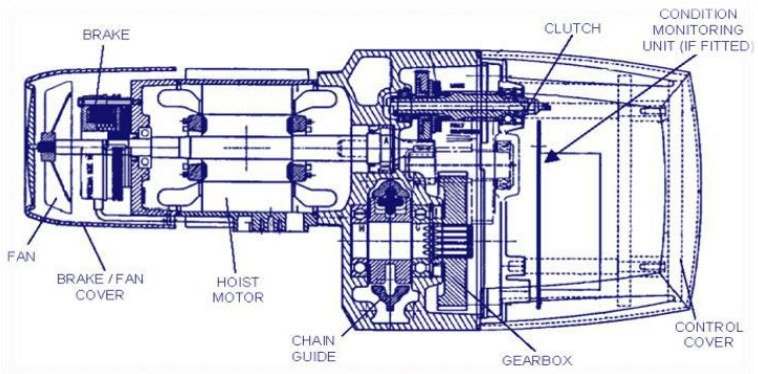
The hoist shown here operates in a similar way to the unit we have previously explored, but its configuration provides better headroom by incorporating a planetary gearbox.

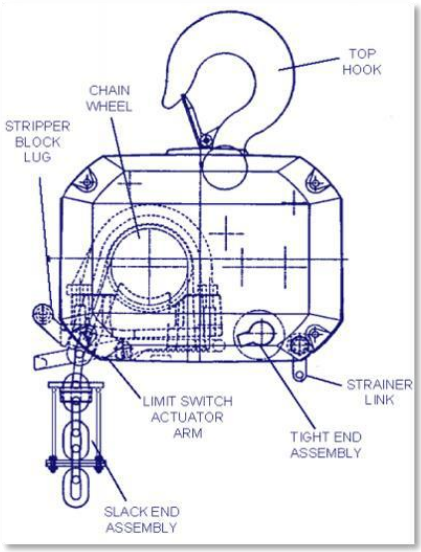
A slipping clutch is used for overload protection but also, as this is a fairly modern hoist, features such as additional limit switches for hoist and lower motions, motor thermal overloads and condition monitoring are also fitted. We will look at these in later modules of the course.

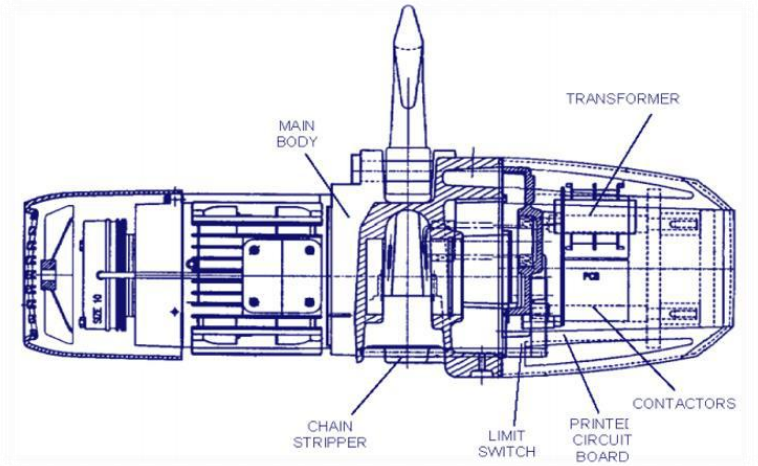
A general parts arrangement of this hoist is shown on the following page.

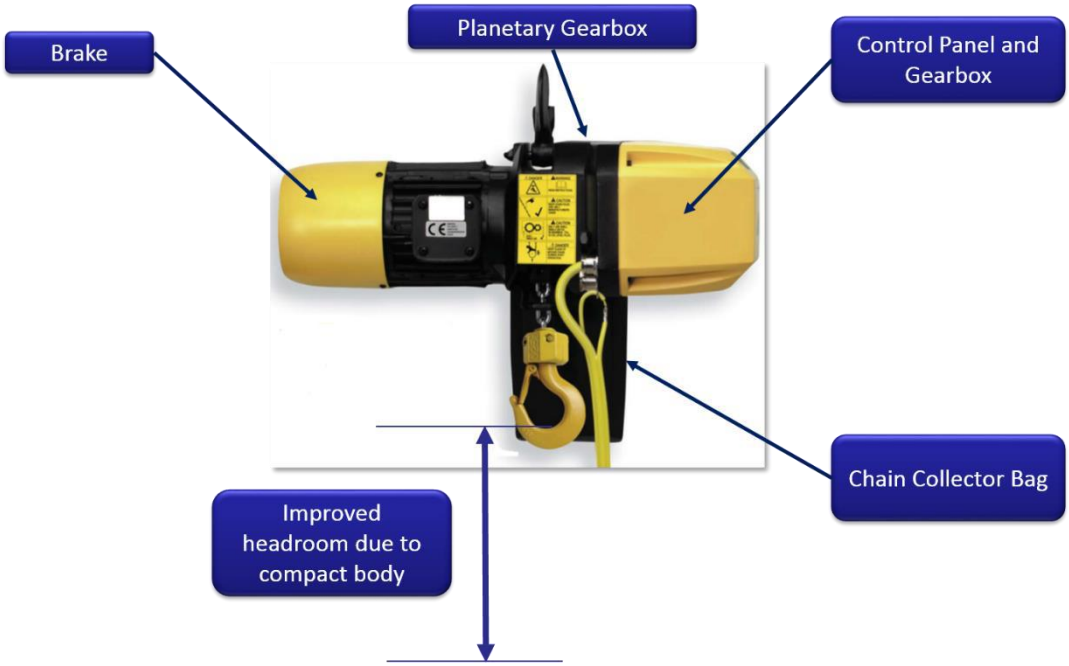


Condition Monitoring - fitted in most new hoists



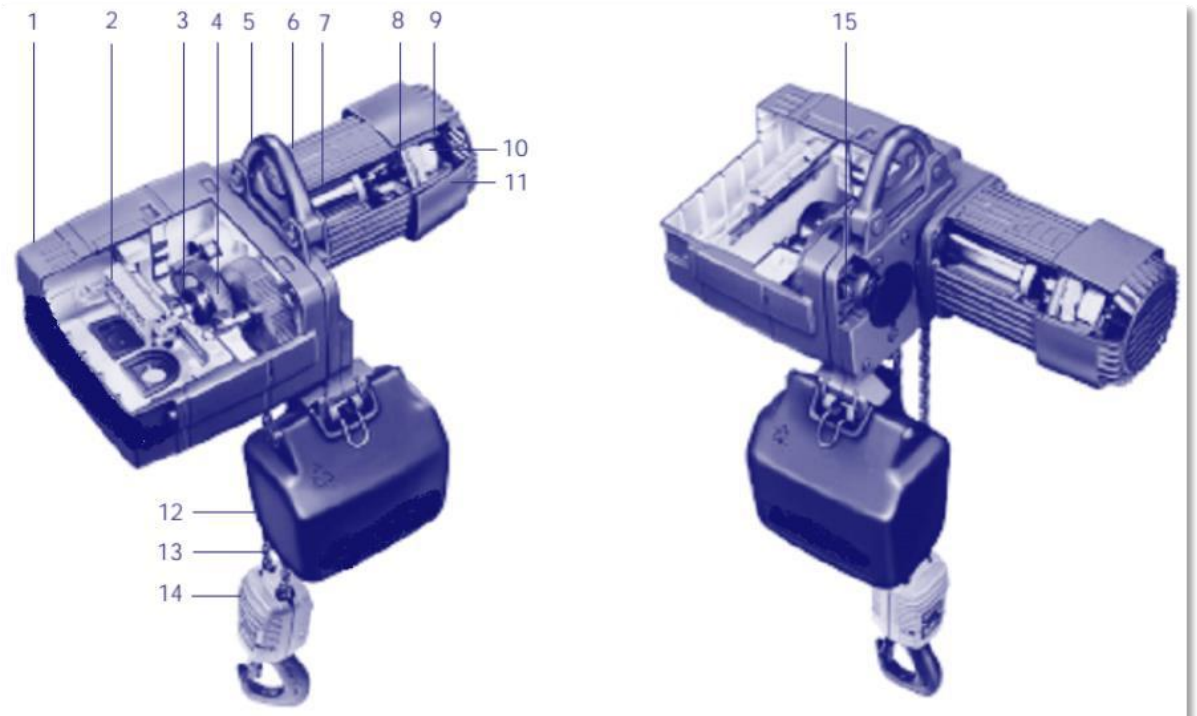






Notes:

The illustration below shows a similar type of electric chain hoist to that of which we have previously seen in this module.



Principle for Selection

Electric chain hoists are suitable for a wide variety of purposes. For all applications, initial consideration should be given to the following:

- Capacity
- Range of lift
- Speed(s)
- Suspension
- Operating level(s)
- Availability and suitability of power supply, including protection and isolation facilities
- Service conditions
- Nature of load
- The documentation required by legislation (EC Declaration of Conformity or report of thorough examination as appropriate). If this is not on record refer the hoist to a Competent Person for thorough examination

Note: It should be recognised that power operated hoists are designed to lift in the vertical plane only. The application should be fully discussed with the supplier to ensure that the correct equipment is selected.

Service Conditions
Standard electric chain hoists are manufactured to meet normal service conditions and assume:

- Use under cover, i.e. not directly exposed to the elements
- Use at ambient temperatures between -10°C and 40°C without high local heating or cooling
- Use in clean air free from excess of humidity, contamination and deposits

Environmental Conditions
Examples of environmental conditions requiring special attention are:

- Outdoor use
- Salt air
- High humidity
- Ambient temperatures above or below the normal range
- The presence of local heat sources, e.g. furnaces
- Dust/abrasives in the atmosphere

Hazardous Substances
Hazardous substances fall into two main groups; those that would harm the hoist or its associated electrical equipment, e.g. corrosives; and those that may be affected by the operation of the hoist, e.g. explosives. Examples of hazardous substances requiring special attention are:

- Flammable or explosive gases, vapours or dust
- Corrosive vapours and liquids
- Volatile liquids
- Toxic substances
- Molten metal

The manufacturer's or supplier's specific advice should be sought if power operated hoists are to be operated in an acidic or alkaline environment. Such conditions can cause stress corrosion cracking for example on some types of chain (hydrogen embrittlement)

Other Potential Hazards
Other potential hazards may arise as the result of the work being carried out in the general location or be caused by the hoist performing lifting and moving operations over the heads of personnel or similar. Examples of such potential hazards requiring special attention are:

- Use in mines and quarries
- Use in laundries
- Use in galvanizing, pickling and hot dipping processes
- Use in paint shops
- Use over work areas
- Use over walkways and footpaths

Standards

BS EN 60204 Pt 1 and Pt 32 – Safety of Machinery – Electrical Equipment of Machines – general requirements deals with the electrical safety of machines covered in this module. Part 32 deals specifically with hoisting machinery. The standard promotes safety of persons and property, consistency of control response and ease of maintenance.

General Requirements of BS EN 60204

Electromagnetic Compatibility

- Hoists shall be in accordance with BS EN 60204-32:
    - The hoist must not generate electromagnetic disturbances that will interfere with other machinery, and additionally, it must have a level of immunity from being affected by other machinery creating electromagnetic disturbances

Electrical Supply

- The hoist shall be designed such that it operates reliably in the event of a voltage drop at the hoist of up to 5% between no-load operation and the peak current of the largest motor

Outdoor Use - Protection

- The enclosures for electrical equipment, with exception of the motor, shall have at least a degree of protection IP 55
- The enclosure of the motor shall have a degree of protection of at least IP 54

5	Protected against dust - limited ingress permitted but no harmful deposits allowed. Full protection against human contact	5	Protected against low pressure jets of water (6.3mm nozzle) from all directions. Limited ingress is permitted

Notes:

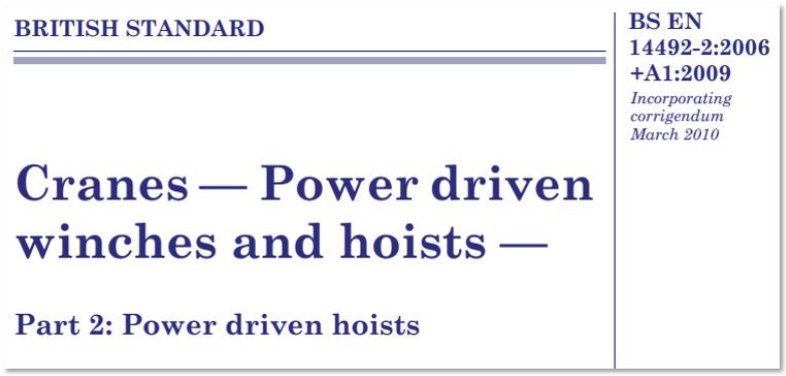
Electrical Disconnection

- The electrical equipment of a hoist shall contain devices for the following functions:
    - Isolation of the electrical equipment from the mains power supply so that work may be performed without the risk of electric shock or burning
    - Switching-off in the event of emergency switching off or emergency stop

Standards

The following standards are applicable to electric chain hoists and this module:

BS EN 14492 – Power driven winches and hoists – **PART 2 – Power driven hoists.**


BRITISH STANDARD

BS EN 14492-2:2006 +A1:2009

Incorporating corrigendum March 2010

Cranes — Power driven winches and hoists —

Part 2: Power driven hoists

This standard covers pneumatic, hydraulic and electrically powered hoists, using chain, wire rope and belts as lifting media.

General Requirements of BS EN 14492-2

- Connections and individual components of hoists shall incorporate features so that they cannot self-loosen
- Moving transmission parts (shafts, fans, wheels, gears, belts, couplings) shall be designed, positioned or guarded in order to protect against the risks associated with possible contact of exposed persons during the intended use

Control Devices

- Devices for starting and stopping manually-controlled hoists shall be fitted with 'hold-to-run' control elements so that the power supply is interrupted when the actuating elements are released (usually a pendant control station)

Electromagnetic Compatibility

- Hoists shall be in accordance with EN 60204-32:
    - The hoist must not generate electromagnetic disturbances that will interfere with other machinery, and additionally, it must have a level of immunity from being affected by other machinery creating electromagnetic disturbances

Overload Protection

Hoists manufactured since the Machinery Directive came into force and which have a WLL of 1 tonne or more or which are installed such that the overturning moment is 40,000 Nm or more, must be fitted with devices to warn the operative and prevent dangerous movements of the load in the event of overload or of the moments conducive to overturning being exceeded. Older equipment may not be fitted with such devices and we recommend that, if not, consideration is given to upgrading it.

Overload protection devices take different forms but may usually be set so that a load up to the proof load can be lifted or to allow a load in excess of the SWL but less than the proof load to be raised. This protects the hoist from accidental overloading but allows for variations in the imposed load due to dynamic loading.

- Electric Chain hoists can be protected from the worst effects of physical overload in several ways depending on the design of the appliance
    - Slipping clutches are sometimes used in power operated chain hoists and may also be found on some manually operated equipment. These are set to slip when the load increases beyond a predetermined amount, e.g. working load limit plus an allowance which takes into account the effects of dynamic loading. Slipping clutches are also used in some designs of lifting appliances as the upper (hoisting) limit, thereby serving a dual purpose

- Load measuring or sensing devices are used to prevent physical overload by stopping the appliance operating if the load exceeds that intended. At one time these were not generally fitted as standard but since the implementation of the European Machinery Directive, they have become a standard feature of many appliances

Rated Capacity Limiters (Overload Protection)

Rated Capacity Limiters and Indicators (RCL)

- Hoists with a rated capacity of 1000 kg or more shall be fitted with a rated capacity limiter (overload protection)
    - For **'direct acting'** RCLs, it will be set at 110% of rated capacity to allow for dynamic load testing (see note 1 below)
    - For **'indirect'** RCLs, it will be set at 125%of rated capacity (see note 2 below

Note 1: A 'direct acting' RCL act directly in the chain of the drive elements of the chain hoist, for example, a slipping clutch (friction torque limiters).

Note 2: 'Indirect' RCLs measure the load using a sensor and switch off the energy supply for the lifting operation. This usually engages the hoist brake simultaneously.

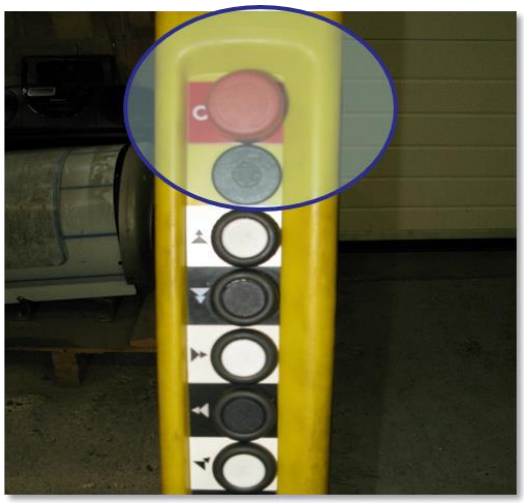
Friction Torque Limiter

Hosting and Lowering Limits

- For safety reasons, to prevent the bottom hook 'over travelling' and causing damage to the hoist, a hoisting or upper limit is used
- For modern hoist units it is a mandatory requirement of EN 14492-2 to have upper and lower limits fitted that conform to the minimum requirements of EN 12077-2. In the case of a power operated hoist found in-service and not fitted with a bottom limit, it is advisable that one is fitted
- The type of limit used will depend on the hoist design and may be a mechanical device, e.g. a slipping clutch, or an electro mechanical device which uses a mechanical method of actuating a limit switch
- Whichever type is used, hoist limits are not intended for regular use, they must be considered as emergency safety devices. There are several electro-mechanical methods of actuating a limit which all utilize the movement of the mechanism to disconnect the power to the motor and thereby apply the brake
- In most cases, hoisting and lowering limits are easily reset by reversing the direction of the hoist however in some cases manual resetting may be necessary

Emergency Stop

- The standard requires the fitting of an emergency stop function which is to be available at all times
    - The emergency stop must override all other functions and operations of the hoist



Notes:

Hoist Brakes

Brakes should be fitted to the hoist, enabling the load to be arrested at any point during the lifting operation should any of the following occur:

- The operator releases a hoist/lower control button, returning to the neutral position
- The emergency stop is pressed and activated
- The external power supply to the brake is interrupted
- The power supply to the hoist motor is interrupted or switched off
- 2 x phases of the power supply to the hoist motor are interrupted (3 phase motors)

- The general principle of "power off = brake on" shall be used in all cases (fail-safe)

Hooks

Load hooks must be designed so that they prevent unintentional displacement of the load. This can be done by either of the following methods:

- Incorporating a safety device (usually in the form of a latch)
- Designing the safety requirement into the shape of the hook

The ACoP to Regulation 6 (1) of LOLER. This states that:
"Hooks and other devices provided for lifting should be of a type that reduces the risk of the load becoming displaced from the hook or other devices."

Notes:

Load Chain

- Where short-link load chain is used as the lifting medium, it will meet the requirements of BS EN 818-7
- Roller chains should meet the requirements of ISO 606 with a working coefficient of 6:1

Short Link Chain

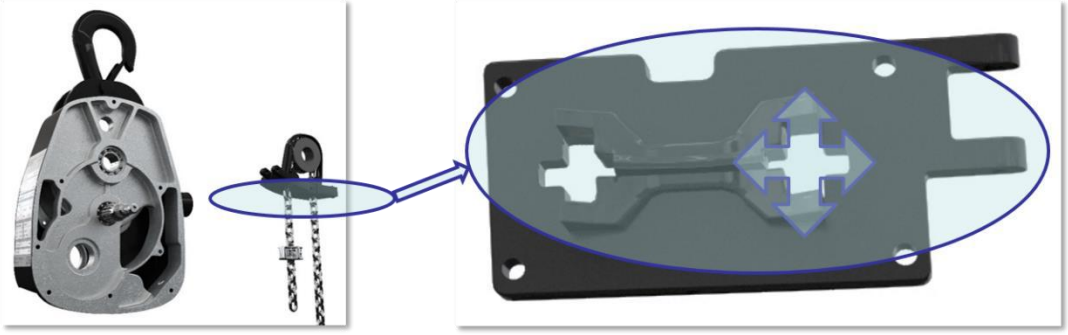
Roller Chain

Chain Guides

In order that the load chain runs correctly over the load wheel (load-sprocket) a guide must be fitted. The illustration below shows a chain guide sitting over the load chain ensuring it runs smoothly in the load-wheel.

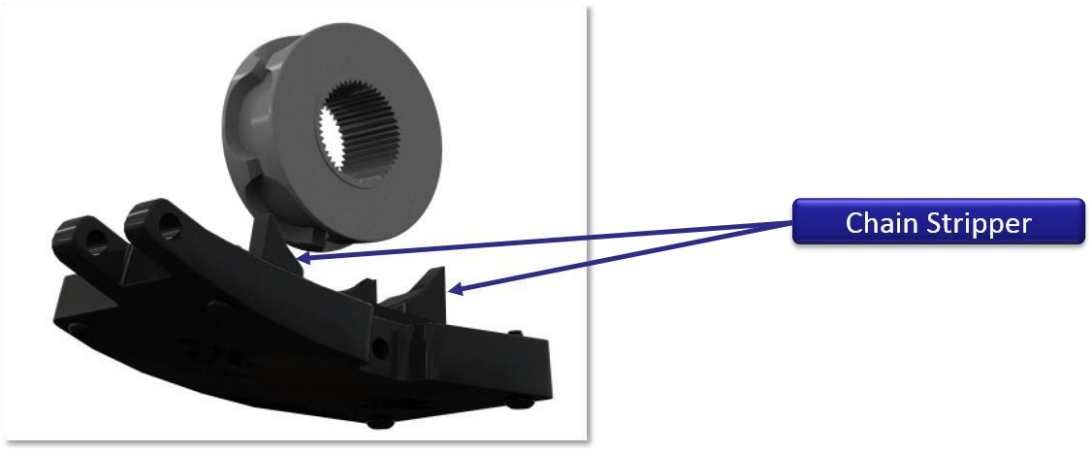
The chain must be aligned correctly with the chain wheel. In situations where the chain may become slack or twisted, or where it may approach the wheel at an angle to the plane of rotation, a suitable chain guide is used. A hoist must not be used when direct entry of the chain on the chain wheel is prevented or when the chain is twisted.

Looking at the underside of the chain entry/exit guide shown below, we can see that the guide is shaped in a + pattern so that the load chain cannot twist when entering or leaving the hoist.



Chain Stripper

As the chain is a close fit, provision is made in the pockets to forcibly remove it from the slack side of the chain wheel. If this were not done, links at the slack side would tend to remain in the wheel. This mechanical disengagement is achieved using a stripper. This usually takes the form of a finger installed between the chain strands, extending well into the centre groove of the wheel, which engages links in the plane of rotation and forces them to leave the wheel.



Load Wheel

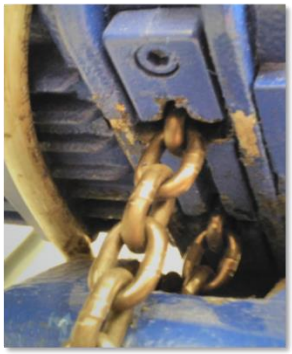
- To engage correctly into the chain wheel, the chain needs to be under tension (the weight of a few links is sufficient). The tension is necessary to maintain the gauge length of the chain

- The chain should not be allowed to become corroded or covered in dirt and debris which will impair free movement and increase wear. Debris can also be carried over and deposited in the pockets of the chain wheel affecting the proper seating of the chain

Load Chain to Hoist Body Anchorage

- Chain anchorage devices must be able to withstand 4x times the static chain tensile force at rated capacity of the hoist without rupture

- Threaded connections on chain anchorage devices shall be locked to prevent self-loosening. The condition of the fastening shall be verifiable



Load Chain to Hoist Body Anchorages

Load Chain Slack End Anchor

The unloaded end of the chain shall be secured against running off the chain sprocket. This safety arrangement shall withstand the forces that occur when the end position is approached.

Chain Collector Bag/Bucket

In the case of a power operated chain hoist, the slack chain collecting box, bucket or bag is perhaps the most common and important accessory and the following points should be considered:

- Without a collecting box the slack chain will hang loose from the hoist. This could be a source of danger as it may catch on the load or other obstructions or strike the operative if allowed to hang freely

- A purpose designed slack chain collecting box may be used to house the chain safely but it must be of adequate capacity to house all of the chain. If the box is of inadequate capacity, the chain can spill over and, rather like a siphon, once this occurs all the chain will be pulled from the box at an accelerating rate
    - The uncontrolled fall of the chain could inflict serious injury upon any personnel in its path, as well as subjecting the hoist to a high shock load
    - Another effect of the box being of inadequate size is that the chain may feed into the hoist with links in the wrong plane causing damage to the hoist and in extreme cases breaking the chain and allowing the load to drop
    - A build-up of chain may cause the hoisting limit to operate cutting out the motion
- The box should be provided with suitable drainage to prevent a build-up of moisture which could corrode the chain

Environment Protection

When electric chain hoists are required to operate both inside and outdoor, consideration should be given to the use of a weatherproof cover. This should form a large enough canopy to prevent the hoist being directly exposed to rain etc.

When electric chain hoists are required to operate over furnaces and quench tanks etc., the use of a heat shield should be considered. This should be large enough to prevent the hoist being directly exposed to flames.

In steam-laden atmospheres, such as dye houses and laundries, special precautions are necessary to limit corrosion. Consideration should therefore be given to the use of galvanised wire rope, plated chain and additional lubrication points.

Chain Lubrication

- Chain is a medium in which high bearing pressures are developed
- In order to maintain a satisfactory working life it is therefore necessary to provide adequate and appropriate lubrication
- Suitable lubricants are those which can withstand these high pressures and will adhere to the chain
    - In adverse working conditions, such as foundries, or where the lubricant may contaminate other items, e.g. food stuffs, the use of dry lubricants in the form of colloidal graphite dispersions are recommended
    - All lubricants must be acid free in nature
- It is important that the manufacturer's recommendations for lubricants and their application are followed.

Notes:

Information to be Supplied by the Manufacturer

The manufacturer must provide operating instructions containing information and instructions for the commissioning, use, regular examination and maintenance of electrically operated chain hoists. The following information should also be included:

- The use for which the hoist mechanism is intended shall be clearly described
    - Warnings shall be provided with regard to misuse of the hoists which, according to experience, may occur
    - This information should include any limitations of the design, for example the intended duration of service
- Information about the operation of the hoist and lower limits and their periodic inspection
- Training requirements for the operating personnel
- Maintenance and repair work required to ensure the safe functioning of the hoist unit
- Including inspection and lubrication requirements, operating principles, safety devices etc.

Marking

- Electric chain hoists are to be marked with the following information:
- CE Mark
- Business name and address of the manufacturer
- Designation of the machinery
- Type designation
- Identification number, if any
- Year of manufacture
- Explosion proof class (if applicable)
- IP rating
- Rated capacity
- Range of lift
- Group of mechanisms
- Details of lifting media, Chain diameter, pitch and grade or wire rope construction and minimum breaking force
- Power supply information, voltage, phase(s), frequency, rated flow (hydraulics) and rated pressure (pneumatics)
- Motor size (kW)
- Rated hoisting speed
- Rated traverse speed if fitted with combined trolley

Note: If manufacturer does not provide a unique identification mark, then the owner of the equipment will be responsible for ensuring that the equipment is marked with one.

Notes:

Information which Should be Exchanged Between the user and Designer or Supplier

As electric power operated hoists are frequently used for miscellaneous lifting purposes, precise details of the load to be lifted are not always available. In these circumstances, only a general specification can be given and this should include the following information:

- Maximum load to be lifted or SWL
- Type of hoist, i.e. chain or wire rope
- Range of lift
- Maximum drawn up dimension
- Maximum extended dimension
- Type of suspension, e.g. hook/eye, push/geared/electric travel trolley, in the case of a trolley suspension, details of the runway beam section and size
- Lifting speed(s)
- Power supply, voltage, phase(s) and frequency
- Details of the power feed system if required
- Type of control, e.g. pendant, remote etc., including pendant length etc. If unspecified, the manufacturer will assume pendant control and this will be arranged to suit the hoist on the basis of the operating level being at the extended dimension
- Special service conditions or safety requirements which may affect the hoist design, e.g. outdoor use, use in a flammable atmosphere etc.
- Classification if known or details of the state of loading and duty cycle etc.
- Any accessories that may be required, e.g. slack chain collecting box, working limits etc.
- Any other special requirements

It may subsequently be found that a more detailed exchange of information is necessary to ensure the correct selection. For all but the simplest or repeat installations, a visit by the supplier to survey the site should always be considered as this will minimize the information exchange and reduce the chance of incorrect selection.

Further technical information may be required by the user at the time of installation or for maintenance purposes. It will be contained in the manufacturer's operations and maintenance handbook, which will be supplied with the hoist, and does not otherwise form part of the information exchange.

Pre-Use Checks

Operator pre-use checks should include:

- Visual check for any obvious signs of damage
- Check operation of upper and lower limit switches (no load condition)
- Hoist brake
    - No slipping or overrun when lowering
    - No unusual noises
- Load chain
    - Free from any obvious signs of damage
    - Kinks and twists
- Check the bottom hook for smooth operation, ability to swivel and safety latch operates correctly
- If the hoist is fitted to a runway beam, ensure the trolley operates correctly and that the beam appears undamaged with no obvious obstructions
    - Ensure end stops are fitted at both ends of the beam
- Check the operation of the emergency stop button and ensure that you are aware of the location of the hoist power isolator switch

In-Service Inspection

In addition to the statutory thorough examination by a Competent Person, electric chain hoists should be visually inspected by a Responsible Person prior to use or on a regular basis, taking account of the conditions of service and statutory requirements. The inspection should include the fixings, suspension points and supporting structures, guidance on the in-service inspection of runways, slewing jib cranes and mobile gantries is given in further sections of this code and reference should also be made to BS 7121-2.

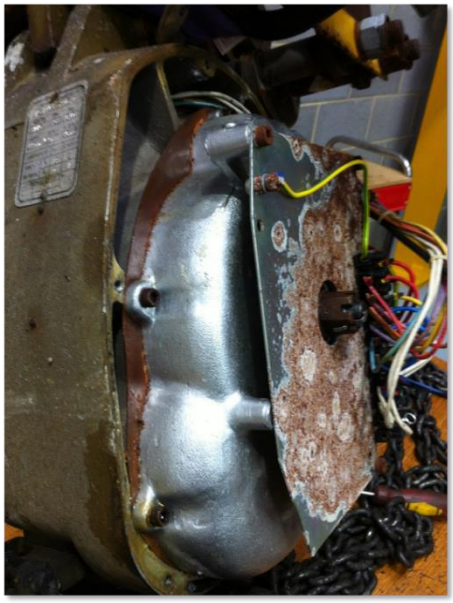
The inspection should include the following points in addition to any specific checks recommended by the supplier:

- State of chain or wire rope
- Correct operation of the brake
- Correct operation of hoist and, where fitted, lower limits
- Correct operation of controls
- A visual check for any obvious defects

If any of the following faults are found, the hoist should be withdrawn from service and referred to a Competent Person.

- Signs of wear, deformation or damage to hooks, trolleys or other terminal or suspension fittings
- Hook safety latch damaged or inoperative. In the event of the latch appearing to be too short, this is an indication of the hook having opened out and may be the result of the hoist being overloaded
- Signs of wear and fretting corrosion to screw threaded shanks
- Load slips when hoisting or load will not lift although motor is running
- Load stops midway through a lifting cycle. In this case, where possible action must be taken to lower the load. If this cannot be done, the area must be cordoned off to prevent anyone approaching
- Hoist will not operate although power is on
- Spasmodic or erratic lifting operation and similar symptoms on the travel motion
- Trolley slips or skids on the runway
- Damage to any electric cable or cable gland
- Damage to the pendant control hand set including cable, rubber covers, legends or labels and support wire, chain or cord
- Excessive noise or unusual sounds from any part of the hoist, including motor, clutch, gearbox or brake
- Travel and/or hoist motions operate in opposite direction to control indication
- Load continues to travel excessive distance after motion control has been released
- Load chain worn or damaged, in particular when wear has occurred on the bearing surfaces inside the links and to damage in the form of bent, notched, stretched or corroded links. In certain circumstances, very rapid wear of the load chain can develop, which is characterised by a rough appearance on the mating surfaces inside the links
- Load chain does not articulate freely
- Signs of damage or distortion to the slack end anchor which connects the load chain to the hoist casing and/or signs of damage or distortion to the load chain stop where one is fitted
- When bottom hook is fully extended to its lowest possible working position, the slack end of the chain pulls tight transmitting the load onto the slack end anchor

- When operating under load, the chain jumps and/or is excessively noisy
- Chain does not hang freely or is twisted over its length
- Chain does not enter or leave the load wheel freely. Chain guide or stripper are worn or damaged
- Chain collecting box is damaged or distorted

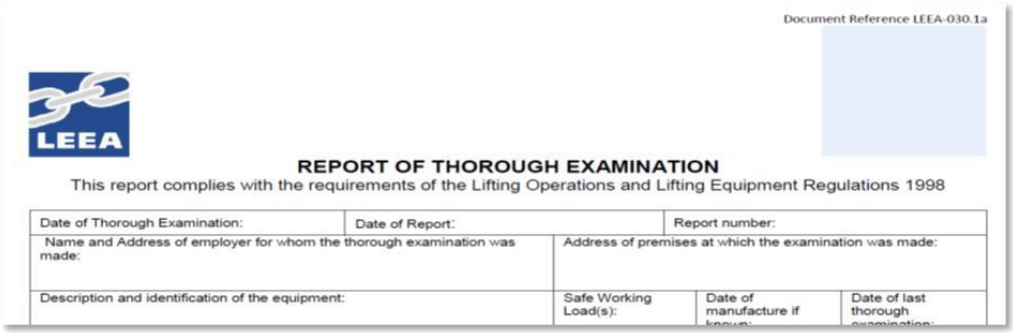


Legal Requirements

The definition of lifting equipment and accessories used in LOLER make it clear that power operated chain hoists are lifting equipment.

Unless a written scheme of examination, drawn up by a Competent Person, is in place and operating they must be thoroughly examined by a Competent Person at intervals not exceeding 12 months.

Reports of thorough examination should be retained and cross referenced to the hoists historical records for inspection by the Competent Person or HSE.



Document Reference LEEA-030.1a

LEEA

REPORT OF THOROUGH EXAMINATION

This report complies with the requirements of the Lifting Operations and Lifting Equipment Regulations 1998

Date of Thorough Examination:	Date of Report:	Report number:	
Name and Address of employer for whom the thorough examination was made:	Address of premises at which the examination was made:		
Description and identification of the equipment:	Safe Working Load(s):	Date of manufacture if known:	Date of last thorough examination:

Inspection/Examination (Ensure Lock Out-Tag out isolation!)

The Thorough Examination

For some applications it may also be necessary to have the installation thoroughly examined by a Competent Person before the hoist is put into service.

Regulation 9 of LOLER states:

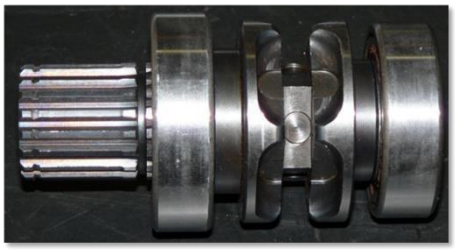
(2) Every employer shall ensure that, where the safety of lifting equipment depends on the installation conditions, it is thoroughly examined:

> (a) after installation and before being put into service for the first time
> And,
> (b) after assembly and before being put into service at a new site or in a new location,
> to ensure that it has been installed correctly and is safe to operate

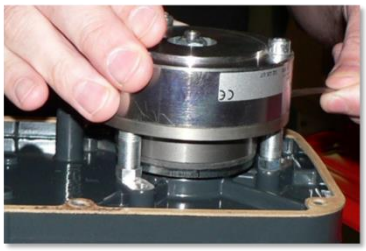
Note: Although not required by legislation, new power operated hoists will usually be issued with a manufacturer's record of proof load testing in addition to, although possibly combined with, the EC Declaration of Conformity. This document forms an important part of the record of the hoist. It should be retained and cross referenced to the hoists historical records for inspection by the Competent Person or HSE.

- The examinations shall be carried out in adequate natural or artificial light
- The machine shall be clean or cleaned and free from rust to enable a proper visual examination of all parts to be carried out
- The examination shall be carried out by a Competent Person in accordance with the schedule of requirements aligned to the employers' quality policy and site procedures reference material and LEEA's Technical Requirements/COPSULE which are available to support them
- Where appropriate the standard procedures of examination, checking of hooks, chain sizes, pitch and diameter of wires and allowable wear and stretch shall be those recommended by the product manufacturer
    - Further criteria may also be given in British Standards, LEEA technical publications and in the LEEA correspondence courses
- Parts shall be exposed and examined sufficiently to enable a proper conclusion as to their condition to be reached and reported on. Where necessary parts must be dismantled and cleaned to achieve this

The operation of mating parts must be checked and observed, e.g. a load chain (as detailed in Module 2 of this course), load wheel, brakes (as detailed in Module 13) and other vital mechanisms must be checked for safe and correct operation.



Load Wheel (limited access on mot hoists

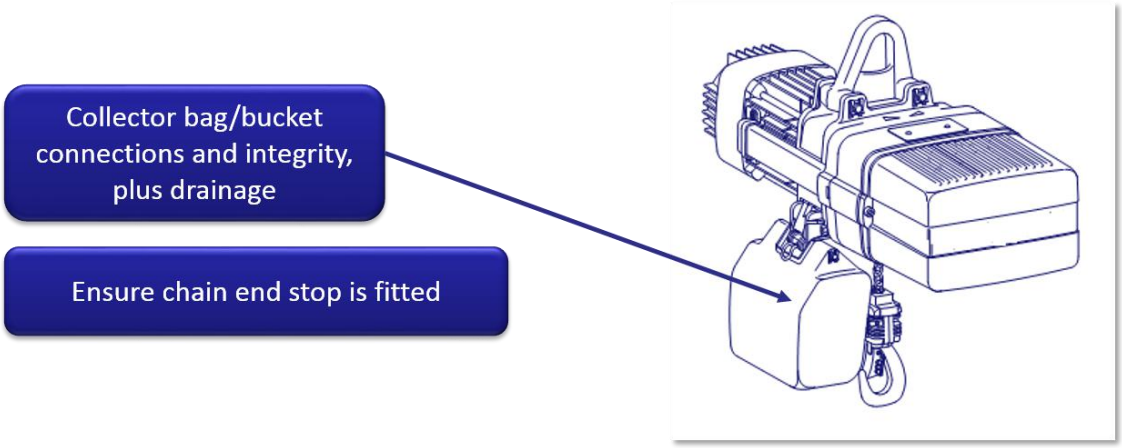


Brake Unit

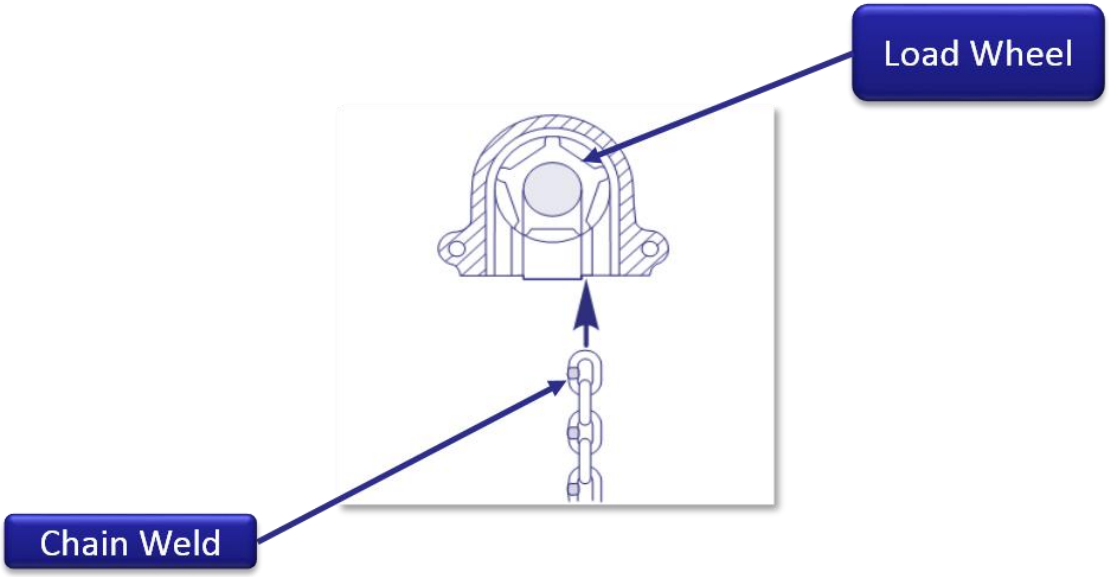
- The assembly of parts, reeving and anchorages must be checked for correctness and proper operation and all locking and securing devices must be checked as being sound and in place

- All power supply, current collecting systems, 'fail safe' mechanisms, limit mechanisms, protective and running equipment must be examined for correctness, safety and proper operation

- The identification number and WLL/SWL shall be checked with the last Report of Thorough Examination or the Certificate of Conformity, and where markings have become illegible be re-stamped or marked



Manufacturers specify which way the load chain should be placed into the load wheel. Generally speaking, most manufacturers specify that the weld on the link of the load chain faces the load wheel, as shown below:



If the load chain is making a noise as it travels around the load wheel, the chain may be stretched, un-lubricated, damaged or incorrectly fitted, or there may be damage/ingress of dirt or foreign object in the load wheel.

- The written report shall give a description of the article examined, the date of the examination and a clear statement of its fitness for further use or details of the defects which affect the WLL/SWL and other observations

    - Where an article is defective, a responsible representative of the user must be informed
    - If dangerously defective, arrangements must be made for its immediate withdrawal from service
    - Where Regulations or Acts require statutory notification of defective equipment, steps must be taken to ensure notification to the correct authority, for example LOLER gives requirements for reporting certain matters to the HSE

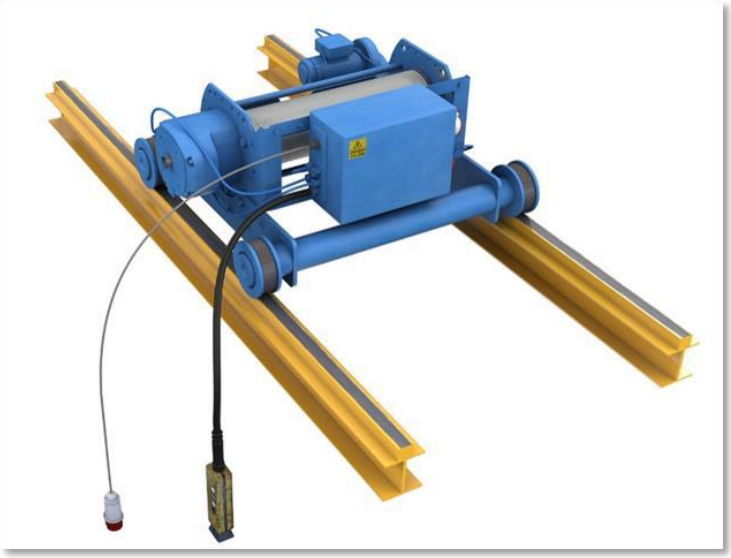
Training

It is of paramount importance that **lifting equipment inspectors or examiners do not work on live electrical equipment**. Lock-out/Tag-out routines should always be considered as part of your risk assessment.

Notes:

10. Electric Wire Rope Hoist

Introduction to Electric Wire Rope Hoists



Irrespective of the manufacturer, the new generation of hoist units all tend to be very similar in their construction. In an extremely competitive industry, electric wire rope hoists must provide performance, reliability, flexibility, satisfy the BS and ISO requirements, and be reasonably priced.

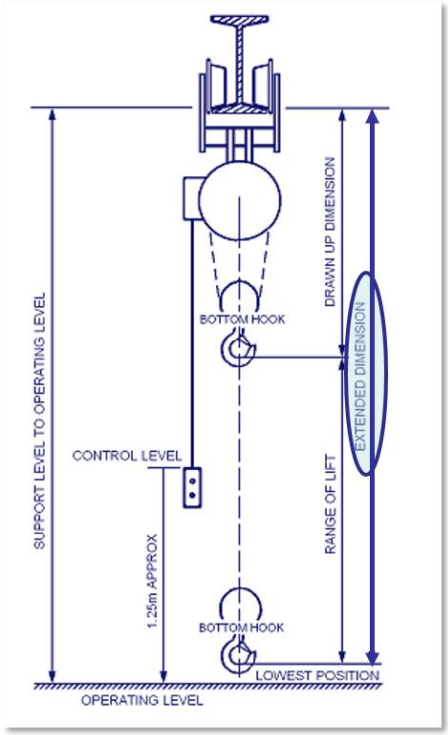
The earliest of these designs dates back some twenty-five years to a period when a lot of research and development was done.

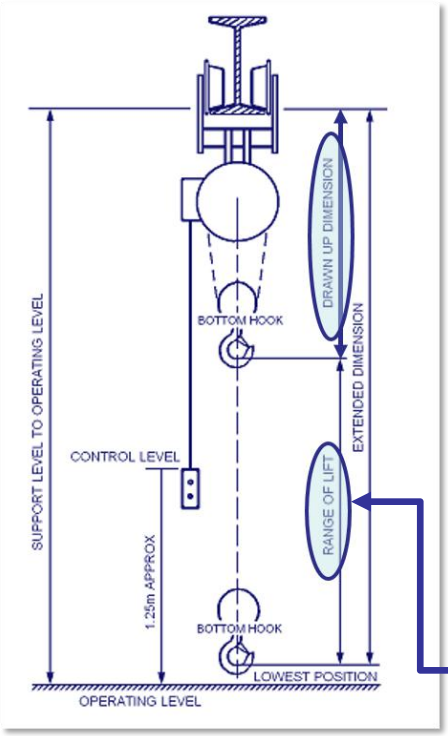
In more recent times standard unit engineering practices have been adopted which enable a wide range of units to be produced from a small range of standard components. However, the general design principles remain the same.

Definitions and Terminology

Extended Dimension

The extended dimension is the distance between the support level and the bottom hook seat in the extended position, as shown opposite:





Drawn up Dimension

The drawn up dimension is the distance between the support level and the bottom hook seat when the bottom hook is in the raised position.

This is sometimes referred to as the 'headroom' as it is the effective headroom taken up by the hoist. However, the term headroom has not been used as it is sometimes used in everyday language to have other meanings.

Range of Lift

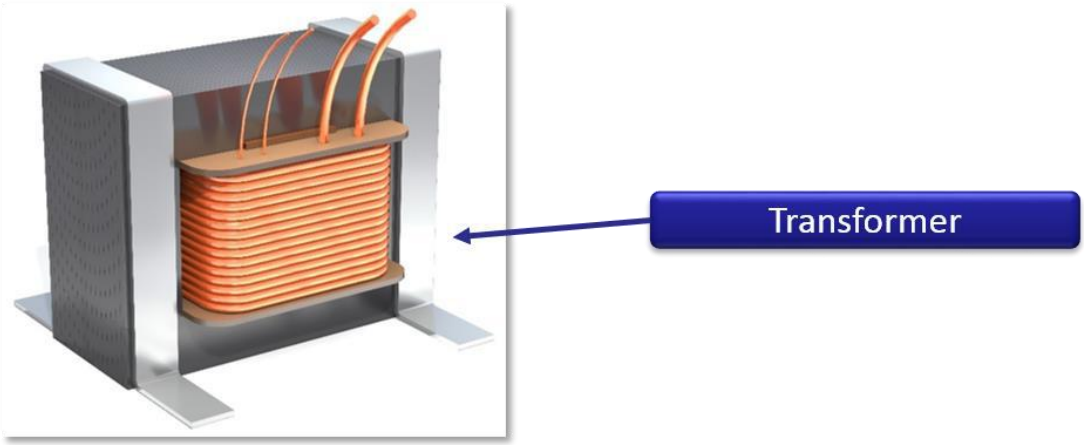
The range of lift is the vertical distance which the bottom hook travels between the extended and drawn up positions

Electrical Supply

Electric wire rope usually require a 3 phase AC supply current. Some of the lower capacity models are available with single phase or low voltage motors.

Low Voltage (LV) Control

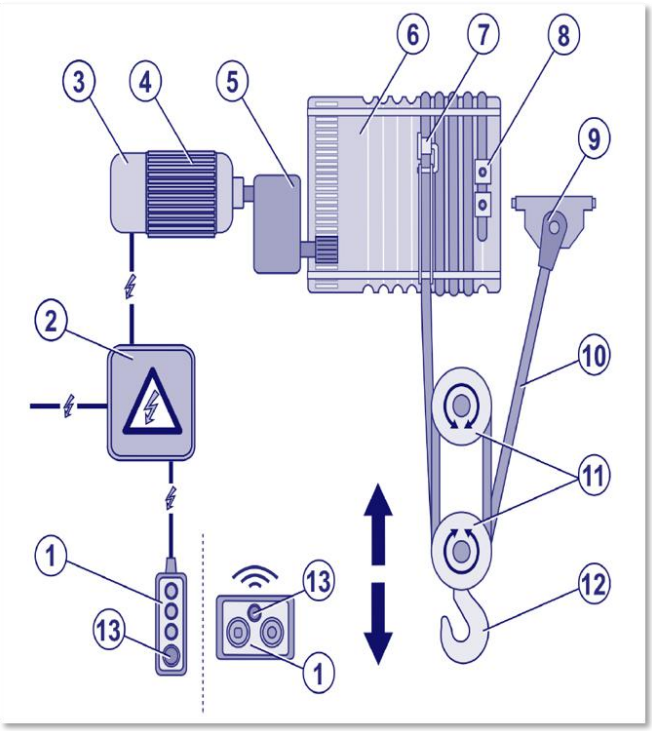
Modern electric wire ropes are normally fitted with low voltage control which is derived internally within the unit by transformer. This is usually in the range of 24 to 50 volts AC or DC and is often known as 'Extra Low Voltage'. Older hoists and special purpose hoists may not have LV control. It should also be noted that it is common in many European countries to use mains voltage control.



Basic Components

Most electric wire rope hoists consist of similar basic components as illustrated:

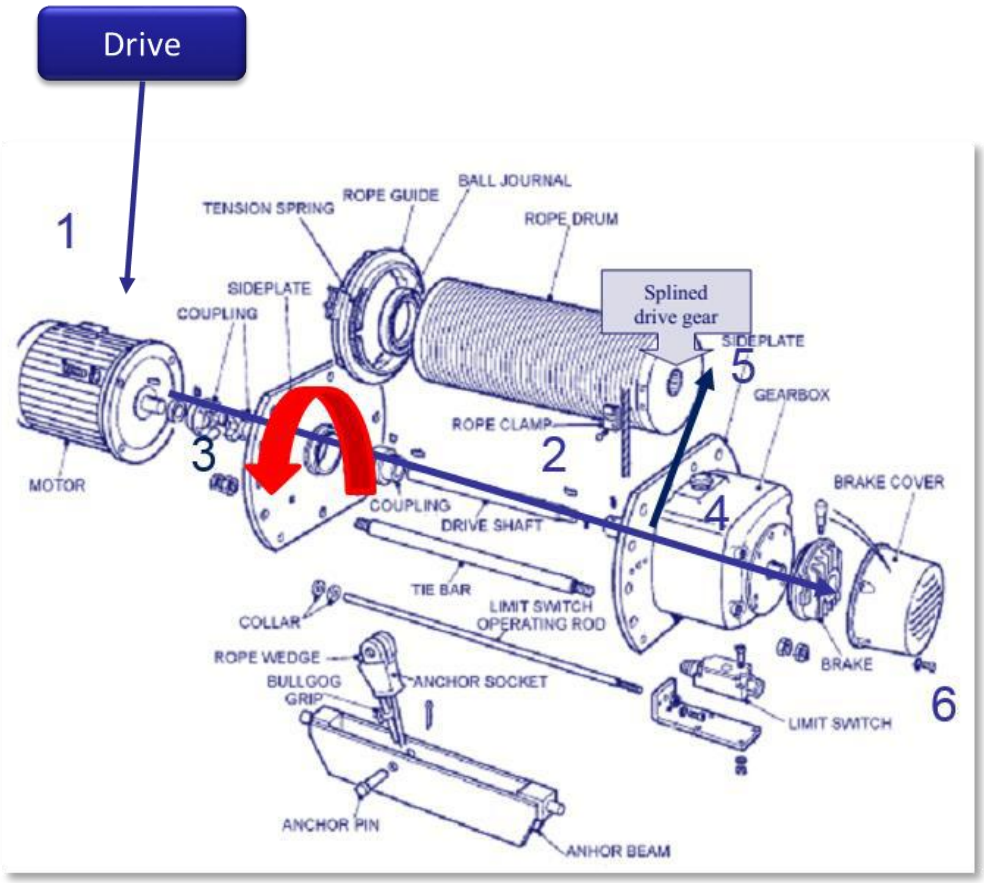
1. Pendant controller
2. Control panel
3. Brake
4. Motor
5. Gearbox
6. Rope drum
7. Rope Guide and pressure arm
8. Rope end clamps
9. Dead end anchor
10. Load rope
11. Return sheave and pulley block assembly
12. Load hook
13. Radio / Infra-red remote controller



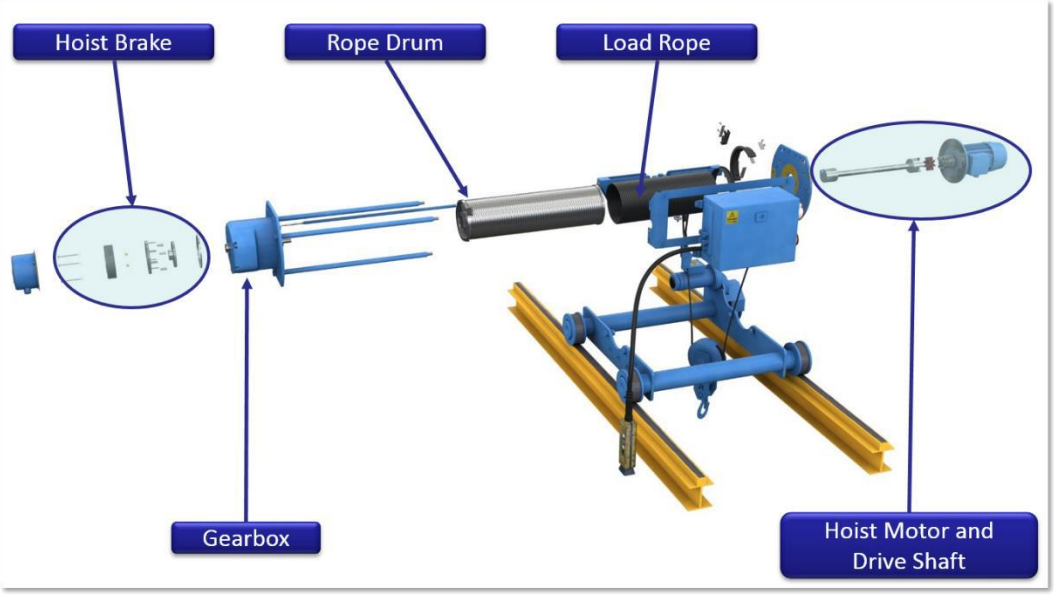
General Operation

In this older, coaxial type wire rope hoist, power is transmitted from the motor (1), via a transmission shaft (2) which connects to the motor using a spider coupling (3), through to the gearbox input pinion (4) and onto a drive pinion to a splined drive gear inside the rope drum (5).

Note: The hoist brake (6) is situated on the hoist gearbox as opposed to the hoist motor.



General Arrangement



General Arrangement (Reversed)

Notes:

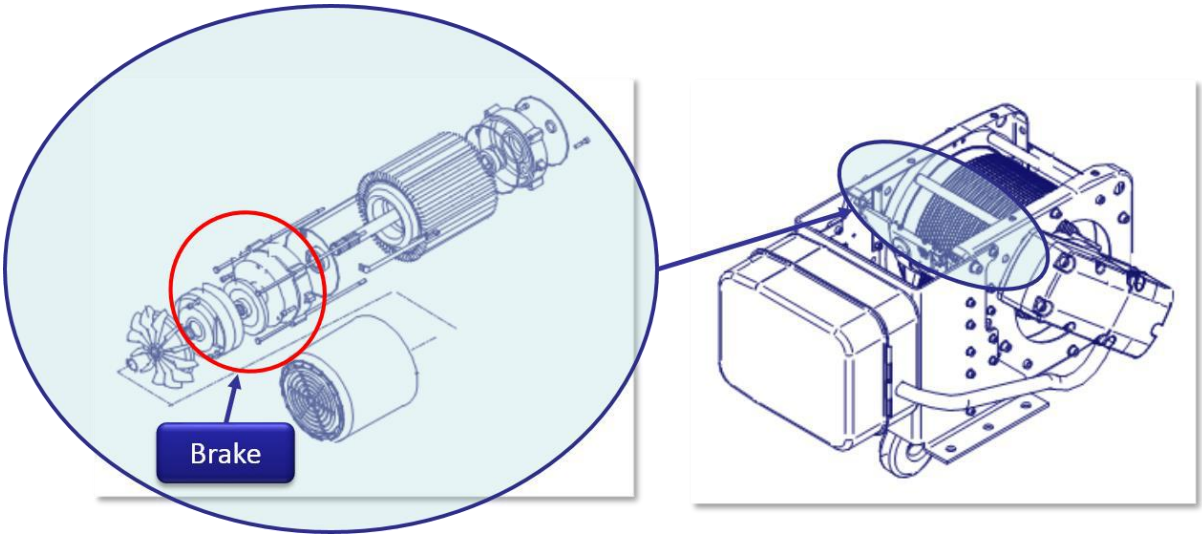
New Generation Hoist Design

Irrespective of the manufacturer, the new generation of hoist units all tend to be very similar in their construction. In an extremely competitive industry, blocks must provide performance, reliability, flexibility, satisfy the BS and ISO requirements and be reasonably priced.

By rotating the component parts around a common axis a very compact hoist unit has been developed.

General Operation

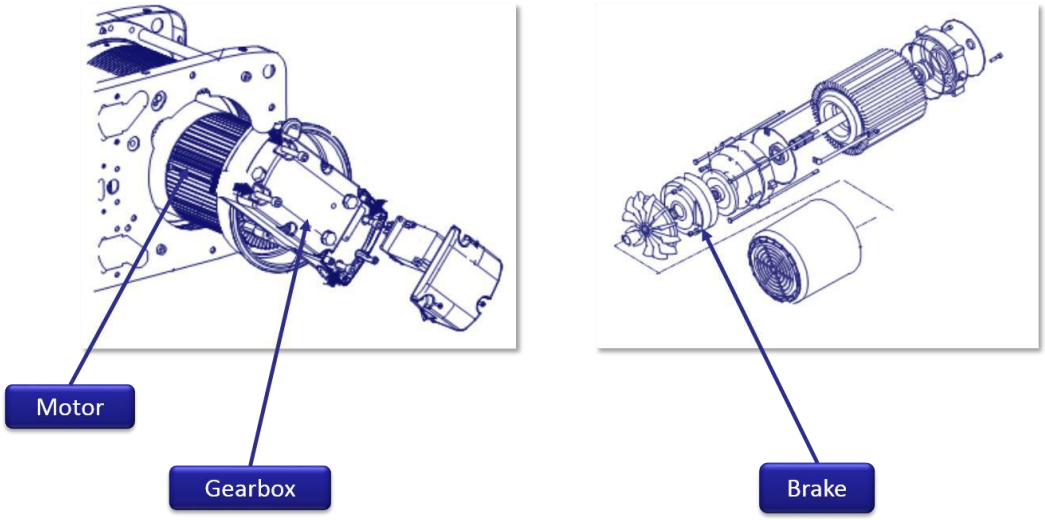
The drive motor is mounted inside the hoist drum. The drive is then transmitted via a coupling to the hoist gearbox, which is totally enclosed. On this model, the electro-magnetic hoist brake is of the disc type. Other models may incorporate a tapered rotor motor and conical brake unit.



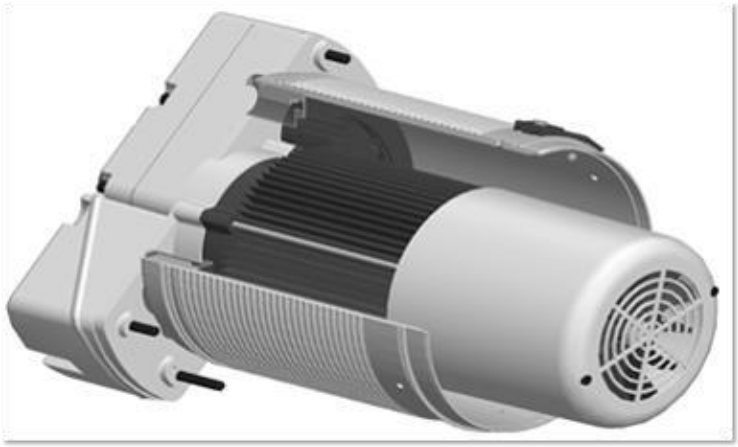
Notes:

General Arrangement

Note that the drive motor is located inside the rope drum which saves space and the fan on the motor drives cooling air through the rope drum which improves cooling efficiency. The hoist motor and brake are accessible outside of the drum.

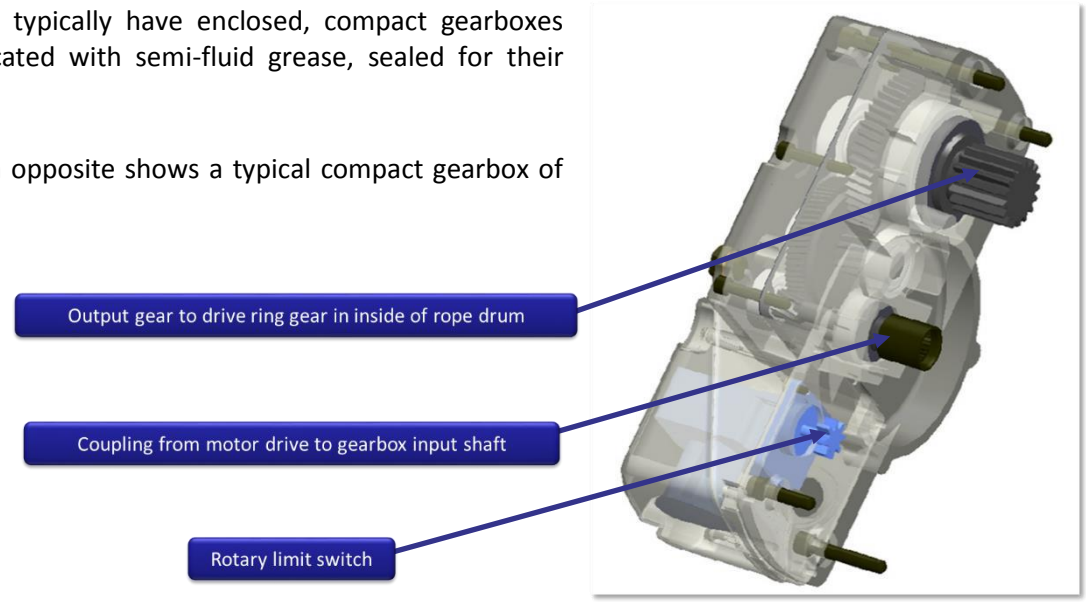


General Operation



Modern hoists typically have enclosed, compact gearboxes that are lubricated with semi-fluid grease, sealed for their service life.

The illustration opposite shows a typical compact gearbox of this nature.

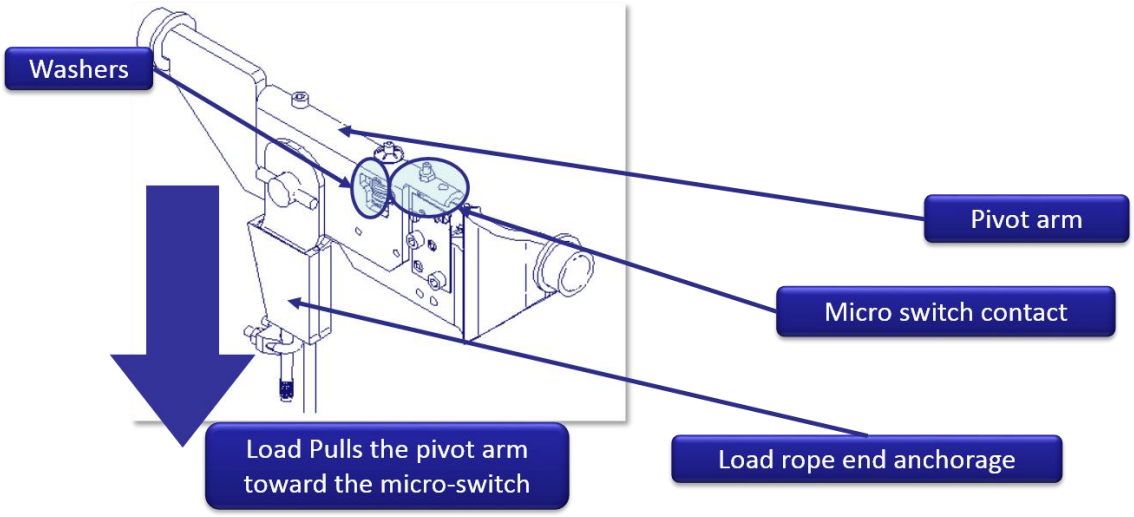


General Arrangement

The illustration below shows a typical load rope end-anchor assembly arrangement which is usually supported by a cross beam incorporating an overload limiting device.

Lever Operated, Electro-Mechanical Load Limiter

The lever operated, electro-mechanical load limiting device illustrated below prevents the hoist from overload. When load is applied, the pivoting load arm is pulled down towards the operating micro-switch and the calibration is set by a pack of spring washers.
When the load exceeds the set limit, the micro-switch will operate and stop the 'up' motion, only allowing the operator to lower.



Notes:

Principles of Selection

Electric wire rope hoists are suitable for a wide variety of purposes. For all applications, initial consideration should be given to the following:

- Capacity
- Range of lift
- Speed(s)
- Duty classification
- Suspension
- Operating level(s)
- Availability and suitability of power supply, including protection and isolation facilities
- Service conditions
- Nature of load
- The documentation required by legislation (EC Declaration of Conformity or report of thorough examination as appropriate). If this is not on record refer the hoist to a Competent Person for thorough examination

Note: It should be recognised that power operated hoists are designed to lift in the vertical plane only. The application should be fully discussed with the supplier to ensure that the correct equipment is selected.

Service Conditions

Standard electric wire rope hoists are manufactured to meet normal service conditions and assume:

- Use under cover, i.e. not directly exposed to the elements
- Use at ambient temperatures between -10°C and 40°C without high local heating or cooling
- Use in clean air free from excess of humidity, contamination and deposits

Environmental Conditions

Examples of environmental conditions requiring special attention are:

- Outdoor use
- Salt air
- High humidity
- Ambient temperatures above or below the normal range
- The presence of local heat sources, e.g. furnaces
- Dust/abrasives in the atmosphere

Hazardous Substances

Hazardous substances fall into two main groups; those that would harm the hoist or its associated electrical equipment, e.g. corrosives; and those that may be affected by the operation of the hoist, e.g. explosives. Examples of hazardous substances requiring special attention are:

- Flammable or explosive gases, vapours or dust
- Corrosive vapours and liquids
- Volatile liquids
- Toxic substances
- Molten metal

The manufacturer's or supplier's specific advice should be sought if power operated hoists are to be operated in an acidic or alkaline environment.

Other Potential Hazards

Other potential hazards may arise as the result of the work being carried out in the general location or be caused by the hoist performing lifting and moving operations over the heads of personnel or similar. Examples of such potential hazards requiring special attention are:

- Use in mines and quarries
- Use in laundries
- Use in galvanizing, pickling and hot dipping processes
- Use in paint shops
- Use over work areas
- Use over walkways and footpaths

Standards

BS EN 60204 Pt 1 and Pt 32 – Safety of Machinery – Electrical Equipment of Machines – general requirements deal with the electrical safety of machines covered in this module. Part 32 deals specifically with hoisting machinery. The standard promotes safety of persons and property, consistency of control response and ease of maintenance.

General Requirements of BS EN 60204

Electromagnetic Compatibility

- Hoists shall be in accordance with BS EN 60204-32:
    - The hoist must not generate electromagnetic disturbances that will interfere with other machinery, and additionally, it must have a level of immunity from being affected by other machinery creating electromagnetic disturbances

Electrical Supply

- The hoist shall be designed such that it operates reliably in the event of a voltage drop at the hoist of up to 5% between no-load operation and the peak current of the largest motor

Outdoor Use – Protection

- The enclosures for electrical equipment, with exception of the motor, shall have at least a degree of protection IP 55
- The enclosure of the motor shall have a degree of protection of at least IP 54

5	Protected against dust - limited ingress permitted but no harmful deposits allowed. Full protection against human contact	5	Protected against low pressure jets of water (6.3mm nozzle) from all directions. Limited ingress is permitted

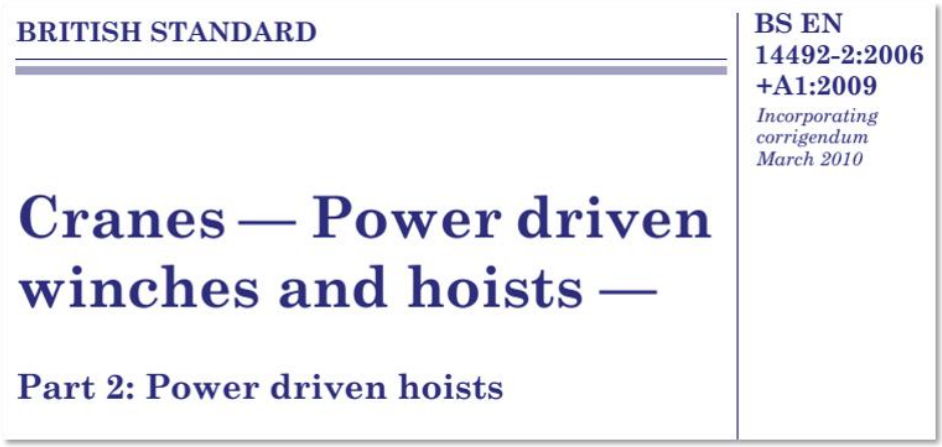
Electrical Disconnection

- The electrical equipment of a hoist shall contain devices for the following functions:
  - Isolation of the electrical equipment from the mains power supply so that work may be performed without the risk of electric shock or burning
  - Switching-off in the event of emergency switching off or emergency stop

Standards

The following standards are applicable to electric wire rope hoists and this module:

BS EN 14492 – Power driven winches and hoists – Part 2 – Power Driven Hoists.


BRITISH STANDARD

BS EN 14492-2:2006 +A1:2009

Incorporating corrigendum March 2010

Cranes — Power driven winches and hoists —

Part 2: Power driven hoists

This standard covers pneumatic, hydraulic and electrically powered hoists, using chain, wire rope and belts as lifting media.

Notes:

General Requirements of BS EN 14492-2

- Connections and individual components of hoists shall incorporate features so that they cannot self-loosen
- Moving transmission parts (shafts, fans, wheels, gears, belts, couplings) shall be designed, positioned or guarded in order to protect against the risks associated with possible contact of exposed persons during the intended use

Control Devices

- Devices for starting and stopping manually-controlled hoists shall be fitted with 'hold-to-run' control elements so that the power supply is interrupted when the actuating elements are released (usually a pendant control station)

Electromagnetic Compatibility

- Hoists shall be in accordance with EN 60204-32:
    - The hoist must not generate electromagnetic disturbances that will interfere with other machinery, and additionally, it must have a level of immunity from being affected by other machinery creating electromagnetic disturbances

Overload Protection

Hoists manufactured since the Machinery Directive came into force and which have a WLL of 1 tonne or more or which are installed such that the overturning moment is 40,000Nm or more, must be fitted with devices to warn the operative and prevent dangerous movements of the load in the event of overload or of the moments conducive to overturning being exceeded. Older equipment may not be fitted with such devices and we recommend that, if not, consideration is given to upgrading it.

Overload protection devices take different forms but may usually be set so that a load up to the proof load can be lifted or to allow a load in excess of the SWL but less than the proof load to be raised. This protects the hoist from accidental overloading but allows for variations in the imposed load due to dynamic loading.

Electric wire rope hoists can be protected from the worst effects of physical overload in several ways depending on the design of the appliance.

Overload protection devices take different forms but may usually be set so that a load up to the proof load can be lifted or to allow a load in excess of the SWL but less than the proof load to be raised. This protects the hoist from accidental overloading but allows for variations in the imposed load due to dynamic loading.

Load measuring or sensing devices are used to prevent physical overload by stopping the appliance operating if the load exceeds that intended. At one time these were not generally fitted as standard but since the implementation of the European Machinery Directive, they have become a standard feature of many appliances.

Notes:

Rated Capacity Limiters (Overload Protection)

Rated Capacity Limiters and Indicators (RCL)

- Hoists with a rated capacity of 1000kg or more shall be fitted with a rated capacity limiter (overload protection)
    - For 'direct acting' RCLs, it will be set at 110% of rated capacity to allow for dynamic load testing (see note 1 below)
    - For 'indirect' RCLs, it will be set at 125% of rated capacity (see note 2 below)

Note 1: A 'direct acting' RCL act directly in the wire rope of the drive elements of the wire rope hoist, for example, a slipping clutch (friction torque limiters).

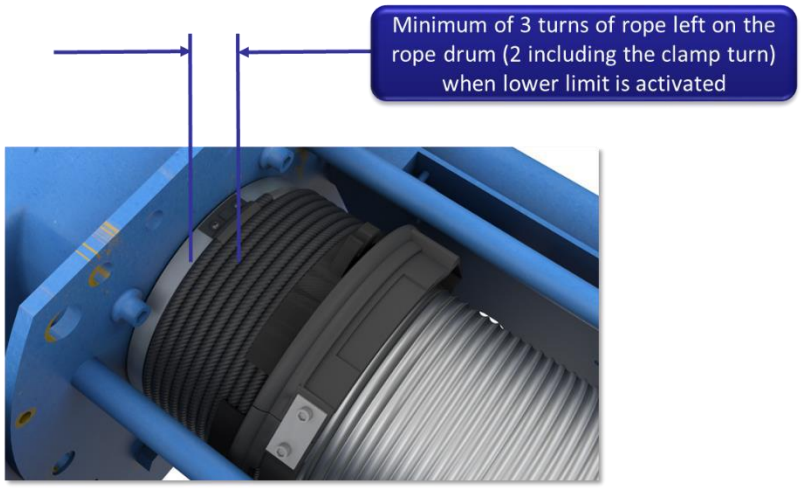
Note 2: 'Indirect' RCLs measure the load using a sensor and switch off the energy supply for the lifting operation. This usually engages the hoist brake simultaneously.

Hoisting and Lowering Limits

- For safety reasons, to prevent the bottom hook 'over travelling' and causing damage to the hoist, a hoisting or upper limit is used
- For modern hoist units it is a mandatory requirement of EN 14492 to have upper and lower limits fitted that conform to the minimum requirements of EN 12077-2. In the case of a power operated hoist found in-service and not fitted with a bottom limit, it is advisable that one is fitted
- The type of limit used will depend on the hoist design and may be a mechanical device, e.g. a slipping clutch, or an electro mechanical device which uses a mechanical method of actuating a limit switch
- Whichever type is used, hoist limits are not intended for regular use, they must be considered as emergency safety devices. There are several electro-mechanical methods of actuating a limit which all utilize the movement of the mechanism to disconnect the power to the motor and thereby apply the brake
- In most cases, hoisting and lowering limits are easily reset by reversing the direction of the hoist however in some cases manual resetting may be necessary

Lowering Limit Requirement

The lowering limiter shall ensure that the minimum engagement of the lifting medium is maintained at all times during operation, e.g. this particular hoist manufacture requires a minimum of 3 turns of the rope on the rope drum. The lowering limiter shall also stop the motion to prevent unwanted coiling in the reverse direction.



Back-Up (Second) Limit

For normal operation a second limiter is not necessary.

A risk assessment based on the particular application may result in the need of a second limiter for certain motions. This second limiter shall not be approached during normal operation, whereas the first limiter can be approached during normal operation.

Note: Based upon the risk assessment, a second limiter may be necessary, for example when the hoisting limiter is activated with regularity and this limiter is not designed for regularity.

Once a second limit has been activated, a restart of the hoist should only be possible once the limit has been manually reset, e.g. by using a key-lockable reset on the control station or a manual reset on the hoist. This is due to the fact that the primary limit has failed, therefore the reason has to be investigated as it should have operated under normal circumstances.

Emergency Stop

- The standard requires the fitting of an emergency stop function which is to be available at all times
    - The emergency stop must override all other functions and operations of the hoist

Hoist Brakes

Brakes should be fitted to the hoist, enabling the load to be arrested at any point during the lifting operation should any of the following occur:

- The operator releases a hoist/lower control button, returning to the neutral position
- The emergency stop is pressed and activated
- The external power supply to the brake is interrupted
- The power supply to the hoist motor is interrupted or switched off
- 2 x phases of the power supply to the hoist motor are interrupted (3 phase motors)

- The general principle of **"power off = brake on"** shall be used in all cases (fail-safe)

Hooks

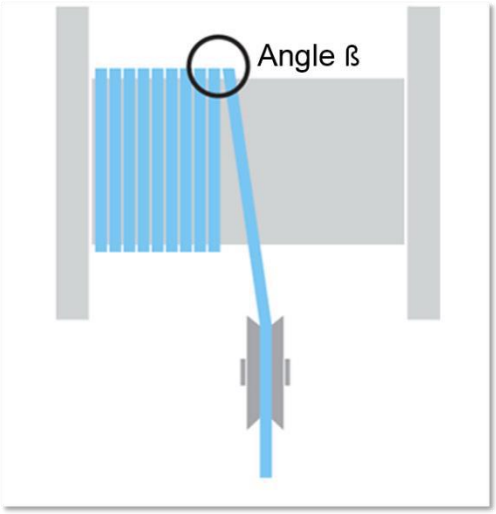
Load hooks must be designed so that they prevent unintentional displacement of the load. This can be done by either of the following methods:

- Incorporating a safety device (usually in the form of a latch)
- Designing the safety requirement into the shape of the hook

The ACoP to Regulation 6(1) of LOLER. This states that:
"Hooks and other devices provided for lifting should be of a type that reduces the risk of the load becoming displaced from the hook or other devices."

Rope Drives

The fleet angle (indicated below by Angle ß) for grooved drums and rope sheaves should not exceed **4°** for all ropes and **2°** for rotation-resistant rope.



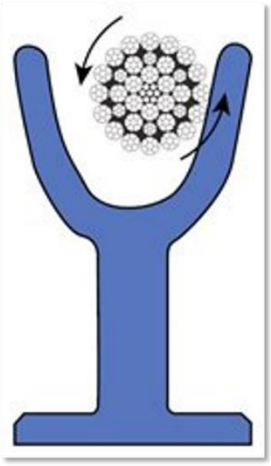
Notes:

Fleet Angle

If a rope enters a sheave under a fleet angle, it will first touch the flange and then roll down into the bottom of the groove, twisting the wire rope slightly every time.

With increasing fleet angle, the amount of twist increases.

If the rope enters the sheave at a fleet angle of 1° it will touch the flange in a very deep position and will only be twisted by 5°. If the rope enters the same sheave at a fleet angle of 5°, it will touch the flange at a very high position and will be twisted by up to 50°.



Ropes rotate as they enter and exit the sheave groove

Rope Drums

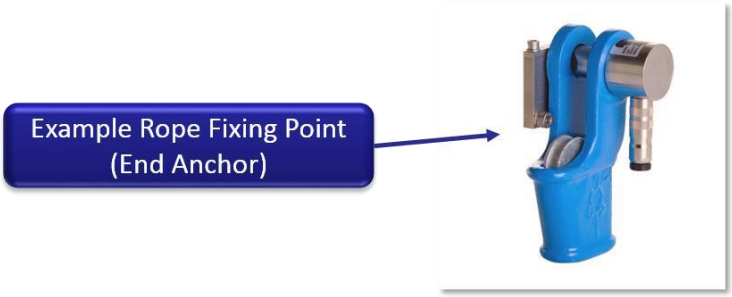
The design of the electric wire rope hoist must ensure that the load rope cannot run off the side of the rope drum.

Note: Suitable preventative measures on drums could include, for example, flanged drum end plates, frame/housing, or rope guides.

Notes:

Rope Drives

- Flanged drum end plates shall protrude beyond the rope wound on the drum at the top layer by at least 1.5 x the nominal rope diameter
- Single layer rope drums must be grooved
    - Grooving must be smooth and free from surface defects liable to damage the rope
    - Grooves must have a radius of 0.525 to 0.56 x nominal rope diameter
    - The rope groove depth must be between 0.28 and 0.45 of the nominal rope diameter
    - The groove pitch must provide sufficient clearance between adjacent rope turns on the drum, taking into account the rope tolerance
- The fixing point of the rope shall be easily accessible for maintenance and replacement of the rope

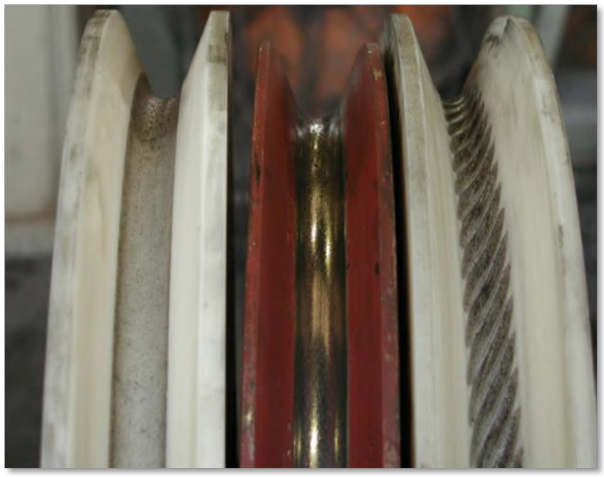


Ropes

- Ropes used for electric hoists are to be selected specifically for a given application and manufactured from suitable materials
- Rotation-resistant ropes must be use in cases of single-fall application so that they will not unwind under load conditions
- All wire rope discard criteria used during a thorough examination should be aligned to the requirements of BS ISO 4309

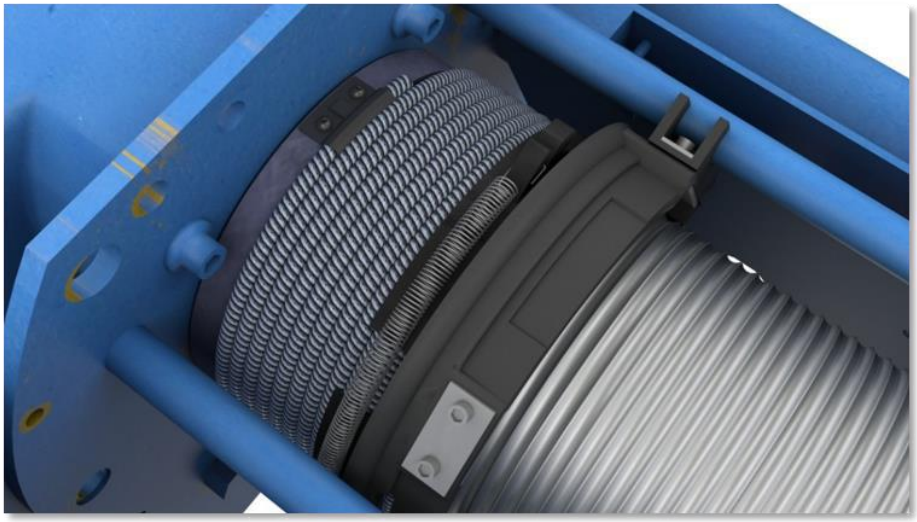
Wire Rope Sheaves

- Sheaves must be designed to prevent the rope from jumping out if the grooves when the wire rope is slack
- Rope grooves on rope sheaves should have a groove radius of (0.52 to 0.56) x nominal rope diameter
- The opening angle of the rope sheave shall be symmetrical and between 30° and 60°
- The depth of the grooves shall not be less than 1.4 x nominal rope diameter



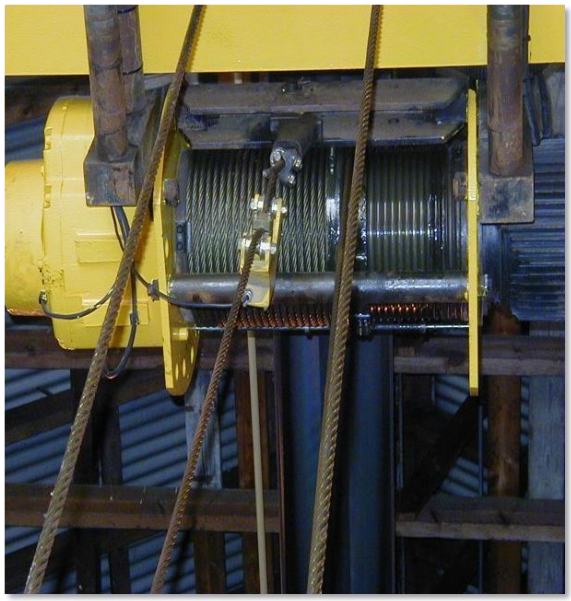
Rope to Rope Drum Connection

- Rope fastening onto the rope drum shall be made in such a way that at least 2.5 times the remaining static force at the fastening device is accommodated when the rated capacity of the hoist is applied to the hoist taking into account the friction effect of the winding on the drum.
- There shall be at least two rope windings remaining on the drum before the fixing point of the rope
    - The fastening elements of the fixing point of the rope shall be selected taking into account the rope and drum contours



Rope Anchorage/Terminations

- Anchorages on the rope shall resist 2.5 times the static rope force resulting from the rated capacity of the hoist without permanent deformation
- Terminations can include:
    - Asymmetric wedge socket to BS EN 13411-6
    - Symmetric wedge socket for rope diameters up to 8mm to BS EN 13411-7
    - Metal and resin sockets to BS EN 13411-4
    - Wire rope clamps to BS EN 13411-3
- **Wire rope grips and rope eyes in conjunction with wire rope grips cannot be used as rope-end terminations!**



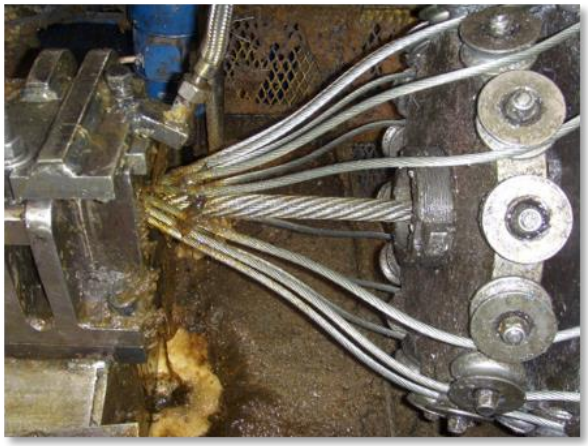
Environment Protection

- When wire rope hoists are required to operate both inside and outdoor, consideration should be given to the use of a weatherproof cover. This should form a large enough canopy to prevent the hoist being directly exposed to rain etc.
- When wire rope hoists are required to operate over furnaces and quench tanks etc., the use of a heat shield should be considered. This should be large enough to prevent the hoist being directly exposed to flames
- In steam-laden atmospheres, such as dye houses and laundries, special precautions are necessary to limit corrosion. Consideration should therefore be given to the use of galvanised wire rope and additional lubrication points

Wire Rope Lubrication

- Wire rope is lubricated during the manufacturing process
- In order to maintain a satisfactory working life it is therefore necessary to provide adequate and appropriate lubrication
- Suitable lubricants are those which can withstand these high pressures and will adhere to the rope
    - In adverse working conditions, such as foundries, or where the lubricant may contaminate other items, e.g. food stuffs, the use of dry lubricants in the form of colloidal graphite dispersions are recommended
    - All lubricants must be acid free in nature

It is important that the manufacturer's recommendations for lubricants and their application are followed.



Information to be Supplied by the Manufacturer

The manufacturer must provide operating instructions containing information and instructions for the commissioning, use, regular examination and maintenance of electrically operated wire rope hoists. The following information should also be included:

- The use for which the hoist mechanism is intended shall be clearly described
    - Warnings shall be provided with regard to misuse of the hoists which, according to experience, may occur
    - This information should include any limitations of the design, for example the intended duration of service
- Information about the operation of the hoist and lower limits and their periodic inspection
- Training requirements for the operating personnel
- Maintenance and repair work required to ensure the safe functioning of the hoist unit
    - Including inspection and lubrication requirements, operating principles, safety devices etc.

Marking

Electric wire rope hoists are to be marked with the following information:

- CE Mark
- Business name and address of the manufacturer
- Designation of the machinery
- Type designation
- Identification number, if any
- Year of manufacture
- Explosion proof class (if applicable)
- IP rating
- Rated capacity
- Range of lift
- Group of mechanisms
- Details of lifting media, wire rope construction and minimum breaking force
- Power supply information, voltage, phase(s), frequency, rated flow (hydraulics) and rated pressure (pneumatics)
- Motor size (kW)
- Rated hoisting speed
- Rated traverse speed if fitted with combined trolley

Note: If manufacturer does not provide a unique identification mark, then the owner of the equipment will be responsible for ensuring that the equipment is marked with one.

Notes:

Information which Should be Exchanged Between the User and Designer or Supplier

As electric power operated hoists are frequently used for miscellaneous lifting purposes, precise details of the load to be lifted are not always available. In these circumstances, only a general specification can be given and this should include the following information:

- Maximum load to be lifted or SWL
- Type of hoist, i.e. chain or wire rope
- Range of lift
- Maximum drawn up dimension
- Maximum extended dimension
- Type of suspension, e.g. hook/eye, push/geared/electric travel trolley, in the case of a trolley suspension, details of the runway beam section and size
- Lifting speed(s)
- Power supply, voltage, phase(s) and frequency
- Details of the power feed system if required
- Type of control, e.g. pendant, remote etc., including pendant length etc. If unspecified, the manufacturer will assume pendant control and this will be arranged to suit the hoist on the basis of the operating level being at the extended dimension
- Special service conditions or safety requirements which may affect the hoist design, e.g. outdoor use, use in a flammable atmosphere etc.
- Classification if known or details of the state of loading and duty cycle etc.
- Any accessories that may be required, e.g. slack chain collecting box, working limits etc.
- Any other special requirements

It may subsequently be found that a more detailed exchange of information is necessary to ensure the correct selection. For all but the simplest or repeat installations, a visit by the supplier to survey the site should always be considered as this will minimize the information exchange and reduce the chance of incorrect selection.
Further technical information may be required by the user at the time of installation or for maintenance purposes. It will be contained in the manufacturer's operations and maintenance handbook, which will be supplied with the hoist, and does not otherwise form part of the information exchange.

Pre-Use Checks

Operator pre-use checks should include:

- Visual check for any obvious signs of damage
- Check operation of upper and lower limit switches (no load condition)
- Hoist brake
    - No slipping or overrun when lowering
    - No unusual noises
- Load rope
    - Free from any obvious signs of damage
    - Kinks and twists
- Check the bottom hook for smooth operation, ability to swivel and safety latch operates correctly
- If the hoist is fitted to a runway beam, ensure the trolley operates correctly and that the beam appears undamaged with no obvious obstructions
    - Ensure end stops are fitted at both ends of the beam
- Check the operation of the emergency stop button and ensure that you are aware of the location of the hoist power isolator switch

In-Service Inspection

In addition to the statutory thorough examination by a Competent Person, electric wire rope hoists should be visually inspected by a Responsible Person prior to use or on a regular basis, taking account of the conditions of service and statutory requirements. The inspection should include the fixings, suspension points and supporting structures, guidance on the in-service inspection of runways, slewing jib cranes and mobile gantries is given in further sections of this code and reference should also be made to BS 7121-2.

The inspection should include the following points in addition to any specific checks recommended by the supplier:

- State of the wire rope
- Correct operation of the brake
- Correct operation of hoist and, where fitted, lower limits
- Correct operation of controls
- A visual check for any obvious defects

If any of the following faults are found, the hoist should be withdrawn from service and referred to a Competent Person.

- Signs of wear, deformation or damage to hooks, trolleys or other terminal or suspension fittings
- Hook safety latch damaged or inoperative. In the event of the latch appearing to be too short, this is an indication of the hook having opened out and may be the result of the hoist being overloaded
- Signs of wear and fretting corrosion to screw threaded shanks
- Load slips when hoisting or load will not lift although motor is running
- Load stops midway through a lifting cycle. In this case, where possible action must be taken to lower the load. If this cannot be done, the area must be cordoned off to prevent anyone approaching
- Hoist will not operate although power is on
- Spasmodic or erratic lifting operation and similar symptoms on the travel motion
- Trolley slips or skids on the runway
- Damage to any electric cable or cable gland
- Damage to the pendant control hand set including cable, rubber covers, legends or labels and support wire, chain or cord
- Excessive noise or unusual sounds from any part of the hoist, including motor, clutch, gearbox or brake
- Travel and/or hoist motions operate in opposite direction to control indication
- Load continues to travel excessive distance after motion control has been released
- Load rope worn or damaged, in particular any increase or decrease in diameter, opening of strands, kinks or broken wires. Any signs of mechanical damage such as flattening, crushing, cuts, burring and corrosion. Faults are most likely to occur at the terminations and where the rope passes over sheaves and pulleys, in particular compensating sheaves
- Wire rope does not feed onto the drum correctly or winds in the wrong direction in relation to the control direction selected
- Damaged or worn rope guides and bands
- Signs of damage or distortion of the anchorage points or of the wire rope pulling through any clamping devices
- When bottom hook is fully extended to its lowest working position, there are less than 2 full turns of rope remaining on the drum

- Under no circumstances must there be less than 2 full turns of rope remaining on the drum but consult the manufacturer's instructions as with some units 3 full turns must remain
- Wire rope is cabled, i.e. multiple falls of rope are twisted together

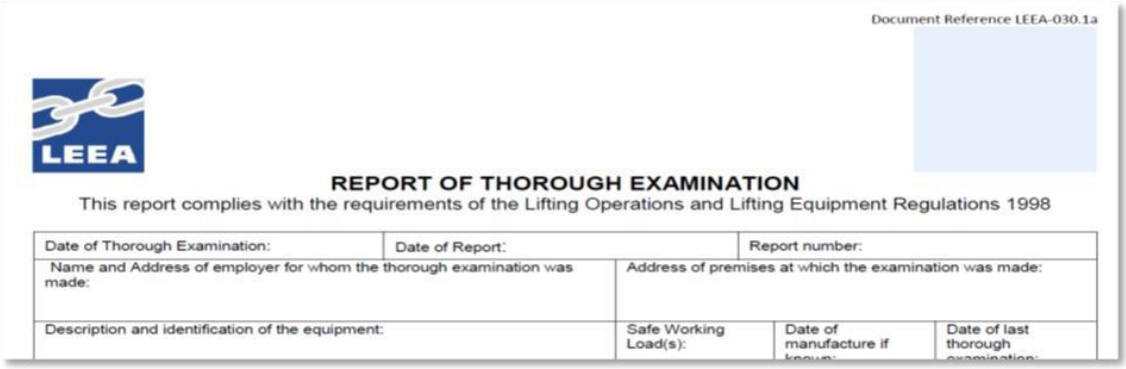
Further guidance on inspection procedure and rejection criteria for wire rope is given in BS ISO 4309, BS EN 12385-3 and BS 7121-2.

Legal Requirements

The definition of lifting equipment and accessories used in LOLER make it clear that power operated wire rope hoists are lifting equipment.

Unless a written scheme of examination, drawn up by a Competent Person, is in place and operating they must be thoroughly examined by a Competent Person at intervals not exceeding 12 months.

Reports of thorough examination should be retained and cross referenced to the hoists historical records for inspection by the Competent Person or HSE.



Document Reference LEEA-030.1a

LEEA

REPORT OF THOROUGH EXAMINATION

This report complies with the requirements of the Lifting Operations and Lifting Equipment Regulations 1998

Date of Thorough Examination:	Date of Report:	Report number:	
Name and Address of employer for whom the thorough examination was made:	Address of premises at which the examination was made:		
Description and identification of the equipment:	Safe Working Load(s):	Date of manufacture if known:	Date of last thorough examination:

Inspection/Examination (Ensure Lock Out-Tag Out Isolation!)

Notes:

The Thorough Examination

For some applications it may also be necessary to have the installation thoroughly examined by a Competent Person before the hoist is put into service.

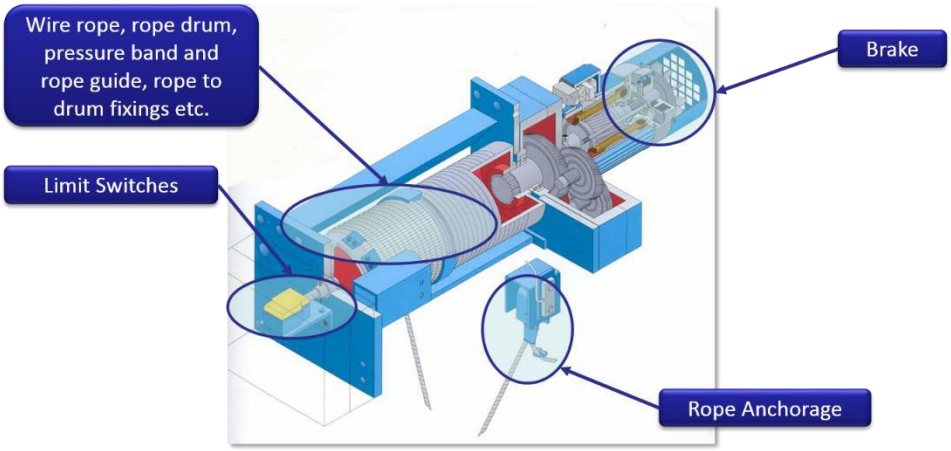
Regulation 9 of LOLER states:
(2) Every employer shall ensure that, where the safety of lifting equipment depends on the installation conditions, it is thoroughly examined:

> (a) after installation and before being put into service for the first time
> And,
> (b) after assembly and before being put into service at a new site or in a new location,
> to ensure that it has been installed correctly and is safe to operate

Note: Although not required by legislation, new power operated hoists will usually be issued with a manufacturer's record of proof load testing in addition to, although possibly combined with, the EC Declaration of Conformity. This document forms an important part of the record of the hoist. It should be retained and cross referenced to the hoists historical records for inspection by the Competent Person or HSE.

- The examinations shall be carried out in adequate natural or artificial light
- The machine shall be clean or cleaned and free from rust to enable a proper visual examination of all parts to be carried out
- The examination shall be carried out by a competent person in accordance with the schedule of requirements aligned to the employers' quality policy and site procedures reference material and LEEA's Technical Requirements/ COPSULE which are available to support them
- Where appropriate the standard procedures of examination, checking of hooks, chain sizes, pitch and diameter of wires and allowable wear and stretch shall be those recommended by the product manufacturer
    - Further criteria may also be given in British Standards, LEEA technical publications and in the LEEA correspondence courses
- Parts shall be exposed and examined sufficiently to enable a proper conclusion as to their condition to be reached and reported on. Where necessary parts must be dismantled and cleaned to achieve this

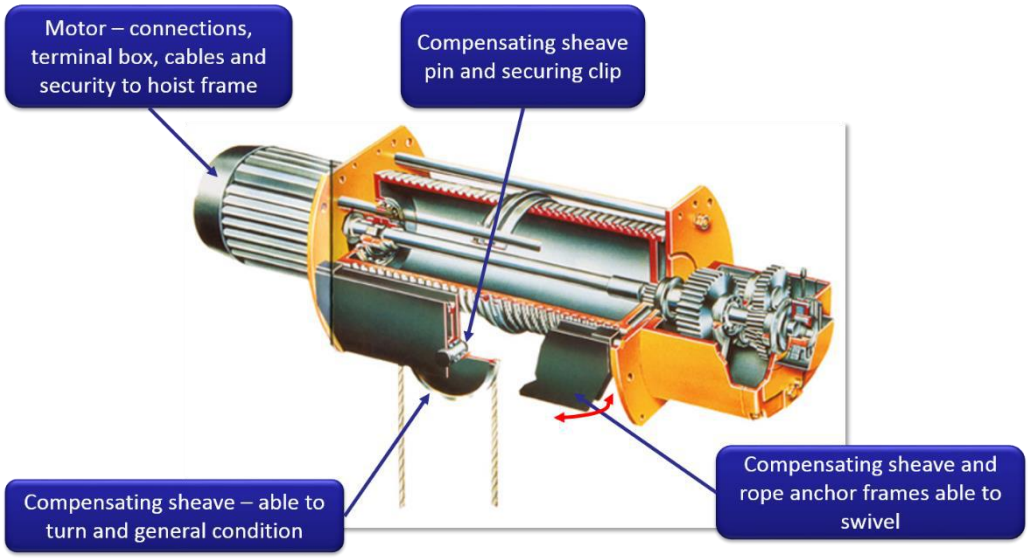
The operation of mating parts must be checked and observed, e.g. a load rope, rope drum (as detailed in Module 3 of this course), rope guide and pressure band, brakes (as detailed in Module 13) and other vital mechanisms must be checked for safe and correct operation



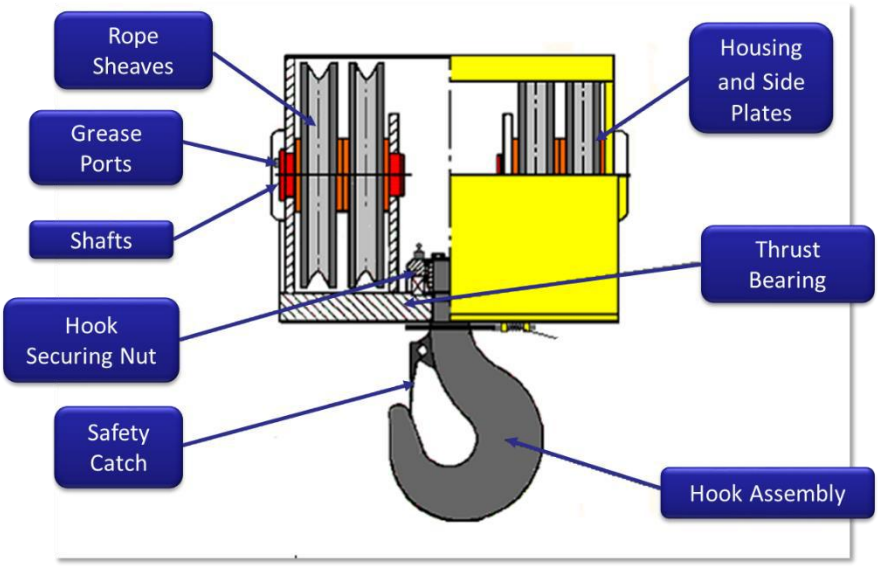
- The assembly of parts, reeving and anchorages must be checked for correctness and proper operation and all locking and securing devices must be checked as being sound and in place

- All power supply, current collecting systems, 'fail safe' mechanisms, limit mechanisms, protective and running equipment must be examined for correctness, safety and proper operation

- The identification number and WLL/SWL shall be checked with the last Report of Thorough Examination or the Certificate of Conformity, and where markings have become illegible be re-stamped or marked



The Thorough Examination – Block



- The written report is to provide a description of the article examined, the date of the examination and a clear statement of its fitness for further use or details of the defects which affect the WLL/SWL and other observations
    - Where an article is defective, a responsible representative of the user must be informed
    - If dangerously defective, arrangements must be made for its immediate withdrawal from service
    - Where Regulations or Acts require statutory notification of defective equipment, steps must be taken to ensure notification to the correct authority, for example LOLER gives requirements for reporting certain matters to the HSE

It is of paramount importance that **lifting equipment inspectors or examiners do not work on live electrical equipment**. Lock-out/Tag-out routines should always be considered as part of your risk assessment.

Notes:

11. Pneumatic Hoists

Introduction to Pneumatic Hoists

To a large degree, the requirements for the safe use of pneumatic power operated hoists are the same as those for electric power operated hoists.

Pneumatic power operated hoists tend to be more limited in use than electric power operated hoists, mainly due to the problems associated with the provision of a suitable air supply. However, they offer many advantages over electrically operated equipment and as a result are widely used in industries where air is provided for other purposes or where the safety aspects associated with air operated equipment are a major consideration.

Pneumatic powered hoists are within the scope of BS EN 14492-2.

Types of Pneumatic Hoists

Pneumatic power operated hoists utilize both vane and piston air motors to provide the drive.

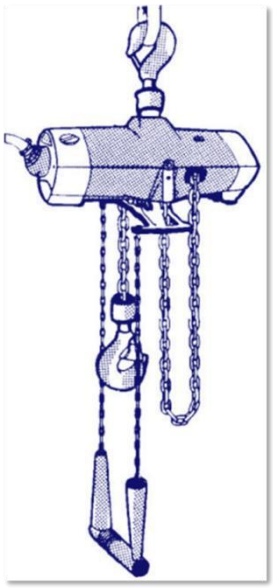
Hoists with vane motors are more compact than those with piston motors but for heavier duties piston motors are better suited. Due to this, the lower capacity units generally utilize vane motors, the resulting hoist being more compact than the equivalent electric power operated hoist.

An older type of pneumatic power operated hoist which used a piston cylinder and a system of fixed sheaves to raise a wire rope may still be found in service although these are no longer manufactured.

Pneumatic power operated hoists may use link chain, roller chain or wire rope as the lifting medium.

Due to the wide range of manufacturers and models available, the following is of a general nature only. It is necessary to consult with specific manufacturers to establish the range of designs, capacities and lifts they are able to offer.

Modern pneumatic power operated link chain hoists are generally available in a range of capacities from 250kg.

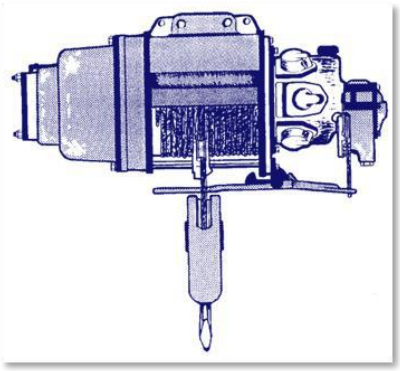


They are available with top hook suspension or with built-in trolleys for runway mounting. Some models are available with a top lug making them suitable for building into structures for fixed suspension applications or for use in crane crab units.

These hoists offer shorter drawn up dimensions than their equivalent electric power operated hoists, making them ideal for use where headroom is restricted.

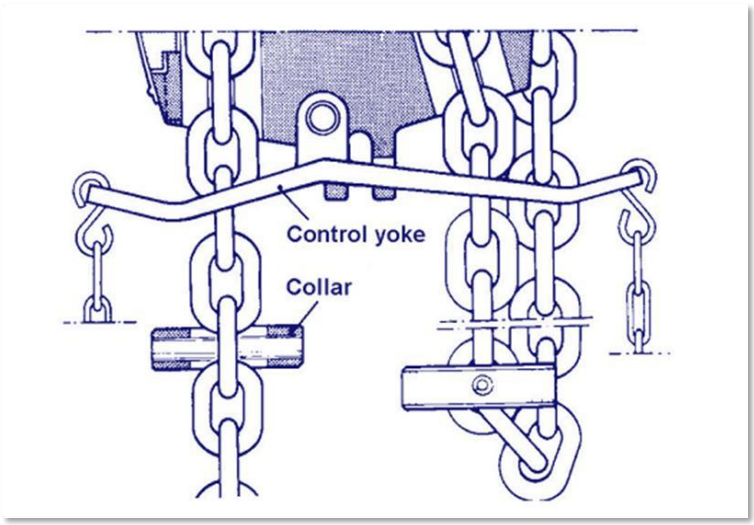
Pneumatic power operated roller chain hoists are available in a similar range of designs to those of the link chain models. However, roller chain is only flexible in one plane, limiting the suitability for some applications as storage of the slack chain cannot be achieved in the same way and as a result, heights of lift are more normally limited to 3 metres.

Pneumatic power operated wire rope hoists are generally available in a range of capacities from 250kg. Some models may be available with vane motor drives but piston motors are more usually used, particularly for the higher capacity models. A range of low headroom models, usually up to 5 tonnes capacity, is also available. Wire rope hoists are available with built in trolleys or with top lug fittings for fixed suspension. Standard headroom hoists are available with heights of lift up to 50 metres, whilst low headroom units are more normally limited to 15 metres.



Motion Limits

Pneumatic hoists are usually fitted with hoist and lower limits which directly operate the control valve, closing this when the maximum travel position has been reached. These can often be set to any desired position and, unlike electric hoist and lower limits, may be used to position the bottom hook in certain applications.



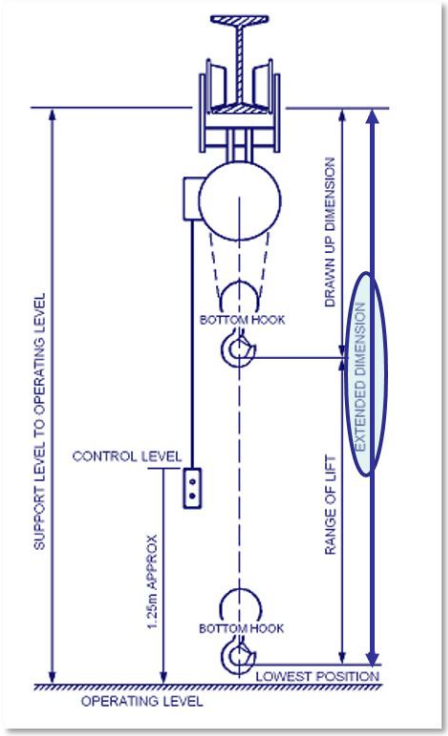
Notes:

Ancillary Equipment

In addition to the previously mentioned equipment, pneumatic hoists can also be fitted with air-powered trolleys for movement of heavy loads and greater control. A vane motor, pendant controlled and fitted with a brake, normally powers the trolley.

The hoists can also be fitted with piped exhausts where the exhaust air is taken to a remote area before discharge. This is necessary in food processing and some chemical works where atmospheric purity is of great importance or the danger of dust being blown about exists.

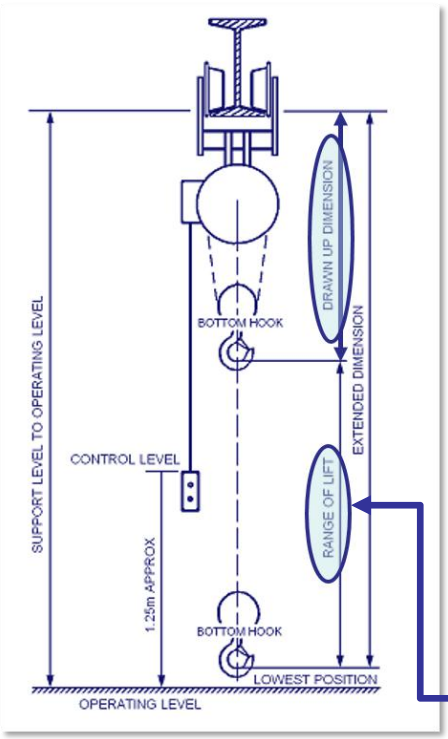
Chain bags are another accessory, which is useful when working in confined spaces over complex machinery.



Definitions and Terminology

Extended Dimension

The extended dimension is the distance between the support level and the bottom hook seat in the extended position, as shown opposite:



Drawn up Dimension

The drawn up dimension is the distance between the support level and the bottom hook seat when the bottom hook is in the raised position.

This is sometimes referred to as the 'headroom' as it is the effective headroom taken up by the hoist. However, the term headroom has not been used as it is sometimes used in everyday language to have other meanings.

Range of Lift

The range of lift is the vertical distance which the bottom hook travels between the extended and drawn up positions

Notes:

Vane Motor

These are a common means of powering air hoists and will be looked at in detail later in this module.

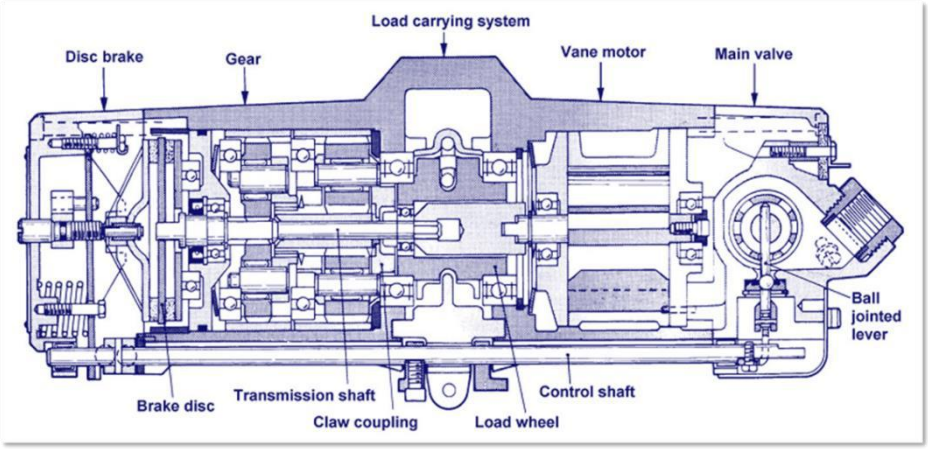
Control

The method which is used to control the raising and lowering.

Basic Components

General Arrangement

The illustration below shows a typical arrangement of a pneumatic hoist. It consists of 5 basic sections: **1)** Main valve **2)** Vane motor **3)** Load carrying system **4)** Gearbox and **5)** Braking system.

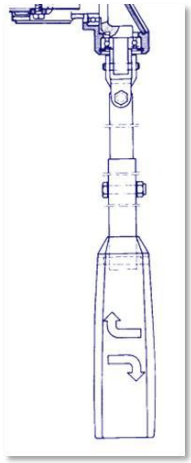


General Operation

This arrangement with the gearbox and motor situated either side of the load wheel is typically found. It keeps the machine balanced about its centre when it is loaded and unloaded.

The raising and lowering is controlled by the operator using one of the following methods shown below:

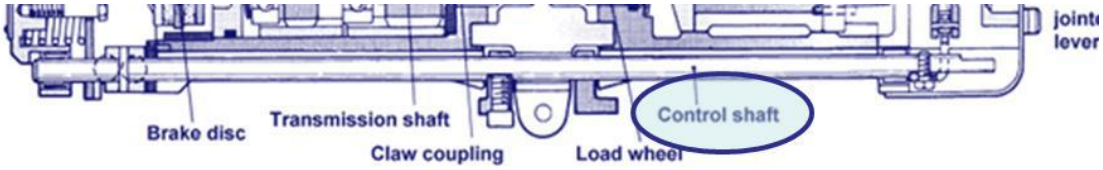
Twist Rod Control



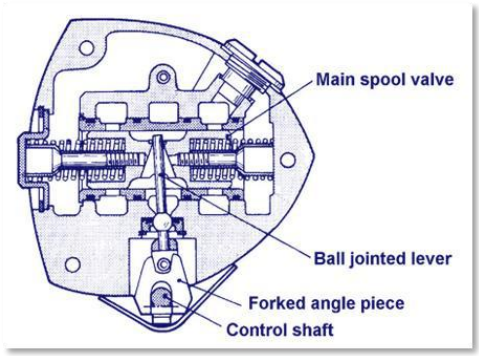
Cord Control

Pendant Control

Whichever method is used; the effect is to rotate the control shaft in a clockwise or anti-clockwise direction about its rest position. This then controls the direction and speed of the load chain.



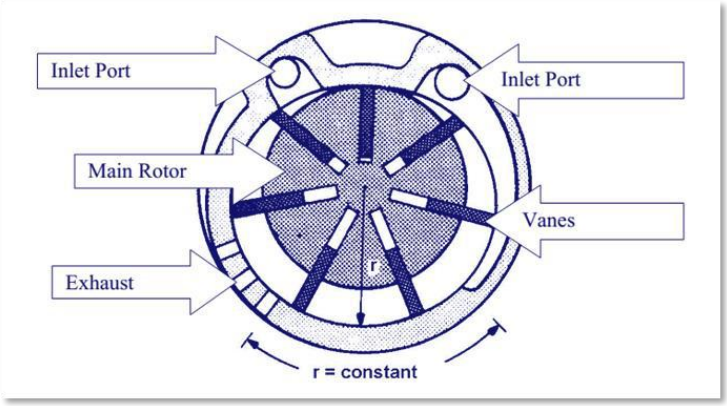
When the control shaft is rotated it moves the main valve spool via a lever or gear arrangement. One design uses a ball-jointed lever operated by a forked angle piece attached to the shaft as shown below:



The lever moves the spring centred spool of the main valve which directs air into the vane motor in the selected direction.

The motor normally has seven vanes as shown in the illustration below. It has a cylinder casing of high grade nodular cast iron to give excellent abrasion resistance. The vanes consist of a fabric-based Bakelite material which is strong, light, quiet and has good sealing properties. The vanes will wear in preference to the casing and will need to be replaced from time to time. This can be done at minimal expense. The rotor and shaft are made from alloy steel.

From this illustration, it can be seen that the rotor is mounted towards the top of the casing cylinder so that the arrangement has an eccentric contour. This means that when a vane is working under pressure across the lower section, i.e. when it is transmitting maximum torque to the rotor, it is working at a constant force on the projected area of the vane and eliminates the risk of air leakage.



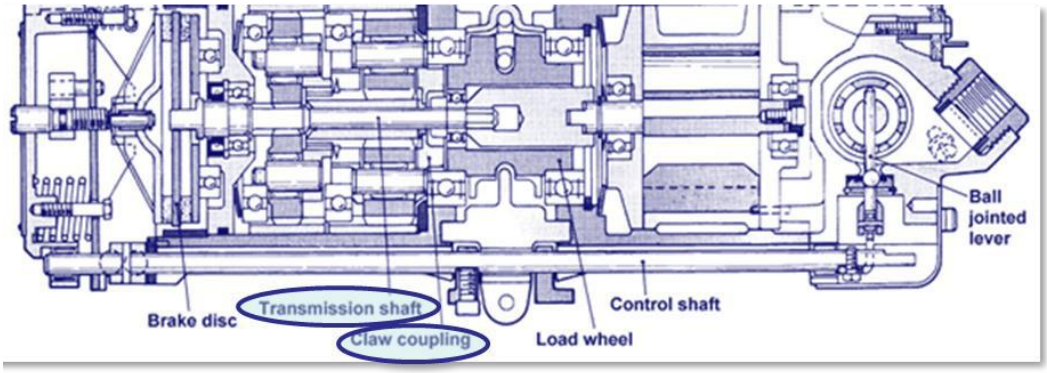
In operation the vanes are forced against the cylinder wall to achieve a good seal. Some motors use spring loaded vanes but most now use air loaded vanes. When air is initially supplied through one of the two ports at the top of the cylinder a small amount is directed under the vanes forcing them against the cylinder wall. When a predetermined pressure is achieved the air is then directed into the cylinder to drive the motor.

The direction of the motor is governed by the air entry port selected. One port acts as the inlet whilst the other remains closed.

The air exhausts from the bottom of the cylinder to one side of the centre on the clockwise rotation of the motor (i.e. the lift side). The motor is then reversed by changing supply ports so that now the air exhausts before the centre line of the cylinder. This has the advantage of giving air motors an important safety feature. If the air supply should fail whilst the brake is open, or if the brake fails, the motor will try to turn due to the downward action of the load. However, this causes it to act as a compressor. It will then build a resisting pressure in the motor casing which in turn prevents further movement of the motor. Due to loss of pressure through leakage, the motor may in fact continue to turn and lower the load. However, the motion will be extremely slow, so although it is not strictly true, air motors can be considered to be fail-safe.

The drive from the motor is transmitted to the gearbox by a **transmission shaft**. This provides the input to an epicyclic gearbox which is connected to the load wheel by a **claw coupling**.

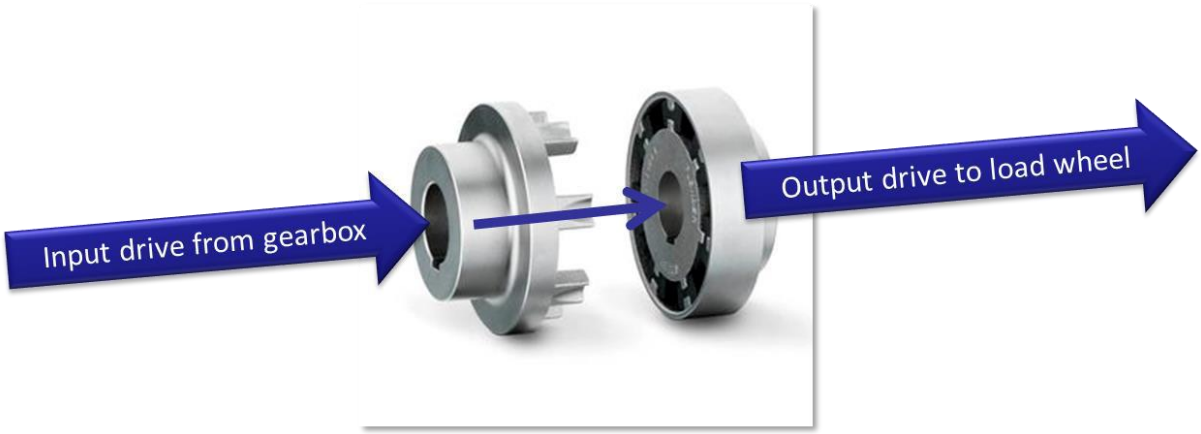
The epicyclic gear arrangement is chosen because it is compact and capable of transmitting high torques.



The load can be stopped and held in any position while raising or lowering by means of a ‘fail-safe' brake.

General Arrangement

The illustration below shows the principle of a 'claw' type coupling but it is not necessarily the exact coupling that would be found in a particular brand of pneumatic hoist:

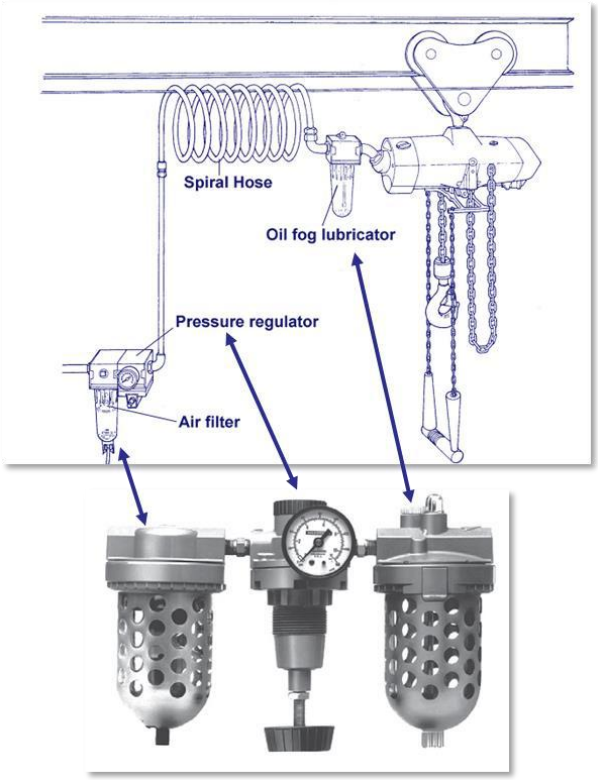


Air Supply

For any hoist to work efficiently it must receive an adequate supply of clean, dry air. The supply must be maintained at the required pressure and delivery rate. Normal factory air supply pressure is 5.5 to 6 bar (80 to 90 lbs/sq. inch) and pneumatic hoists are generally made to operate in this range.

The illustration opposite shows one system of providing the hoist with an adequate air supply whilst allowing limited free movement of the hoist/trolley unit. In this case a plastic covered support cable is pulled taut along the length of the beam. The tension is maintained by a spring loaded tensioning screw.

The preformed spiral PVC hose rests on the wire as shown. It extends and retracts like a spring when the hoist is moved.



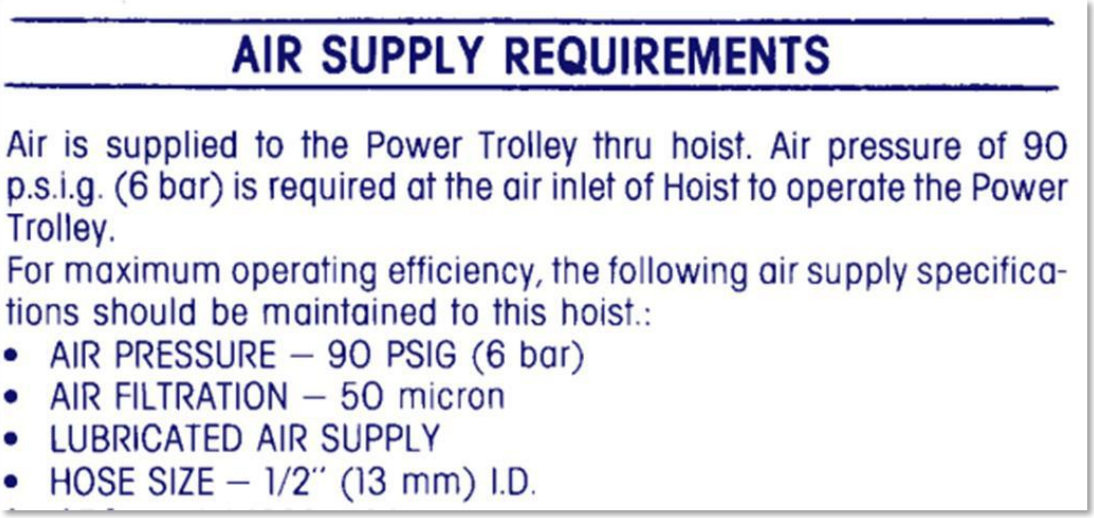
As hoses are stiffer and heavier than electrical cables the gathered loops of hose, when the hoist is at the end of the runway, occupy more space than cables. This is one of the governing factors on their overall length.

A further factor is that over long runs air pressure is lost. In extreme cases this results in a loss of lifting capacity. Delays in the arrival of the full pressure at the unit also lead to a delay in response to control commands.

As a result, it is necessary to have several supply points along the length of long runways. This means the hoist has to be disconnected and reconnected at intervals throughout the travel if long travel distances are involved.

Note: BS EN 14492 states that disconnection from the pressurised air supply shall not result in load dropping.

Manufacturers will provide details of air supply requirements for their hoists, as shown in the example below:



AIR SUPPLY REQUIREMENTS

Air is supplied to the Power Trolley thru hoist. Air pressure of 90 p.s.i.g. (6 bar) is required at the air inlet of Hoist to operate the Power Trolley.
For maximum operating efficiency, the following air supply specifications should be maintained to this hoist.:

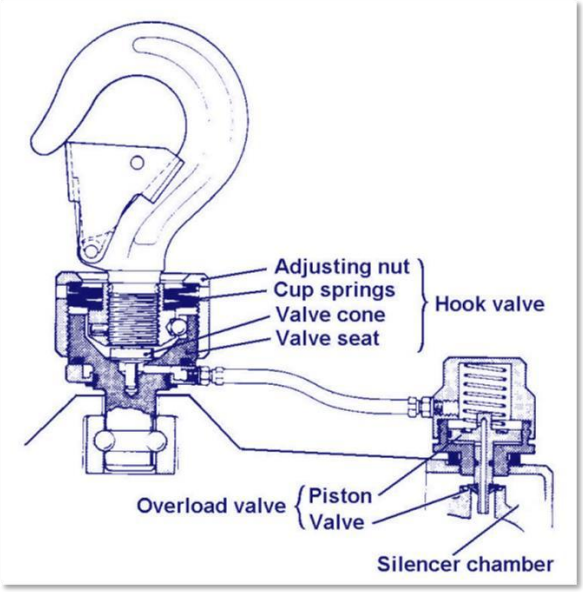
- AIR PRESSURE – 90 PSIG (6 bar)
- AIR FILTRATION – 50 micron
- LUBRICATED AIR SUPPLY
- HOSE SIZE – 1/2" (13 mm) I.D.

Air feed systems should be inspected on a regular basis and action taken to close leaks and replace damaged or worn hoses. Movement and flexing of hoses at the appliance entry port can cause a breakdown of the hose wall. Oil mist lubricators should be checked on a regular basis and oil levels topped up as necessary. Drain filters should be cleared of any moisture which has accumulated. If left, this will eventually return to the air supply or prevent further moisture from being collected. Shut off valves should be checked to ensure they operate correctly.

When working on compressed air lines and systems, care must be exercised to ensure no residual pressure remains. Before disconnecting hoses or attempting maintenance work on pneumatic appliances, it is advisable to close shut off valves and then operate the appliance so as to release any residual pressure.

Notes:

Overload Protection



Although pneumatic motors stall to safety, pneumatic appliances may include a device which uses pressure springs or washers which compress under load and, if the design load is exceeded, they open a vent valve which carries the air supply to the exhaust stopping the motor from operating. When the pull on the hoist exceeds a set value the air supply to the vane motor is reduced, thereby decreasing the lifting capacity and preventing further hoisting.

The device shown in opposite consists of two main parts, the **hook valve** and the **overload valve** connected by a length of PVC tubing as shown. The hook valve is connected via a 'banjo' coupling (see explanation on next page) which allows it to turn about the mounting.

The hook valve is fitted in place of the normal suspension hook and the overload valve fits into a port of the main valve housing special provided for the accessory.

The device is normally adjustable between the proof load (i.e. 1.25 x SWL/WLL) and 80% of the SWL/WLL.

In operation the hook is set to the required overload value by the adjusting nut which alters the compression in the cup springs. In the overload condition the cup springs are depressed causing the valve cone to lift from its seat. This vacates the space above the overload valve piston, causing it to rise and release the valve attached to its stem.

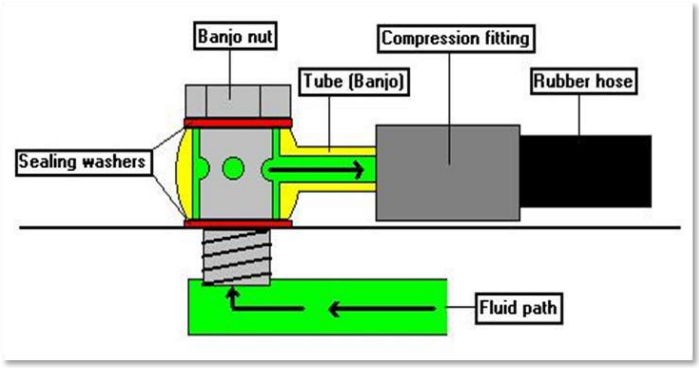
Some of the inlet air to the vane motor is then released to flow into the silencer chamber. The pressure to the vane motor is therefore reduced, decreasing the hoist lifting capacity.

Banjo Fittings

A banjo fitting is a perforated hollow bolt and spherical union for air or fluid transfer. The pipe connected may be either rigid or a flexible hose.

The main advantage of the fitting is in high pressure applications (i.e. more than 50 bar).

The name stems from the shape of the fitting, having a large circular section connected to a thinner pipe, generally similar to the shape of a banjo.



Banjo fittings have the advantage that they do not have to be rotated relative to the host fitting. This avoids risk of damage by twisting the hose when screwing the fitting into place. It also allows the pipe exit direction to be adjusted relative to the fitting, then the bolt tightened independently.

Principle for Selection

For all applications, initial consideration should be given to the following:

- Capacity
- Range of lift
- Speed(s)
- Duty classification
- Suspension
- Operating level(s)
- Availability and suitability of air supply
- Service conditions
- Nature of load
- The documentation required by legislation (EC Declaration of Conformity or report of thorough examination as appropriate). If this is not on record refer the hoist to a Competent Person for thorough examination

Note: It should be recognised that power operated hoists are designed to lift in the vertical plane only. The application should be fully discussed with the supplier to ensure that the correct equipment is selected.

Service Conditions

Pneumatic hoists are manufactured to meet particular service conditions.
Manufacturer's instructions should always be followed especially for the following considerations:

- Ambient temperature ranges in which the hoist will operate. Ensure the hoist has a suitable operating temperature ability

Environmental Conditions

Examples of environmental conditions requiring special attention are:

- Outdoor use
- Salt air
- High humidity
- Ambient temperatures above or below the normal range
- The presence of local heat sources, e.g. furnaces
- Dust/abrasives in the atmosphere

Other Potential Hazards

Other potential hazards may arise as the result of the work being carried out in the general location or be caused by the hoist performing lifting and moving operations over the heads of personnel or similar. Examples of such potential hazards requiring special attention are:

- Use in mines and quarries
- Use in laundries
- Use in galvanizing, pickling and hot dipping processes
- Use in paint shops
- Use over work areas
- Use over walkways and footpaths

Notes:

Standards

The following standards are applicable to pneumatic hoists and this module:

BS EN 14492 – Power Driven Winches and Hoists – **Part 2 – Power Driven Hoists.**

This standard covers pneumatic, hydraulic and electrically powered hoists, using chain, wire rope and belts as lifting media.

Rated Capacity Limiters (Overload Protection)

Rated Capacity Limiters and Indicators (RCL)

- Hoists with a rated capacity of 1000kg or more shall be fitted with a rated capacity limiter (overload protection)
    - For **'direct acting'** RCLs, it will be set at 110% of rated capacity to allow for dynamic load testing (see note 1 below)
    - For **'indirect'** RCLs, it will be set at 125% of rated capacity (see note 2 below)

Note 1: A 'direct acting' RCL act directly in the chain of the drive elements of the chain hoist, for example, a slipping clutch (friction torque limiters).

Note 2: 'Indirect' RCLs measure the load using a sensor and switch off the energy supply for the lifting operation. This usually engages the hoist brake simultaneously.

Emergency Stop

- The standard requires the fitting of an emergency stop function which is to be available at all times
    - The emergency stop must override all other functions and operations of the hoist

Hooks

Load hooks must be designed so that they prevent unintentional displacement of the load. This can be done by either of the following methods:

- Incorporating a safety device (usually in the form of a latch)
- Designing the safety requirement into the shape of the hook

The ACoP to Regulation 6(1) of LOLER. This states that:
"Hooks and other devices provided for lifting should be of a type that reduces the risk of the load becoming displaced from the hook or other devices."

Information to be Supplied by the Manufacturer

The manufacturer must provide operating instructions containing information and instructions for the commissioning, use, regular examination and maintenance of pneumatic hoists. In addition, the following documents are to be supplied in accordance with legislation:

- EC Declaration of Conformity (Guidance LEEA 030.1e)
- Manufacturer's instructions for Use (Guidance LEEA SI.14.3)

Marking

Pneumatic hoists are to be marked with the following information:

- CE Mark
- Business name and address of the manufacturer
- Designation of the machinery
- Type designation
- Identification number, if any
- Year of manufacture
- Explosion proof class (if applicable)
- IP rating
- Rated capacity
- Range of lift
- Group of mechanisms
- Details of lifting media, wire rope construction and minimum breaking force
- Power supply information and rated pressure (pneumatics)
- Rated hoisting speed
- Rated traverse speed if fitted with combined trolley

Note: If manufacturer does not provide a unique identification mark, then the owner of the equipment will be responsible for ensuring that the equipment is marked with one.

Notes:

Information which Should be Exchanged Between the User and Designer or Supplier

As pneumatic hoists are frequently used for miscellaneous lifting purposes, precise details of the load to be lifted are not always available. In these circumstances, only a general specification can be given and this should include the following information:

- Maximum load to be lifted or SWL
- Type of hoist, i.e. chain or wire rope
- Range of lift
- Maximum drawn up dimension
- Maximum extended dimension
- Type of suspension, e.g. hook/eye, push/geared/travel trolley, in the case of a trolley suspension, details of the runway beam section and size
- Lifting speed(s)
- Type of control, e.g. pendant, twist rod etc., including pendant length etc. If unspecified, the manufacturer will assume pendant control and this will be arranged to suit the hoist on the basis of the operating level being at the extended dimension
- Special service conditions or safety requirements which may affect the hoist design, e.g. outdoor use, use in a flammable atmosphere etc.
- Classification if known or details of the state of loading and duty cycle etc.
- Any accessories that may be required, e.g. slack chain collecting box, working limits etc.
- Any other special requirements

The exchange of information necessary for pneumatic hoists will generally take the same form as for electric hoists except for the power supply details, these should be given as follows:

- Pressure and delivery rate
- Type of supply system, e.g. coiled hose, including any requirements for filters, lubricators and pressure regulators
- Type of control. If hoist has powered trolley, this should include the requirements for the trolley controls

Pre-Use Checks

Operator pre-use checks should include:

- Visual check for any obvious signs of damage
- Check operation of upper and lower limit switches (no load condition)
- Hoist brake
    - No slipping or overrun when lowering
    - No unusual noises
- Load rope
    - Free from any obvious signs of damage
    - Kinks and twists
- Check the bottom hook for smooth operation, ability to swivel and safety latch operates correctly
- If the hoist is fitted to a runway beam, ensure the trolley operates correctly and that the beam appears undamaged with no obvious obstructions.
    - Ensure end stops are fitted at both ends of the beam
- Check the operation of the emergency stop button and ensure that you are aware of the location of the hoist power isolator switch

In-Service Inspection

In addition to the statutory thorough examination by a Competent Person, pneumatic hoists should be visually inspected by a Responsible Person prior to use or on a regular basis, taking account of the conditions of service and statutory requirements. The inspection should include the fixings, suspension points and supporting structures, guidance on the in-service inspection of runways, slewing jib cranes and mobile gantries is given in further sections of this code and reference should also be made to BS 7121-2.

The inspection should include the following points in addition to any specific checks recommended by the supplier:

- State of the chain or wire rope
- Correct operation of the brake
- Correct operation of hoist and, where fitted, lower limits
- Correct operation of controls
- A visual check for any obvious defects

If any of the following faults are found, the hoist should be withdrawn from service and referred to a Competent Person.

- Signs of wear, deformation or damage to hooks, trolleys or other terminal or suspension fittings
- Hook safety latch damaged or inoperative. In the event of the latch appearing to be too short, this is an indication of the hook having opened out and may be the result of the hoist being overloaded
- Signs of wear and fretting corrosion to screw threaded shanks
- Load slips when hoisting or load will not lift although motor is running
- Load stops midway through a lifting cycle. In this case, where possible action must be taken to lower the load. If this cannot be done, the area must be cordoned off to prevent anyone approaching
- Hoist will not operate although power is on
- Spasmodic or erratic lifting operation and similar symptoms on the travel motion
- Trolley slips or skids on the runway
- Damage to the pendant control hand set including cable, rubber covers, legends or labels and support wire, chain or cord
- Excessive noise or unusual sounds from any part of the hoist, including motor, clutch, gearbox or brake
- Travel and/or hoist motions operate in opposite direction to control indication
- Load continues to travel excessive distance after motion control has been released

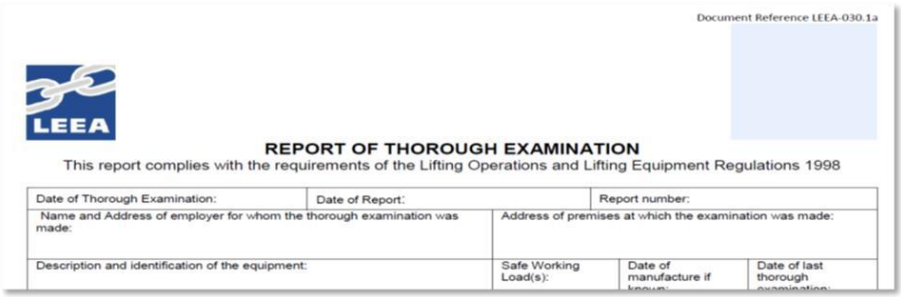
Notes:

Legal Requirements

The definition of lifting equipment and accessories used in LOLER make it clear that power operated chain hoists are lifting equipment.

Unless a written scheme of examination, drawn up by a Competent Person, is in place and operating they must be thoroughly examined by a Competent Person at intervals not exceeding 12 months.

Reports of thorough examination should be retained and cross referenced to the hoists historical records for inspection by the Competent Person or HSE.



Document Reference LEEA-030.1a

LEEA

REPORT OF THOROUGH EXAMINATION

This report complies with the requirements of the Lifting Operations and Lifting Equipment Regulations 1998

Date of Thorough Examination:	Date of Report:	Report number:	
Name and Address of employer for whom the thorough examination was made:	Address of premises at which the examination was made:		
Description and identification of the equipment:	Safe Working Load(s):	Date of manufacture if known:	Date of last thorough examination:

Inspection/Examination (Ensure Lock Out-Tag Out Isolation!)

The Thorough Examination

For some applications it may also be necessary to have the installation thoroughly examined by a Competent Person before the hoist is put into service.

Regulation 9 of LOLER states:

(2) Every employer shall ensure that, where the safety of lifting equipment depends on the installation conditions, it is thoroughly examined:

(a) after installation and before being put into service for the first time
And,
(b) after assembly and before being put into service at a new site or in a new location,
to ensure that it has been installed correctly and is safe to operate

Note: Although not required by legislation, new power operated hoists will usually be issued with a manufacturer's record of proof load testing in addition to, although possibly combined with, the EC Declaration of Conformity. This document forms an important part of the record of the hoist. It should be retained and cross referenced to the hoists historical records for inspection by the Competent Person or HSE.

- The examinations shall be carried out in adequate natural or artificial light

- The machine shall be clean or cleaned and free from rust to enable a proper visual examination of all parts to be carried out

- The examination shall be carried out by a competent person in accordance with the schedule of requirements aligned to the employers' quality policy and site procedures reference material and LEEA's Technical Requirements/COPSULE which are available to support them

- Where appropriate the standard procedures of examination, checking of hooks, chain sizes, pitch and diameter of wires and allowable wear and stretch shall be those recommended by the product manufacturer
    - Further criteria may also be given in British Standards, LEEA technical publications and in the LEEA correspondence courses

- Parts shall be exposed and examined sufficiently to enable a proper conclusion as to their condition to be reached and reported on. Where necessary parts must be dismantled and cleaned to achieve this
- Check the hooks, chain, swivels, load wheel and blocks for wear, stretch, damage or corrosion (8% max. wear, 2% max. increase in length of chain)
- Check anchor pin for integrity and straightness
- Check that the air supply is clean and lubricated in accordance with the manufacturer's instructions. Dirty or unlubricated air can lead to wear of the motor and valves and possible seizure
- Check the brake linings for wear, damage and contamination in accordance with the manufacturer's limits. Adjust for safe working
- Check the transmission system for smooth running. If loose, stiff or jerky check the bearings for free running, gears for damage, shafts for wear and adequate lubrication of the system. Thoroughly clean all parts before re-assembly
- Check the motor for leaks and free running, check vanes, rotor and cylinder for wear or damage. Replace vanes and other parts if necessary
- Check main valve for leakage and smooth operation, check springs, levers, gears and seals for fractures, integrity and wear
- Check that the control mechanism works easily and that a distinct 'OFF' position can be obtained
- Check that hooks rotate freely and chain hangs straight
- Check the brake adjustment in accordance with the manufacturer's instructions
- Check that the hoist starts smoothly at slow speed whilst carrying full WLL/SWL
- Check that the brake operates smoothly whilst lowering full WLL/SWL at slow speed
- Check that the chain engages the load wheel smoothly and quietly
- Check the valves for leakage and the integrity of the sintered bronze filter in the housing
- The written report shall give a description of the article examined, the date of the examination and a clear statement of its fitness for further use or details of the defects which affect the WLL/SWL and other observations
    - Where an article is defective, a responsible representative of the user must be informed
    - If dangerously defective, arrangements must be made for its immediate withdrawal from service
    - Where Regulations or Acts require statutory notification of defective equipment, steps must be taken to ensure notification to the correct authority, for example LOLER gives requirements for reporting certain matters to the HSE

Training

It is of paramount importance that lifting equipment inspectors or examiners do not work on live compressed air equipment, other than for functional and operational checks as part of the thorough examination. Lock-out/Tag-out routines should always be considered as part of your risk assessment.

Notes:

12. Powered Winches

Introduction to Powered Winches

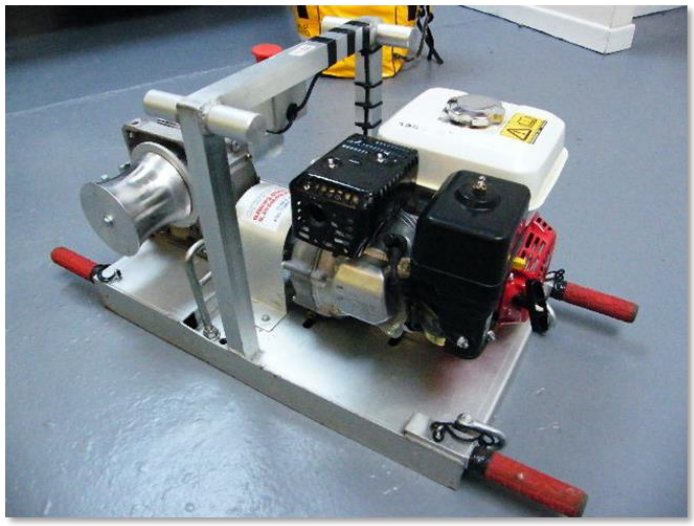
Winches are versatile lifting and pulling appliances, lending themselves to easy adaptation and are widely used throughout industry for both permanent and temporary rigging applications. The range of designs and capacities is extensive and many are designed for specific applications. They may be power or manually operated.

Powered winches are within the scope of BS EN 14492-1.

Mooring winches – not within the scope of this module – are covered by BS 7471.

This module covers only lifting applications or applications that have an element of lifting.

Types of Power Driven Winches

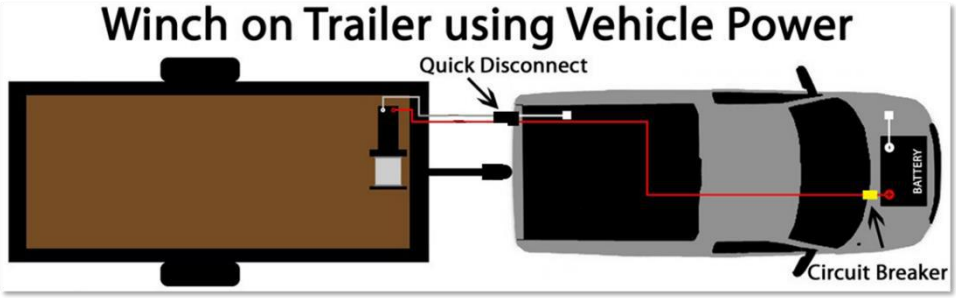


Trailer and Skid Mounted Winches

To allow greater portability, petrol/diesel winches are available either trailer or skid mounted. This allows for applications where a power operated winch is required but no power source is available. In this case, it is necessary to anchor the trailer or skid unit to a suitable fixing to prevent movement of the winch in use. Trailer mounted winches are normally limited to a maximum of 5 tonnes capacity but rope drum storage can be varied to suit the application.

Battery Operated Winches

These are intended for vehicle mounting, are generally available in a range of capacities up to 500kg; a heavy duty range is available up to 2 tonne capacity. They operate on a 12 volt or 24-volt DC electric supply and are intended to run off the vehicle batteries. The design permits the winch to be mounted in any position and they may therefore be fitted direct to the vehicle, to a jib or other structure mounted on the vehicle, or on a portable structure intended to be used adjacent to the vehicle. They may also be utilized in other situations where a suitable DC supply is available. Rope drum capacities are usually limited to a maximum of 10 metres.



Power driven winches for which the prime mover is an electric motor, hydraulic motor, internal combustion motor or pneumatic motor are designed for the lifting and lowering of loads which are suspended on hooks or other load handling devices, or for the lifting and lowering of loads on inclined planes or the exclusive pulling of loads on planes which are normally horizontal.

- Power winches may be fitted or built into structures to enable loads to be moved from one position to another
- They may be used to advantage as a safe method of lifting loads in confined spaces as they can be arranged to occupy less headroom than other lifting appliances and the operative may be remote from the load

The use of winches for lifting purposes is always associated with other lifting gear and accessories, guidance on which may be found in the relevant sections of this code, and often the use is in conjunction with pulley blocks.

This module only covers powered winches using wire rope as its primary lifting/winching media.

Definitions (Lifting and Pulling)

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.**

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.**

For example, if a load were being 'pulled' up an incline on wheels it would be regarded for the purposes of this section of the code as a lifting application as, in the event of a failure, the load would descend the incline under gravity.

Definitions and Terminology

***Rated Capacity**
This is the load that the winch is designed to lift. For winches with multi-layer winding, this is the value in the top layer of the drum.

***Note:** The maximum load that can be taken at the drum (first wrap of rope) is sometimes referred to as the line pull of the winch. However, the actual line pull will vary with the number of layers of rope wound onto the drum, i.e. as the number of layers increases so the line pull diminishes. For lifting applications, the rated capacity of a winch should be based on the line pull when the drum is full of rope or has all of the rope for that application fitted.

Notes:

General Requirements of BS EN 14492-1

Rated Capacity Limiters and Indicators

- Winches for **lifting and lowering purposes** with a rated capacity of 1000 kg or more and winches for pulling purposes with a pulling force of 10,000 N or more shall be fitted with a rated capacity limiter. The rated capacity limiter shall be designed to prevent overloading of the winch
    - It must also limit the forces transmitted to the supporting structure, which are to be provided by the manufacturer
    - Overloading means exceeding the designed operating forces

Note: A rated capacity limiter may also be incorporated within the supporting structure into which a winch is fitted.

- Rated capacity limiters shall operate to override the controls of the winch as required in EN 12077-2
- Winches must be designed to take account of the static and dynamic forces which may occur at intended use
    - This includes forces which occur due to the activation of the rated capacity limiter and the emergency stop device
- Accessible parts shall not have sharp edges, sharp angles or protruding parts that can cause injury. This can be achieved by e.g. de-burring, flanging, trimming, sand blasting
- Connections and individual components of winches shall incorporate features so that they cannot self-loosen
- Moving transmission parts (shafts, fans, wheels, gears, belts, couplings) shall be designed, positioned or guarded in order to protect against the risks associated with possible contact of exposed persons during the intended use
- Risk of burn during hoisting operation caused by contact between the operator's skin and hot surfaces of the winch shall be reduced by following the principles of BS EN 13732 (this standard supersedes EN 563)
- Winches must be fitted with a device which prevents the load from running back unintentionally
    - This requirement is accomplished, for example, by self-locking drives, an automatically acting service brake and/or automatically engaging gears
- *The standard specifies information for use of winches in specific applications, such as:
    - Explosive atmospheres (Annex B)
    - Aggressive environments and outdoor use (Annex C)
    - Low operating temperatures (Annex D)
- *We will look at these specific requirements late in this module

Control Devices

Devices for starting and stopping manually controlled winches shall be fitted with hold-to-run control elements so that the drive energy supply is interrupted when the actuating elements are released.

Actuating elements of control devices shall incorporate features that prevent unintentional operation or not wanted movements of the load.

Actuating elements of control devices must incorporate features, and be arranged and marked in such a way that their function, direction of operation and switching state are unmistakably recognisable, using pictograms (symbols), where appropriate.

Emergency Stop Function

Winches must be fitted with an emergency stop facility. This should be available at all times regardless of what mode the winch is operating in.

Hoisting and Lowering Limits

For safety purposes, to prevent over-running when the wire rope has reached its maximum extended or retracted position, in most cases a limit can be fitted to the wire rope or winch. In the case of manually operated winches, this is normally in the form of a simple stop. In the case of power operated winches, it is often in the form of a stop and lever operated switch, valve or slipping clutch arrangement. Such arrangements are not however normally supplied as standard and the requirement should be discussed with the supplier.

Note: Limiting devices must be in accordance with the requirements of BS EN 12077-2:

Cranes safety — Requirements for health and safety —

Part 2: Limiting and indicating devices

General Requirements of BS EN 14492-2

Brakes for Lifting and Lowering
Movements of the winch must be decelerated, the winch must also hold the load, and any unintended movements are to be prevented.

Brakes shall engage automatically in the following cases;

- When the control device returns to its 'neutral' position
- When the emergency stop is activated
- When the external power supply to the brake is interrupted
- When the power supply to the drive motor is interrupted

For 3 phase motors:

- The brakes must automatically apply if two phases of the supply are interrupted
- If one phase fails, the load should not be able to lower or drop

For winches using combustion engines as a primary drive:

- The load shall not lower or drop in an uncontrolled manner in case of lack of fuel

Requirements for Vehicle Recovery Winches and Boat Trailers

- Where a risk assessment finds that there is no hazard of overloading the winch and its supporting structure when using it under the conditions intended by the manufacturer, there is no need to provide a rated capacity limiter
    - Conditions for this are that the load is prevented from running back and that a failure of the driving motor is excluded

Note: A rated capacity limiter is not necessary, if, for example, the limited driving power of the motor prevents overloading of the winch and the supporting structure.

- Motion limiters are not required

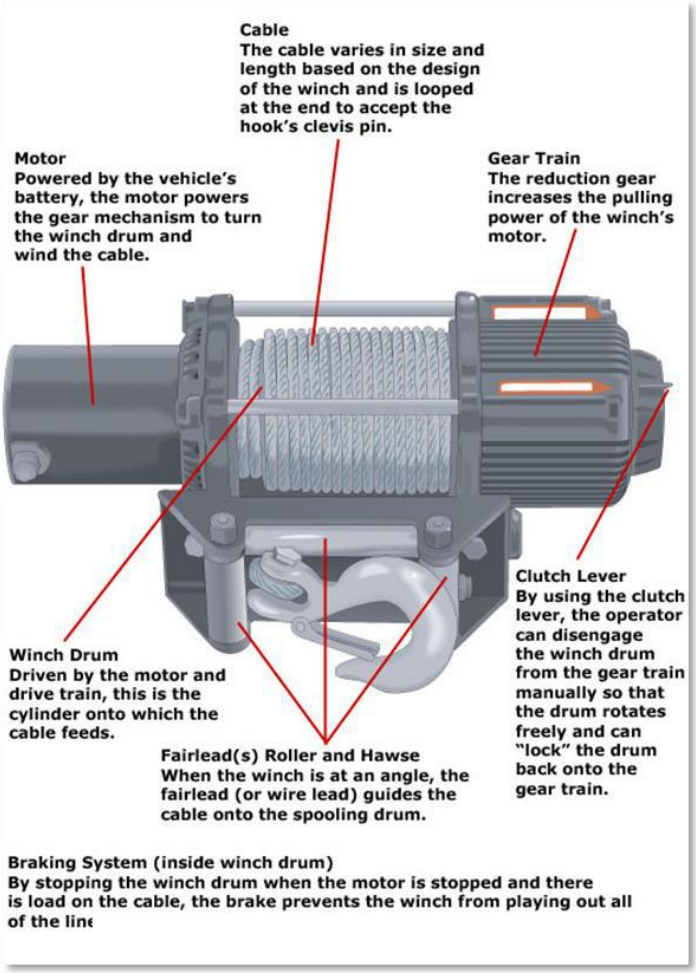
Free-Spooling Clutch
Where engaging and disengaging clutches are used for the purpose of pulling out the hoist medium, these clutches should not be capable of being engaged and disengaged at a pulling force corresponding to 3% of the maximum pulling force (resulting from the rated capacity of the winch). As far as winches with multi-layer winding are concerned, consideration should be given to the fact that, as a rule, the rated capacity decreases with increasing number of rope layers; the lowest value of the rated capacity must be taken into consideration

Rope Drives
Rope drives shall at least correspond to the either of the following conditions:

- The working coefficient for the first rope layer shall be at least 2
    - In this case, the working coefficient shall be determined from the ratio of the minimum breaking force of the rope and the maximum possible pulling force
    - The maximum possible pulling force results from the maximum motor torque respectively from the maximum force when the rated capacity limiter operates
- The D/d ratio to the centre of the rope shall be at least:
    - 10 for drums
    - 11.2 for sheaves

- The working coefficient for the first layer of rope shall be at least 2
- The D/d ratio to the centre of the rope shall be at least:
    - 11.2 for drums
    - 12.5 for sheaves
- The rated capacity limiter shall ensure that the value of 1.2 times the static rated tensile force is not exceeded

Basic Components of a Trailer Mounted Winch

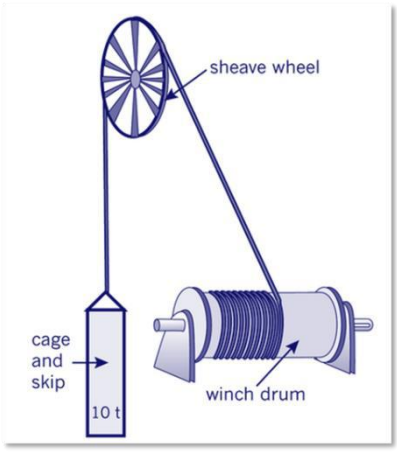


Notes:

Principles for Selection

Application

The general application must be fully considered. This must include an appraisal of the intended arrangement including the mounting and rigging details. Due to the extensive range of types of winch, design options and rigging arrangements possible, it is recommended that the application is fully discussed with the supplier to ensure the most suitable equipment is selected.



Capacity

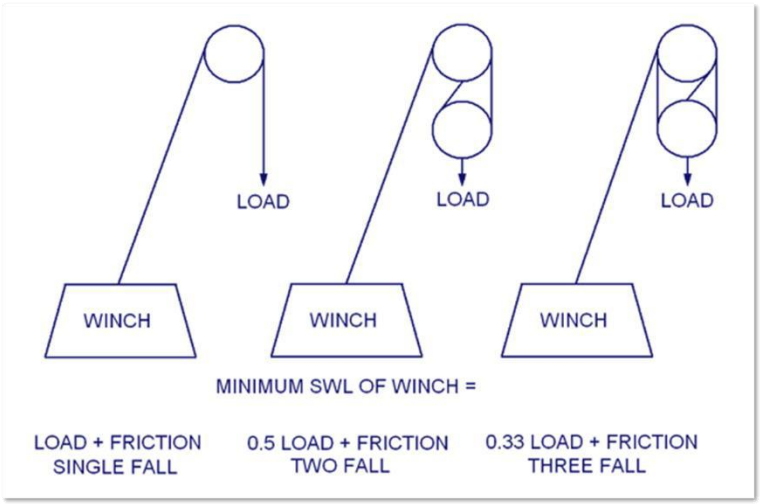
The capacity of the winch to be selected will depend on the maximum load to be lifted and the rigging method to be employed.

If the rigging arrangement calls for a single fall of rope, then the safe working load of the winch must be at least equal to the maximum load to be lifted.

However, if the rigging arrangement utilizes multiple sheaves or blocks, the load will be proportionally shared between the falls of rope.

For example, if there are two falls of rope, the load in the rope will be half the total load to be lifted; if there are three falls of rope the load in the rope will be one third the total load to be lifted and so on. (See illustration on next page)

In such cases, the SWL of the winch should be at least equal to the load in the rope plus an allowance for the effects of friction. Although the effects of friction will vary, dependent on the type of sheave and bearings, it is normal to assume that this will be 8% per sheave.



Type of Winch

In considering the type of winch to be selected, the following must be taken into account:

- Mounting or suspension details, e.g. wall, floor, built into a structure etc.
- If the installation is to be permanent or temporary. If the arrangement is of a temporary nature and the winch is to be portable, then the self-weight of the winch and the facilities for handling the winch must also be considered
- Method of operation, i.e. manual or power. If power operated, whether electric, pneumatic, hydraulic or petrol/diesel. Consideration must be given to the availability of a suitable power source and any environmental factors affecting the selection
- Where applicable, the type of control and method of brake operation

Rope Drum Storage Capacity

- If the wire rope is to be used in a single fall, then the rope drum must be large enough to store an amount of rope at least equal to the maximum height of lift
- However, if the wire rope is to be used with a pulley block arrangement, it must be remembered that the drum will need to accommodate a rope length equal to the height of lift x the number of falls of rope
- Care must be taken to ensure that the rope does not over fill the drum and the manufacturer's recommendations should be followed
- When the rope is fully wound onto the drum, the drum flanges should be at least 2 x the rope diameter higher than the outer coil of rope

Selection of the Wire Rope

When selecting a wire rope for use on a winch, the following factors should be taken into account:

- Required minimum breaking load
    - Wire rope used for lifting should, in most cases, have a working load limit of not more than one fifth of the wire rope's minimum (or catalogue) breaking load. That is a factor of safety of 5:1, although this figure may be varied by a Competent Person for specific circumstances of use. Hence the factor of safety and load rating of the winch will determine the required wire rope's breaking load, i.e. rope minimum breaking load = load rating x factor of safety

Notes:

When selecting a wire rope for use on a winch, the following factors should be taken into account:

- Rope construction
    - The use of wire rope on a winch usually involves wrapping the rope around a drum of a relatively small diameter when compared to other wire rope applications. The choice of a wire rope with sufficient flexibility is therefore important
    - Ropes with strands comprising a single layer of wire, e.g. 6 x 7 (6/1) are generally UNSUITABLE for winch applications due to their lack of flexibility. Winches also subject the rope to crushing forces, particularly when more than one layer of rope is accommodated on the winch drum. For this reason, ropes with wire cores are to be preferred
    - In some cases, e.g. when a winch is used as a lifting machine by passing the rope over a pulley such that the load is lifted by a single part of rope, a rotation resistant rope may be required due to the propensity of six stranded ropes to un-spin under such conditions. In these circumstances, the advice of the wire rope supplier should be sought

When selecting a wire rope for use on a winch, the following factors should be taken into account:

- Corrosion protection
    - During manufacture of wire rope, the rope maker applies a dressing which acts both as a lubricant and protection against corrosion. In all cases, winch ropes should be adequately protected from the effects of atmospheric corrosion when in use. In severe conditions, this may call for additional dressing to be applied and the manufacturer's advice should be sought
    - Similarly, advice should be sought and followed with regard to the regular service dressing of the rope. In some cases, e.g. when it is known that the winch will be working in a wet environment, a galvanised rope should be selected. In special cases, e.g. severely corrosive environments, the use of a stainless steel rope may be appropriate and in such instances the advice of the rope supplier should be sought

When selecting a wire rope for use on a winch, the following factors should be taken into account:

- Effective and actual lengths of wire rope
    - The effective length of wire rope will depend on the manner in which the assembly is rigged. This will be the height of lift x the number of falls + the length of the rope run from the drum to the top suspension sheave
    - The actual length of wire rope required will be longer than the effective length to allow for a number of dead turns to remain on the drum at all times. It is necessary to have a number of dead turns of rope remaining on the drum when the rope is in its fully extended position to provide a frictional grip between the rope and the drum thus preventing the load being imposed on the rope drum anchorage. This will require that at least 2 full turns of rope remain on the drum at all times. However, some manufacturers state that 3 dead turns must remain on their design of winch
    - The manufacturer's recommendations should therefore be sought and followed, but under no circumstances should less than 2 full turns remain on the drum

Note: Do not reduce the diameter of the wire rope in order to accommodate a longer length. If the rope storage drum is of insufficient capacity, select another winch.

Rigging Arrangement

The rigging arrangement must be given full consideration including the need for diverter pulleys, the use of pulley blocks and suitable anchorages. The diameter of sheaves should ideally be 18 times the diameter of the wire rope, but never less than 12 times, to avoid the rope crushing under load and bending fatigue taking place.

Consideration must also be given to the use of accessories and structures. Temporary arrangements may call for the use of tripods (shear legs) or davits for winch and/or pulley block suspension.

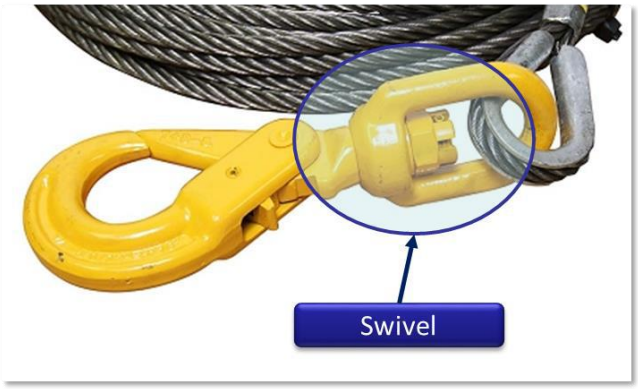
It should be noted that when pulley blocks are used, the load imposed on the supporting structure is increased by the value of the hoisting effort and the effects of friction. This additional load is also imposed on any equipment used to connect the top hook or eye of the pulley block to the structure.

Care should therefore be taken to ensure that the structure, together with all above the hook equipment, e.g. beam clamps, shackles etc., is of adequate capacity. The table on the next slide shows the increase in load for various rigging arrangements assuming 8% per sheave for friction.

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

Where the rigging arrangement calls for a single fall of rope, the rope termination must be considered, e.g. hook or eye and shackle etc., and steps must be taken to prevent the rope rotating thus un-laying itself, e.g. by the use of a swivel.

In some cases, the rope termination may be of insufficient weight to keep the rope under tension. This can result in the rope jumping out of the grooves of pulleys or becoming twisted. To prevent this, a small purpose made weight, sufficient only to keep the rope in tension, may be fitted to the rope immediately above the terminal fittings.



Service Conditions

Generally, winches are manufactured to meet normal service conditions and assume:

- Use under cover, i.e. not directly exposed to the elements
- Use at ambient temperatures between -10°C and 40°C with no sources of high local heating and cooling
- Use in clean air free from excess of humidity, contamination and deposits

It should be noted however that some designs of winch may operate successfully in cold or damp conditions. In some other cases, special arrangements are possible to prevent the brake/brake linings being affected by such conditions. It is therefore necessary to discuss any service conditions, other than that deemed to be normal, with the supplier to ensure correct selection.

Environment Conditions

Examples of environmental conditions requiring special attention are:

- Outdoor use
- Salt air
- High humidity
- Ambient temperatures above or below the normal range
- The presence of local heat sources, e.g. furnaces
- Dust/abrasives in the atmosphere

Notes:

Hazardous Substances

If the winch is to be used in association with hazardous substances, special consideration is necessary. Hazardous substances fall into two main groups; those that would harm the winch and its associated equipment, e.g. corrosives; and those that may be affected by the operation of the winch, e.g. explosives.

Examples of hazardous substances requiring special attention are:

- Flammable or explosive gases, vapours or dust
- Corrosive vapours and liquids, acids and alkalis
- Volatile liquids
- Toxic substances
- Molten metal

Other Potential Hazards

Other potential hazards may arise as the result of the work being carried out in the general location or be caused by the winch performing lifting operations over the heads of personnel or similar.

Examples of such potential hazards requiring special attention are:

- Use in mines and quarries
- Use in laundries
- Use in galvanizing, pickling and hot dipping processes
- Use in paint shops
- Use over work areas
- Use over walkways and footpaths

Notes:

Safe Working Load

- For lifting applications, under normal operating conditions, i.e. where there are no hazardous conditions the safe working load will be the same as the working load limit
- The working load limit of the winch and wire rope should not be more than 20% of the failure load, i.e. there should be a minimum factor of safety of 5:1. For certain terminal fittings this factor may be 4:1
- For man-riding applications, the safe working load should not exceed 50% of the working load limit, i.e. the factor of safety should be increased to a minimum of 10:1. Additional precautions are however required
    - Standard winches should NOT be used for man-riding applications. For such applications, the manufacturer should be consulted as certain winches are purpose designed for this work. Further additional safety requirements will be necessary, e.g. the installation of descent arrestors, and the supplier's recommendations should be sought in this respect and strictly followed

Other Considerations

- Ease of maintenance
- Access for service/maintenance
- Brakes - some brake mechanisms only working effectively in one direction. It is therefore important that the winch is rigged to take this into account. Winches are therefore often marked with the direction of rotation for lifting
- Mounting and anchoring facilities
- Handling and transportation arrangements
- Terminal fitting of rope, e.g. thimble eye, wire rope socket, shackle, hook etc. Attention is drawn to the ACoP to Regulation 6(1) of LOLER. This states that*:* "Hooks and other devices provided for lifting should be of a type that reduces the risk of the load becoming displaced from the hook or other devices."
- Availability and suitability of power supplies, protection and isolation facilities
- Required documentation

Information which Should be Exchanged Between the user and Designer/Supplier

As winches are frequently used for miscellaneous lifting purposes, precise details of the load to be lifted and rigging arrangement to be used are not always available. In these circumstances, only a general specification can be given and this should include the following information:

- Details of the rigging arrangement in so far as is known, e.g. use of pulley blocks, diverters etc.
- Maximum load to be lifted or line pull required
- Winch mounting details, e.g. wall, floor, built into a structure
- Type of winch, e.g. worm geared, power operated
- Rope drum storage capacity
- Effective and actual length of wire rope required
- Details of wire rope termination, e.g. hook, eye
- Where applicable, operating speed(s)
- Where applicable, details of the power source or number of operatives required at full load

- Details of any other lifting equipment and accessories required, e.g. pulley blocks, tripod (shear legs)
- Details of application in so far as is known, e.g. nature of load, duty cycle, whether temporary or permanent installation
- Special service conditions which may affect the winch or its associated equipment, e.g. flammable atmosphere, chemical environment, outdoor use
- Special safety considerations, e.g. positive limits to prevent over-winding, overload protection, use for man-riding applications
- Any special requirements for painting or protective finish
- Any other special requirements

It may subsequently be found that a more detailed exchange of information is necessary to ensure correct selection. Where the winch is committed to a single purpose use or is a permanent installation, this is not difficult, but similar consideration should be given to units that are to be used for multipurpose or temporary installations.

For all but the simplest installations, a visit by the supplier to survey the site should always be considered as this will minimize the information exchange and reduce the chance of incorrect selection.

Marking

The following information should be permanently and legibly marked on a suitable part or parts of the winch:

- Identification mark
- Safe working load
- Name of manufacturer or supplier
- Rope drum storage capacity. Where a winch must be fitted with a specific size and/or construction of steel wire rope, this should also be clearly marked on the winch

Further information may also be marked on the winch but in any event should be readily to hand. This will vary with the type of winch but some or all of the following information will be necessary:

- Model or type
- Year of manufacture
- Lifting speed(s)
- Details of power supply; e.g. voltage, phase and frequency; pressure and delivery rate etc.
- Details of operating handle if this may vary. Number of operatives required for operation at full load
- Direction of rotation of drum when lifting
- The minimum number of dead rope turns which must remain on the drum at all times

It should be noted that the wire rope fitted to the winch, together with any permanent attachments made to the rope, must be considered as individual items. They must therefore carry their own marking in accordance with the individual requirements applicable. Similarly, any pulley blocks used in association with the winch must also be treated as individual items and marked accordingly.

Note 1: For vehicle recovery winches and winches on boat trailers the following statement should also be marked on the winch; “this winch shall only be used for vehicle recovery or for pulling and lowering boats off trailers.”

Note 2: The wire rope/chain fitted to the winch, together with any permanent attachments made to the rope/chain, must be considered as individual items. They must therefore carry their own marking in accordance with the individual requirements applicable. Similarly, any pulley blocks used in association with the winch must also be treated as individual items and marked accordingly.

Documentation

Documents to be supplied in accordance with the relevant legislation and relevant standard:

- EC Declaration of Conformity (Guidance LEEA 030.1e)
- Manufacturer’s instructions for use. (Guidance LEEA SI.15.3)

Although not required by legislation, new winches will usually be issued with a manufacturer’s record of proof load testing in addition to, although possibly combined with, the EC Declaration of Conformity. This document forms an important part of the record of the winch. It should be retained and cross referenced to the winch’s historical records for inspection by the Competent Person or HSE.

In-Service Inspection

In addition to the statutory thorough examination by a Competent Person, winches should be visually inspected by a Responsible Person prior to use or on a regular basis, taking account of the conditions of service and statutory requirements. The inspection should include the fixings, suspension points and supporting structures together with any associated pulley blocks or other equipment used in the rigging assembly. If any of the following faults are present, the winch should be withdrawn from service and referred to a Competent Person:

- Winch mounting insecure. Missing, loose, damaged or corroded fixing bolts, cracking or crumbling foundation/wall etc.
- Winch frame is corroded, damaged or distorted, guards missing or damaged
- Rope drum damaged, particularly if flanges are chipped or cracked
- Rope anchorages damaged or loose. If rope shows signs of having pulled or slipped in the anchorage or if anchorage bolts are loose, corroded, damaged or missing
- Wire rope does not feed onto the drum correctly and in the case of power operated winches, the rope feeds onto the drum in the wrong direction. The rope should feed onto the drum with each turn sitting comfortably beside the previous turn with no bunching or crossing of turns
- In the case of manually operated winches, the winding handle is bent, damaged or does not fit positively onto the shaft. The handle jams or jumps when turned or the winding gears are damaged, worn or distorted
- In the case of power operated winches, the control lever, push buttons or valves are damaged or do not operate
- The winch distorts under load
- Ratchet teeth and/or pawl are damaged, worn or distorted
- Brake lining worn, impregnated with oil or grease, contaminated with dirt or other particles. If the brake lining is torn, pitted or cracked, also if the brake face of the drum etc. is damaged, pitted or corroded
- Winch does not hold under load, load slips when lifting or load will not lift

- Winch stops midway through a lifting cycle. (Immediate action will be necessary to secure or lower the load, depending on the winch design. In some cases, it will be possible to lower the load in a controlled manner using the winches' own mechanism. In other cases, it may be necessary to use a second winch to recover the load. This will call for great care and steps must be taken to ensure no shock loads are imposed to either of the winches or to any slinging arrangements used. Steps should also be taken to prevent access until the load has been safely recovered.)
- Damage to the pendant control hand set including cable, rubber covers, legends or labels and support wire, chain or cord
- Excessive noise or unusual sounds from any part of the hoist, including motor, clutch, gearbox or brake
- Travel and/or hoist motions operate in opposite direction to control indication
- Load continues to travel excessive distance after motion control has been released
- If there is unexpected vibration or noise during operation, particularly when load is descending at a controlled speed
- Load continues to travel excessive distance after applying the brake or load falls at a faster than expected controlled speed

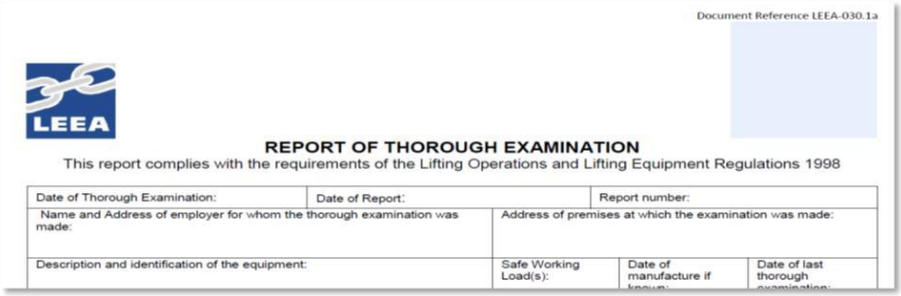
- If there is unexpected vibration or noise during operation, particularly when load is descending at a controlled speed
- Load continues to travel excessive distance after applying the brake or load falls at a faster than expected controlled speed
- The wire rope is worn or damaged, in particular any increase or decrease in diameter, opening of the strands, kinks, broken wires, in addition to any other signs of mechanical damage such as flattening, cuts or corrosion. Faults are most likely to occur at the terminations and where the rope passes over pulleys and sheaves. (Rope damage can be the result of incorrect handling or coiling, particularly when being wound onto the drum in a no load situation. The inspection must therefore be made carefully to ensure that there is no damage to hidden turns on the rope drum, which in turn may cause further damage to other sections of the rope, and that there is no damage as the result of the rope jumping off the drum into the gears etc.)
- Wear, damage or distortion to wire rope terminal fittings. If a swivel is fitted or forms part of the termination, it must operate freely
- Wear, cracks and chips to pulleys and sheaves. Corrosion, seizing or wear to the axle pins of pulleys and sheaves. Where intended, head fittings must swivel freely
- Sliding gear mechanism is too tight or too loose or does not lock positively into the required position
- In the case of power operated winches, the prime mover (e.g. electric motor) must be inspected for any defects, damage or incorrect operation in accordance with the manufacturer's instructions

Legal Requirements

The definition of lifting equipment and accessories used in LOLER make it clear that power operated winches are lifting equipment.

Unless a written scheme of examination, drawn up by a Competent Person, is in place and operating they must be thoroughly examined by a Competent Person at intervals not exceeding 12 months.

Reports of thorough examination should be retained and cross referenced to the winches historical records for inspection by the Competent Person or HSE.



Document Reference LEEA-030.1a

LEEA

REPORT OF THOROUGH EXAMINATION

This report complies with the requirements of the Lifting Operations and Lifting Equipment Regulations 1998

Date of Thorough Examination:	Date of Report:	Report number:	
Name and Address of employer for whom the thorough examination was made:		Address of premises at which the examination was made:	
Description and identification of the equipment:		Safe Working Load(s):	Date of manufacture if known: / Date of last thorough examination:

Inspection/Examination (Ensure Lock Out-Tag Out isolation!)

The Thorough Examination

For some applications it may also be necessary to have the installation thoroughly examined by a Competent Person before the hoist is put into service.

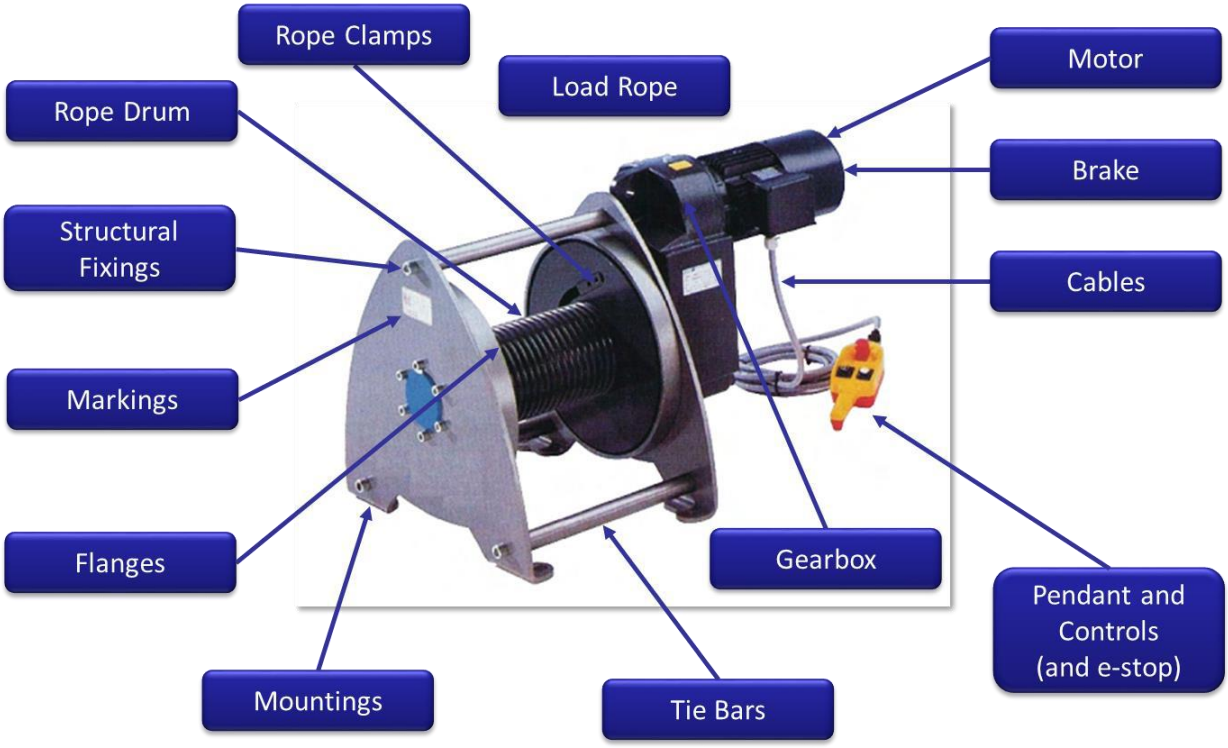
Regulation 9 of LOLER states:

(2) Every employer shall ensure that, where the safety of lifting equipment depends on the installation conditions, it is thoroughly examined:

(a) after installation and before being put into service for the first time
And,
(b) after assembly and before being put into service at a new site or in a new location,
to ensure that it has been installed correctly and is safe to operate

Note: Although not required by legislation, new power operated winches will usually be issued with a manufacturer's record of proof load testing in addition to, although possibly combined with, the EC Declaration of Conformity. This document forms an important part of the record of the hoist. It should be retained and cross referenced to the hoists historical records for inspection by the Competent Person or HSE.

- The examinations shall be carried out in adequate natural or artificial light
- The machine shall be clean or cleaned and free from rust to enable a proper visual examination of all parts to be carried out
- The examination shall be carried out by a competent person in accordance with the schedule of requirements aligned to the employers' quality policy and site procedures reference material and LEEA's Technical Requirements/COPSULE which are available to support them
- Where appropriate the standard procedures of examination, checking of hooks, diameter of wires and allowable wear and stretch shall be those recommended by the product manufacturer
- Further criteria may also be given in British Standards, LEEA technical publications and in the LEEA correspondence courses
- Parts shall be exposed and examined sufficiently to enable a proper conclusion as to their condition to be reached and reported on. Where necessary parts must be dismantled and cleaned to achieve this
- Always follow the specific instructions for maintenance issued by the supplier. These should be incorporated into the site maintenance programme observing any particular needs due to the site or working conditions
- Regularly inspect the winch and, in the event of the following defects, refer the winch to a Competent Person for thorough examination:
    - Mounting insecure; loose or missing bolts; winch frame distorted; rope drum flanges chipped or cracked; rope anchorage loose or pulled; ratchet or pawl worn; brake worn or slipping; rope worn, or winding incorrectly; broken wires; gears worn, or not positively locating; any other visible damage, corrosion, defects or operational faults



Notes:

- Check the hooks, connected terminal chains where fitted, swivels and load rope for wear, stretch, damage or corrosion (8% max. wear, 2% max. increase in length of chain) BS ISO 4309 rope rejection criteria should be referred to in all cases for the wire rope
- Check the brake linings for wear, damage and contamination in accordance with the manufacturer's limits. Adjust for safe working
- Check the transmission system for smooth running. If loose, stiff or jerky check the bearings for free running, gears for damage, shafts for wear and adequate lubrication of the system. Thoroughly clean all parts before re-assembly
- Check the motor for any signs of damage, power feed problems such as damaged cables / hoses and glands
- Check that the control mechanisms work easily and that a distinct 'OFF' position can be obtained
- Check the brake operation
- Check that the winch starts smoothly at slow speed whilst carrying full WLL/SWL
- Check that winches are properly secured and can transfer the loads to a suitable support point
- The written report shall give a description of the article examined, the date of the examination and a clear statement of its fitness for further use or details of the defects which affect the WLL/SWL and other observations
    - Where an article is defective, a responsible representative of the user must be informed
    - If dangerously defective, arrangements must be made for its immediate withdrawal from service
    - Where Regulations or Acts require statutory notification of defective equipment, steps must be taken to ensure notification to the correct authority, for example LOLER gives requirements for reporting certain matters to the HSE

Training

It is of paramount importance that lifting equipment inspectors or examiners do not work on live equipment, other than for functional and operational checks as part of the thorough examination. Lock-out/Tag-out routines should always be considered as part of your risk assessment.

Notes:

13. Brakes

Hoist Brakes

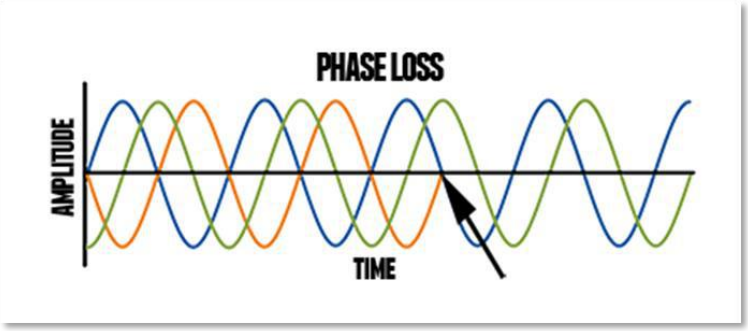
BS EN 14492-2 states the requirements for brakes that are used for hoisting and lowering movements.

Hoists shall be designed in such a way that movements can be decelerated, the load can be held, and that unintended movements are avoided. In addition, the rotating masses, the triggering limit of the rated capacity limiter and the maximum speed, e.g. in the event of a phase failure, shall be taken into account.

Brakes shall engage automatically in the following cases when:

- The control device returns to its neutral position
- The emergency stop function is activated
- The external power supply to the brake is interrupted
- The power supply of the corresponding drive (= motor) is interrupted or switched off

In addition, in the case of 3 phase motors, brakes must engage when two phases of the power supply to the drive (motor) are interrupted.



Failure of Power Supply

Electric hoists shall incorporate features so that:

- The load cannot lower in an uncontrolled manner if a phase should fail
- The load cannot drop if a phase should fail

When one phase of a three-phase system is lost, a phase loss occurs. This is also called 'single phasing'.

Typically, a phase loss is caused by a blown fuse, thermal overload, broken wire, worn contact or mechanical failure. A phase loss that goes undetected can rapidly result in unsafe conditions, equipment failures, and costly downtime.

Phase loss protection devices are relatively inexpensive and simple to install. They provide protection by disconnecting the equipment from the circuit when phase loss is detected. Phase or voltage monitors are the most common solution.

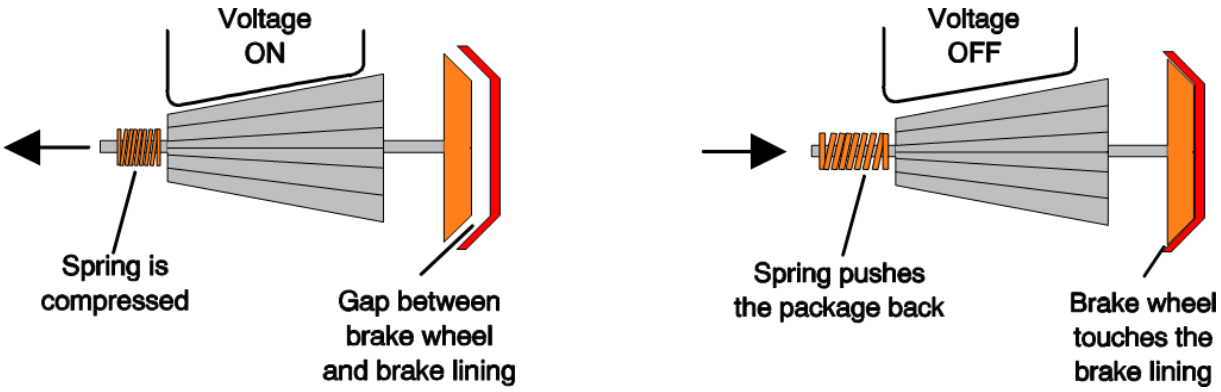
Notes:

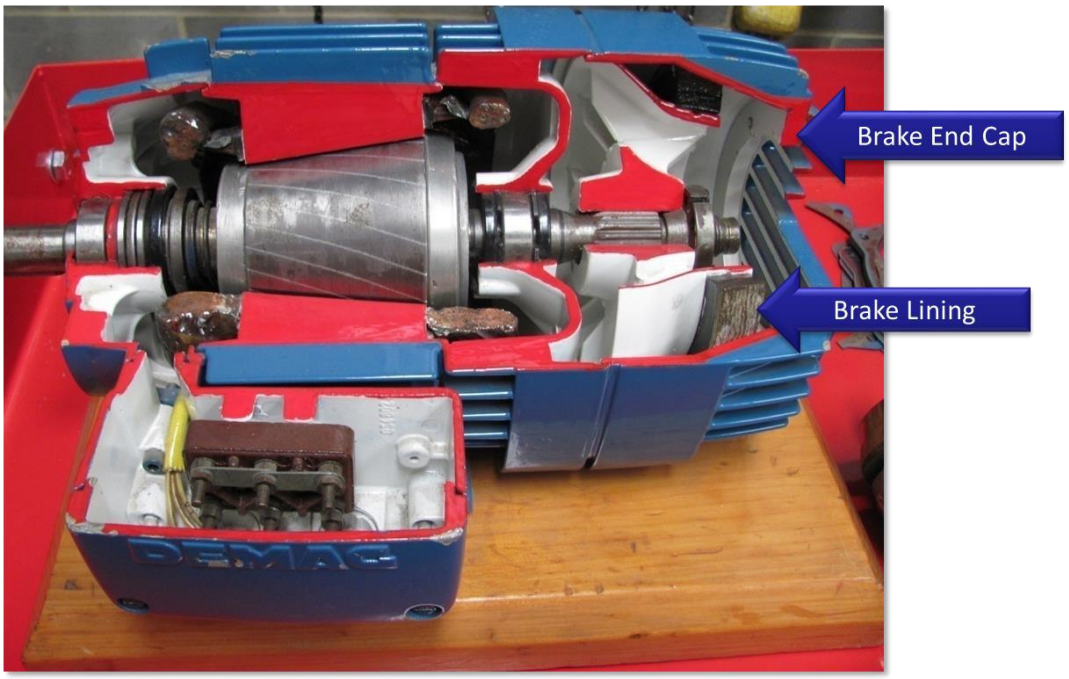
Conical Rotor Motor

The sliding rotor principle uses an electric motor specially designed with a conical rotor and stator windings.

When power is applied to the motor windings the magnetic field is angular to the centre line of the rotor shaft, operating in effect, two components of force at right angles to each other.

The radial component rotates the rotor whilst the horizontal component, pulls the rotor into the windings.





Notes:

Adjustment

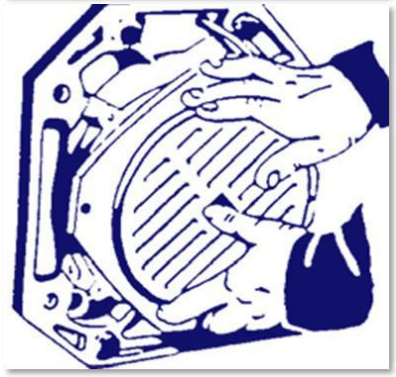
Brake adjustment must always be carried out in accordance with maker's instructions since
incorrect settings will upset motor performance.

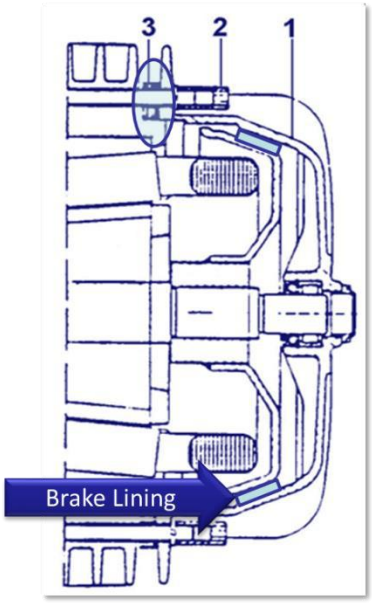
When the brake lining wears the air gap between the rotor and stator increases and, if not adjusted, will produce erratic motor operation because the magnetic forces will not be powerful enough to move the rotor forward and so will not release the brake.

To check if brake adjustment is necessary the rotor should be moved forward manually either by pushing directly onto the shaft or by way of a lever between the brake end cap and the brake wheel.
When the rotor is forward as far as it will go, measure the distance between the end of the rotor shaft and the front of the brake end cap. Release the rotor and take a further measurement.
The difference between the two measurements is the air gap (stroke length) and should be between **0.5 and 1.5mm** and must never be allowed to exceed 3mm.

If brake adjustment is required, remove the four screws that secure the brake end cap.
The brake end cap (which is threaded) can now be turned, and each 90° turn will reduce the air gap (stroke length) by approximately 0.5mm.
The securing screws should now be replaced and the air gap checked once more to ensure correct setting.

During the first week of operation or after changing the brake lining, the brake should be checked daily, since the lining may wear unequally until bedded in.
Ideally it could be argued that the hoist brake should be positioned as near to the hoist drum as possible. For reasons of design accessibility, cooling etc., it is usually on the end of the rotor shaft.





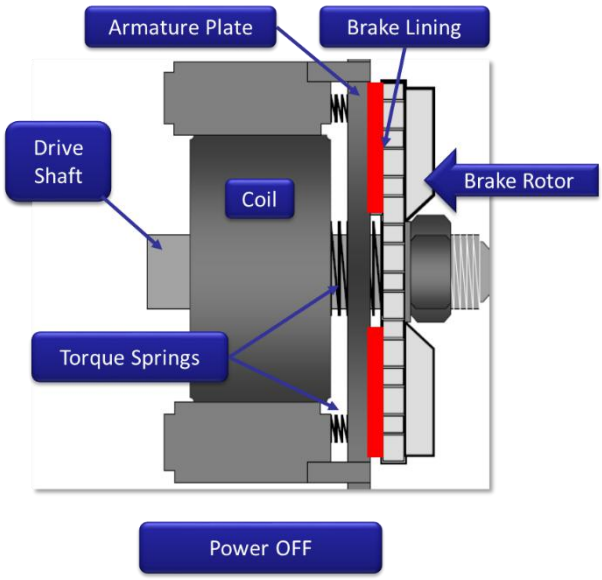
The examiner should take the utmost care to satisfy himself that all components are in good working order. Should for example a key shear or the coupling fail, then the load would fall.

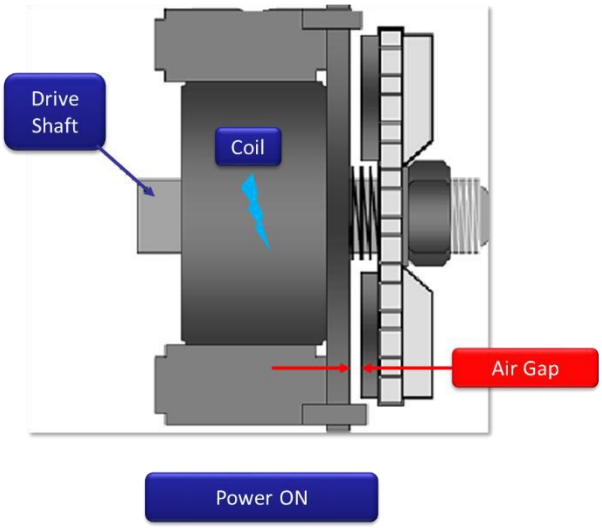
This drawing shows a cross section of a conical hoist brake. Adjustment is made by removing shims (3) as the lining wears. As shims are removed, the brake end cap and brake lining (1 – shown in red) moves further toward the brake rotor at the end of the rotor shaft and closes the gap.

As the brake linings wear down, the path of the rotor displacement increases to a maximum of 3.5mm, after which the braking would become ineffective. It is essential that the movement of the rotor is regularly checked and maintained within the manufacturers limits (approximately 1-1.5mm).

Parallel Rotor Principle

The brake shown is in the power OFF / brake ON position. The torque springs force the armature plate to the brake rotor and linings preventing the motor drive shaft from moving.



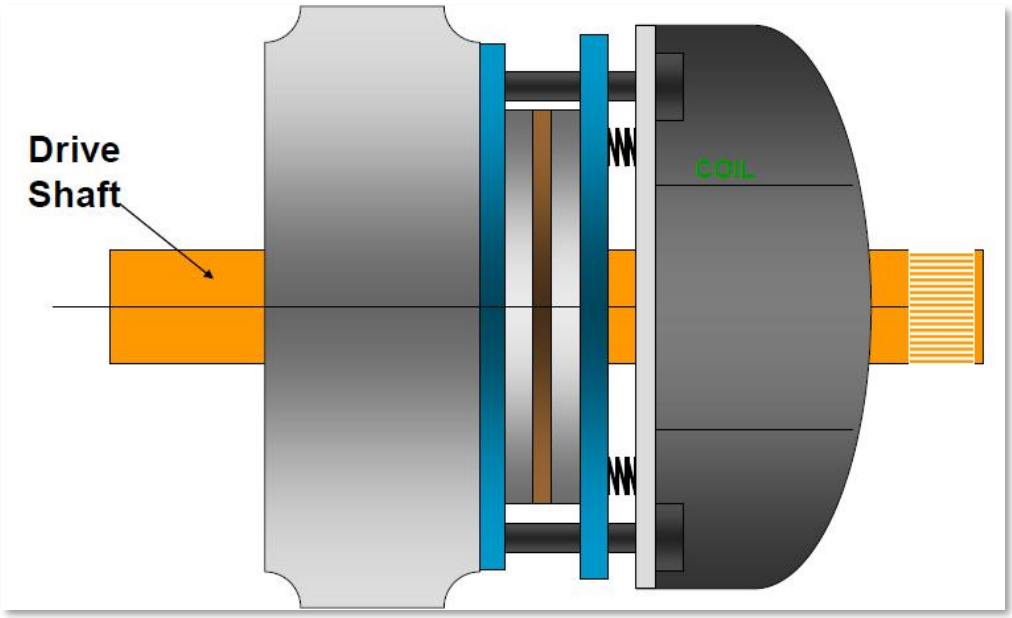


The brake shown is in the power ON / brake OFF position with the coil energised and pulling the armature plate against it. This allows the brake rotor to turn as the motor is powered.

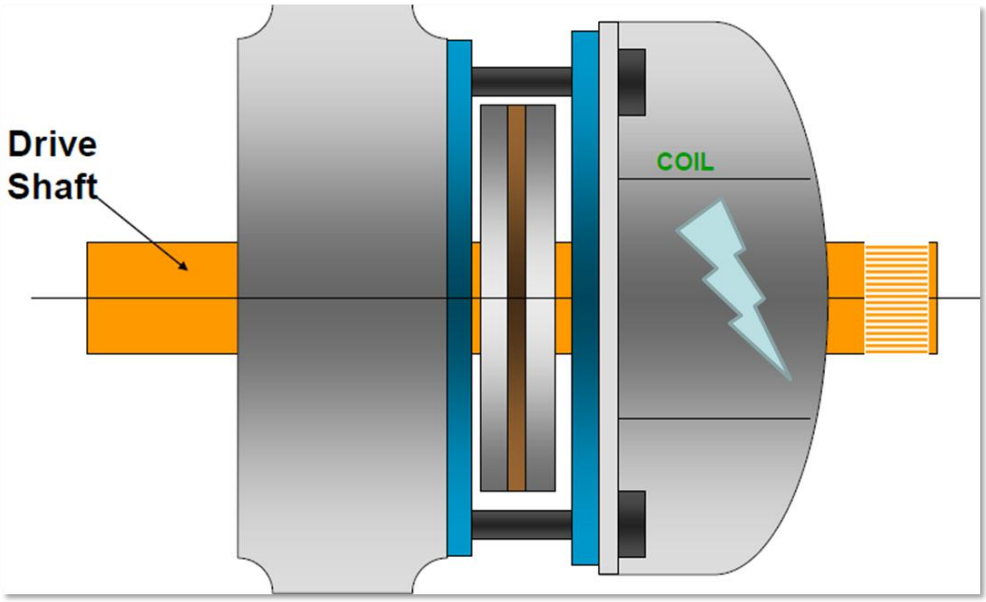
The air gap is clearly shown between the brake rotor and the coil. The air gap should be checked to ensure that it meets the requirements of the manufacturer to ensure effective use.

Brakes (DC Electromagnet)

- The hoist brake is a single disc brake, electro-magnetic spring applied, DC coil release
- The coil configuration is of the stator rotor type, direct current is energised to ensure positive action
- The brake is directly fixed to the main gear case and operates on the primary drive shaft
- Torque is pre-set on factory assembly and should not require further adjustment during its working life
- The brake is readily accessible for periodic safety checks
- For additional safety, it is switched independently of the motor supply
- The fail-safe operation maintains the load in the event of an interruption to the power supply
- A hand release mechanism is fitted to enable the load to be lowered in the event of power failure
- The hand release operating handle is detachable and is stored in the brake cover

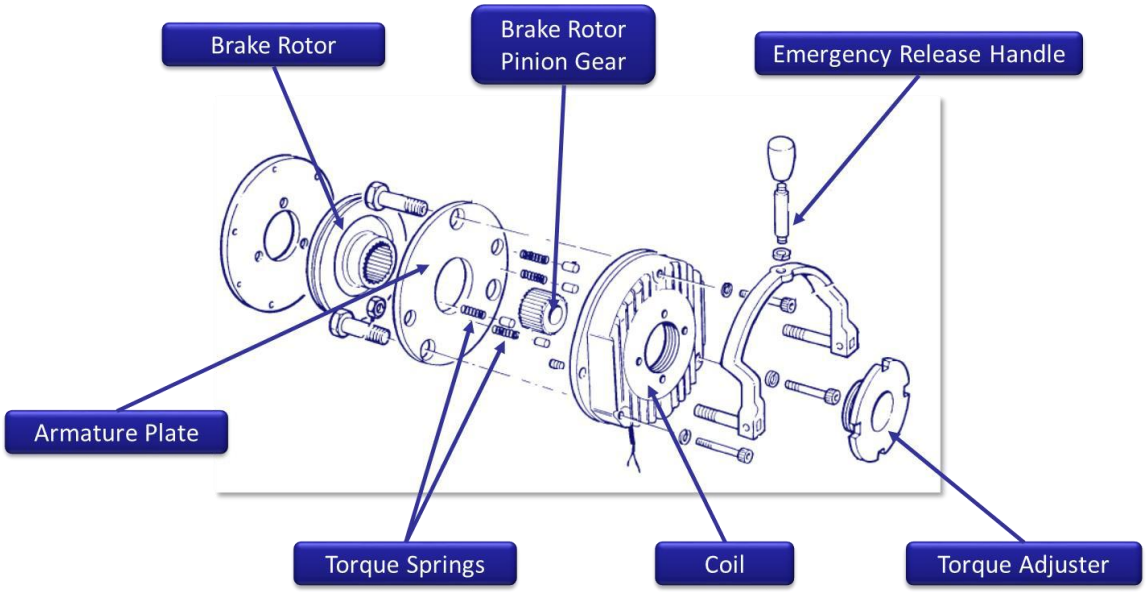


Power "Off"



Power "On"

Brakes



Notes:

Example of Manufacturer's Air Gap Setting

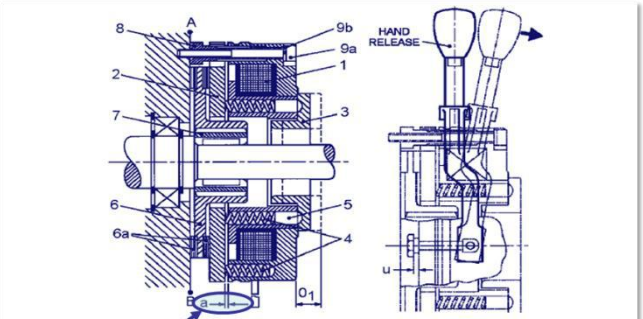


FIGURE 13-11 TYPE L BRAKE ADJUSTMENT

Brake Size:	08	10	12	14	16	18	20	25
Air gap 'a' (mm)								
nominal:	0.2	0.2	0.3	0.3	0.3	0.4	0.4	0.5
maximum:	0.5	0.5	0.7	0.8	1.0	1.0	1.2	1.4
Gap 'u': (mm)	1.0	1.0	1.3	1.3	1.5	1.5	1.5	2.0
Rotor thickness (mm)								
new	9.0	12.0	12.0	12.0	13.0	15	19	23
minimum	5.3	7.3	6.0	6.6	7.0	8.0	9.6	12.5

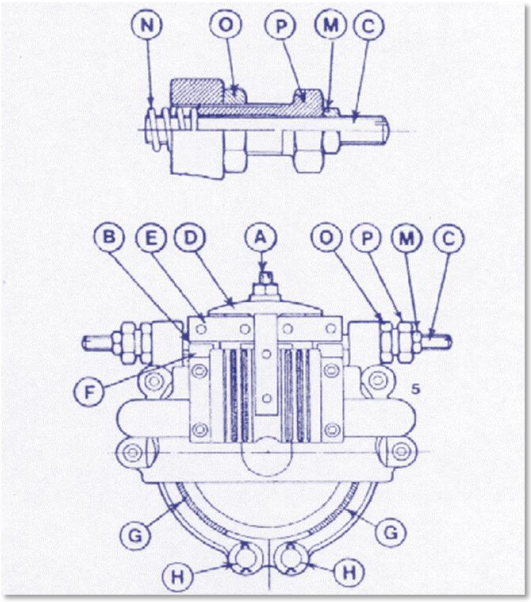
TABLE 13-6 TYPE L BRAKE SETTING

NOTICE

The brake size is the 6th and 7th digit of the brake type number, which is shown on the torque adjusting nut (item 3).

Travel Brakes

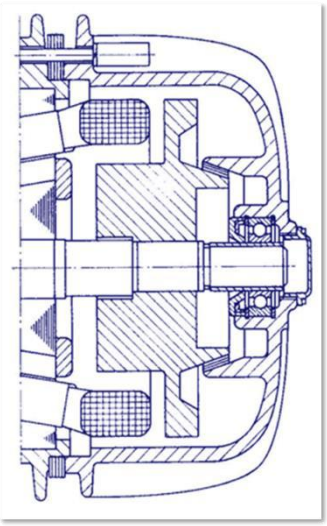
- Travel brakes may be either the disc or the drum type but in both cases their characteristics need to be a lot different to a hoist brake
- Braking characteristics have to be finely tuned in order to avoid excessive braking under no load conditions and providing reasonable braking when travelling with a maximum load
- The "clapper" brake was fitted to older cranes, providing soft braking characteristics, ease of adjustment and reliability in service



Disc Travel Brake

This is a cross section of a travel brake fitted to a conical rotor motor.

- A good example of soft travel braking
- The brake has been greatly reduced on disc and the equivalent of a flywheel has been fitted to the motor shaft
- This flywheel would have the effect of allowing much smoother acceleration as well as decelerations



Thrustor Brake

- Heavy duty applications
- Usually electro-hydraulic in operation
- Centrifugal pump and impeller spinning in oil and developing a pressure head
- Pressure exerted on a piston directly coupled to the load to be lifted (brake arm)
- Centrifugal pump driven by AC motor – pressure developed depends on speed of motor
- Class B insulation, 400v 3Ph 50 Hz motor

Main Parts of the Thrustor Brake

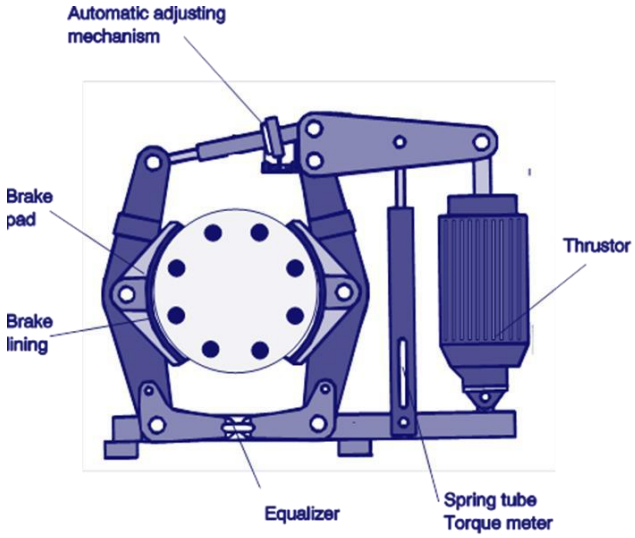
Base/Arms
Rigid wielded construction.

Shoes
Self-aligning, easily removable high grade cast iron filled with best quality linings fitted with stops.

Rods/Grid Rods
The tie rod transmits the spring force on shoes by simple lever system.

Springs
Compression springs are vertically mounted through the grid rods and are held securely between guide plates. One or more springs are used depending on the brake size and thrustor capacity so as to obtain the required braking torque.

Operation
The braking pressure to the shoes is transmitted from the springs and means of extremely rigid and simple lever/tie rod mechanism. Braking is smooth and positive. Release of the brake shoes is by introduction of a 3 phase mains voltage supply to the thrustor which overcomes the spring force and the shoes are moved clear of the drum by the lever/arm linkage system.



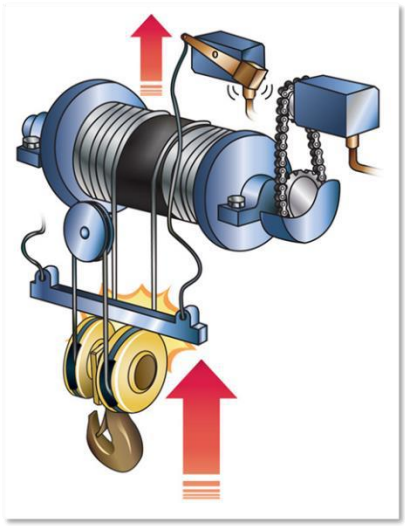
Checking the Thrustor

ALWAYS REFER TO OEM INSTRUCTIONS!

Correct operating limits and settings must be gained from the manufacturers data sheets or the crane maintenance manuals.

14. Limit Switches – Over Travel

Over-Travel Limit Switches

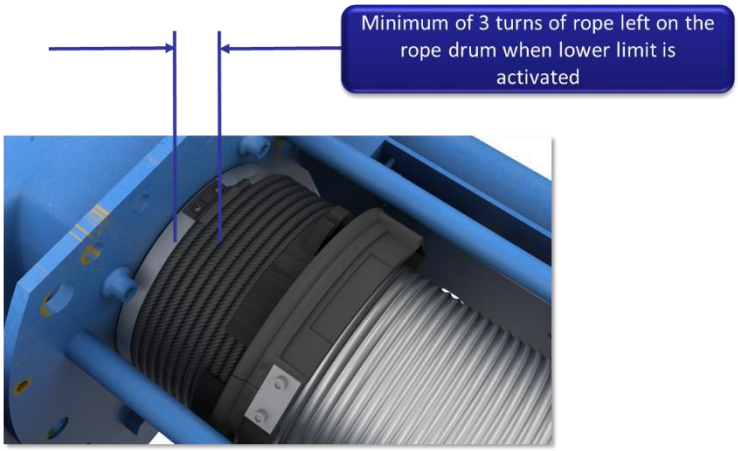


Hoisting and Lowering limits

- For safety reasons, to prevent the bottom hook 'over travelling' and causing damage to the hoist, a hoisting or upper limit is used
- For modern hoist units it is a mandatory requirement of EN 14492 to have upper and lower limits fitted that conform to the minimum requirements of EN 12077-2. In the case of a power operated hoist found in-service and not fitted with a bottom limit, it is advisable that one is fitted
- The type of limit used will depend on the hoist design and may be a mechanical device, e.g. a slipping clutch, or an electro mechanical device which uses a mechanical method of actuating a limit switch
- Whichever type is used, hoist limits are not intended for regular use, they must be considered as emergency safety devices. There are several electro-mechanical methods of actuating a limit which all utilize the movement of the mechanism to disconnect the power to the motor and thereby apply the brake
- In most cases, hoisting and lowering limits are easily reset by reversing the direction of the hoist however in some cases manual resetting may be necessary

Lowering Limit Requirement

The lowering limiter shall ensure that the minimum engagement of the lifting medium is maintained at all times during operation, e.g. minimum of 3 turns of the rope on the rope drum. The lowering limiter shall also stop the motion to prevent unwanted coiling in the reverse direction.



Back-Up (Second Limit)

For normal operation a second limiter is not necessary.
A risk assessment based on the particular application may result in the need of a second limiter for certain motions. This second limiter shall not be approached during normal operation, whereas the first limiter can be approached during normal operation.

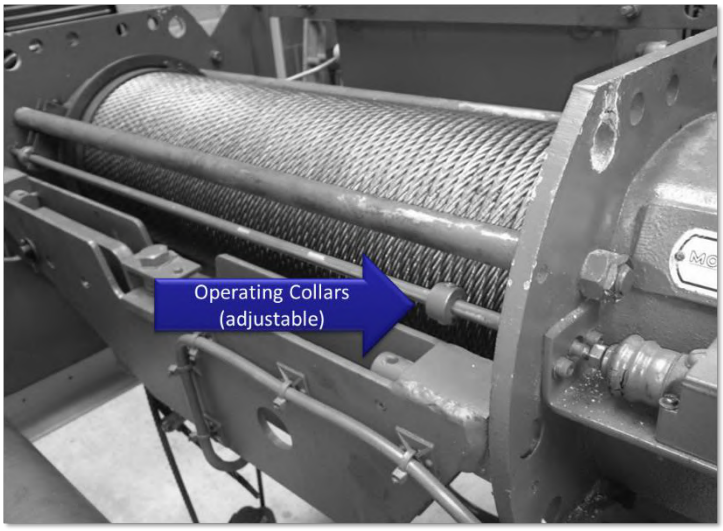
Note: Based upon the risk assessment, a second limiter may be necessary, for example when the hoisting limiter is activated with regularity and this limiter is not designed for regularity.

Once a second limit has been activated, a restart of the hoist should only be possible once the limit has been manually reset, e.g. by using a key-lockable reset on the control station or a manual reset on the hoist. This is due to the fact that the primary limit has failed, therefore the reason has to be investigated as it should have operated under normal circumstances.

Limit Switch Bar

- Typical application on a Morris 400 Series EWRH
- A common with electric wire rope hoists for control of upper and lower hook positions
- The mechanism comprises a bar, spring loaded into the neutral position. The bar carries two stops which are actuated by the rope guide as it moves along the drum and reaches the upper or lower limits of travel
- Two micro switches are situated at the end. When the bar is moved by the guide contacting a stop, one micro switch is depressed, stopping the motor and applying the brake
- The mechanism is reset by operating the block in the opposite direction
- On most hoists the micro switches are easily accessible for maintenance and adjustment

Limit Switch



Notes:

Limit Operation

UP limit circuit "open"

UP limit circuit "closed"

Hook Operated

- Hook operated limit switch trips hoisting movement when hook reaches the adjustable lever
- Hook operated limit switch can be automatic reset or manually reset
- With automatic reset hoisting movement is possible again after tripping as soon as hook has been lowered from the switching area
- Hook operated limit switches with automatic resets can be used as a working limit before standard upper limit tripping height

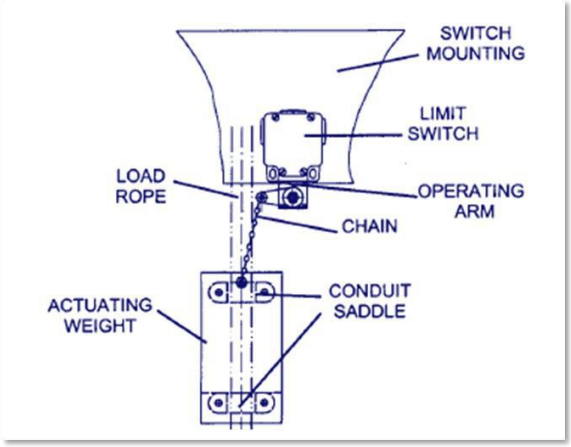
Rotary Limits

Hoisting Limit Switch

- The rotary hoist limit switch contains sets of contacts for default functions
- The rotary limit switch unit for hoisting is usually located in the connection box on the hoist gearbox

Ultimate Limit

To meet European (CE) regulations, a hoist ultimate limit switch prevents damage to the crane by contact between the bottom block and the hoist unit in the event of failure of the over-hoist limit switch by tripping the hoist motor.



Control and Series Limit Switches

- Most electric power hoists have the limit switches connected in the control circuit in a parallel arrangement
- This arrangement means that when one switch is 'open' then the other switch is 'closed' and motion is still possible in this direction when the push button is depressed. In practice only one switch can be open at any time
- Some electric hoists have a second limit switch called the ultimate limit switch
- This operates when the control limit switch fails. It disconnects the supply to the contactors and should only be reset when the faulty shunt limit has been adjusted or replaced
- This switch is connected in series and must be reset physically

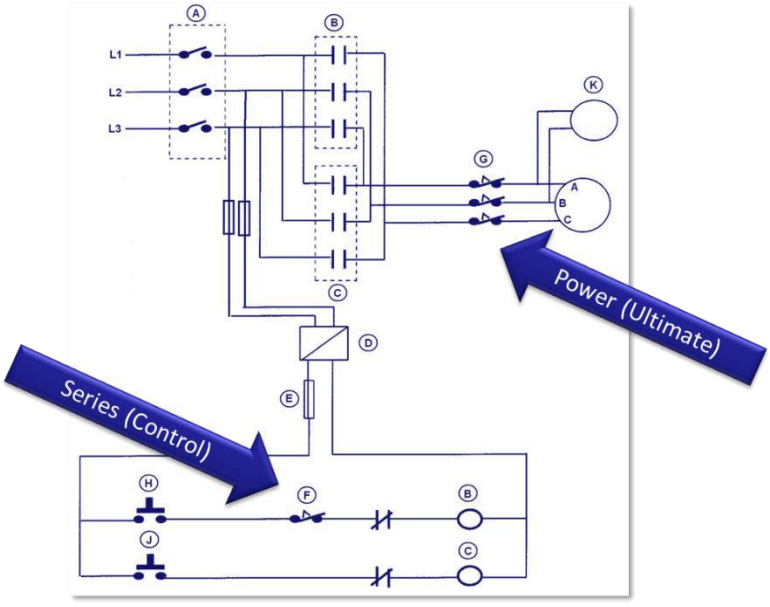
There are two versions of the **ultimate limit switch.**

Control Circuit Type
The limit is wired in the main contactor stop circuit and therefore if the normal direction limit fails, the main contactor will break the main supply to the contactors.

Series Type
The limit has either two or three contacts and is wired directly in the main supply cables to the motor. It must be noted that on older cranes, this is the only type of limit switch fitted.

Both types when used as ultimate limits are usually only re-settable manually by maintenance staff who must investigate the reason why the normal limit switch has failed.

Series and Parallel Limit Switches



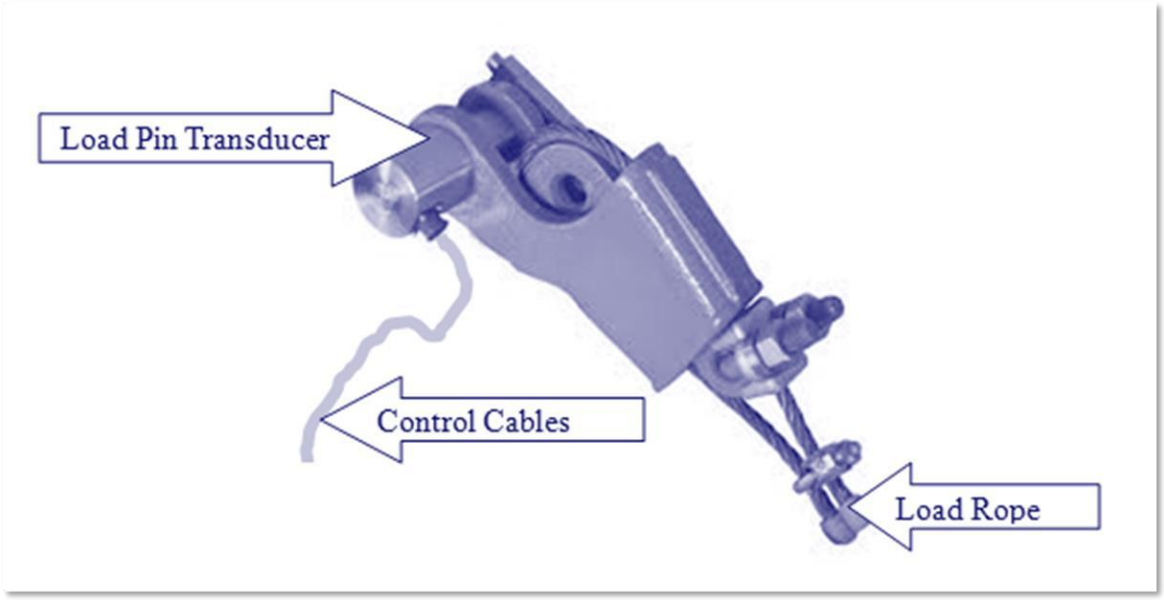
Notes:

15. Overloading Protection – WLL

Overload Devices for Electric Hoists

Load Pin Transducer Limit Switch (WLL)

- Used as an additional form of overload protection on certain wire rope or chain electric hoists
- The device protects both the hoist and the supporting structure from physical overload



Notes:

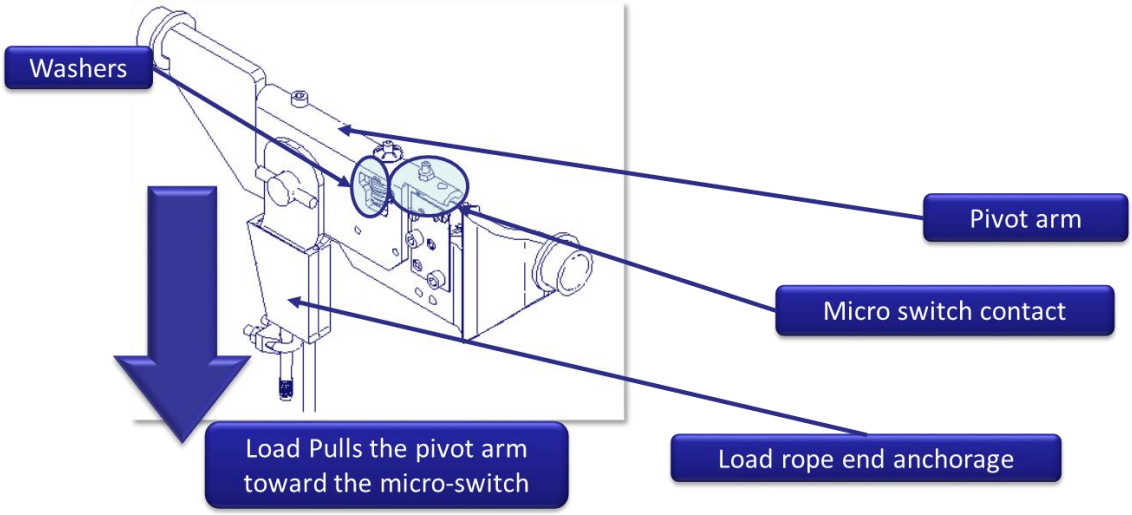
General Arrangement

The illustration below shows a typical load rope end-anchor assembly arrangement which is usually supported by a cross beam incorporating an overload limiting device.

Lever Operated, Electro-Mechanical Load Limiter

The lever operated, electro-mechanical load limiting device illustrated below prevents the hoist from overload. When load is applied, the pivoting load arm is pulled down towards the operating micro-switch and the calibration is set by a pack of spring washers.

When the load exceeds the set limit, the micro-switch will operate and stop the 'up' motion, only allowing the operator to lower.

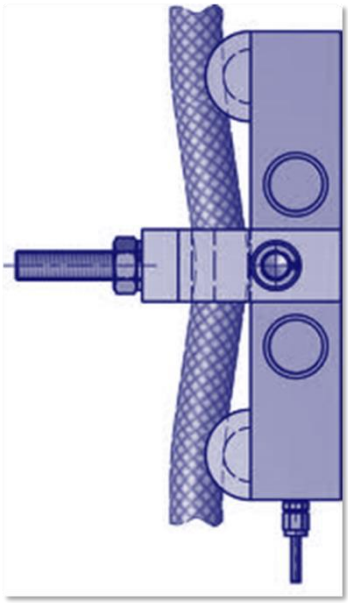


Notes:

Rope Operated Load Limiter

This device is fitted to one fall of the load rope and the rope is deflected at a shallow angle between the jaw of the strain gauge and the positioning wheels.

When the rope is under load condition, it tries to pull itself straight. As it does, it pulls the strain gauge anchor with it which is attached to a shaft. Once the shaft reaches a certain pre-set limit, it will open a micro-switch that opens the control power supply to the hoist motor.



Notes:

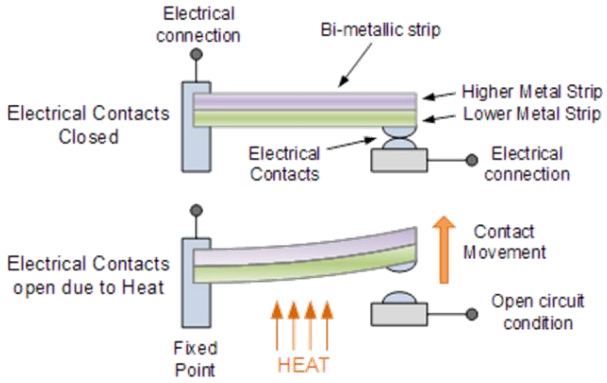
16. Overload Protection – Electrical

Types of Protective Device

- A fuse or circuit breaker, if properly designed, will prevent circuit overload by isolating the circuit from the power supply before any damage is done
    - Once they operate, everything on the working side of them is isolated and is inoperative until they have been repaired, replaced or re-set, they are ultimate protection devices
- Other devices are incorporated into equipment to protect certain parts from damage, e.g. a hoist limit switch, these may then operate to isolate a single component or function but permit other functions to operate. When a hoist limit operates it prevents the block from operating in the hoist mode but still allows the load to be lowered, they are intermediate protection devices

Bi-Metallic Strips

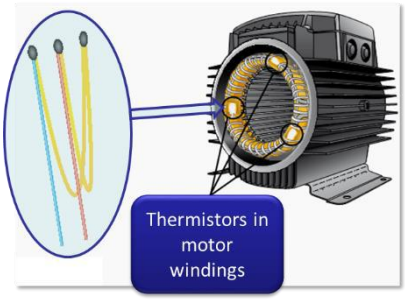
Widely used for motor protection and unbalanced currents.
The bi-metal strip consists of two dissimilar metals (e.g. copper and steel) fixed together as a bar.
When heated, the strip will bend because one metal will expand at a greater rate than the other.
This movement can be used to break contacts in the control circuit to the hoist motor.
The illustration below shows a simple arrangement of a thermal relay in a single-phase circuit:



When the motor supply exceeds a predetermined value its heating effect causes the deflection of the bi-metal strip to open the micro switch and disconnect the hoist motor contactor.

Thermal Devices

- Thermistors
    - Advantage of low cost
    - Auto-reset



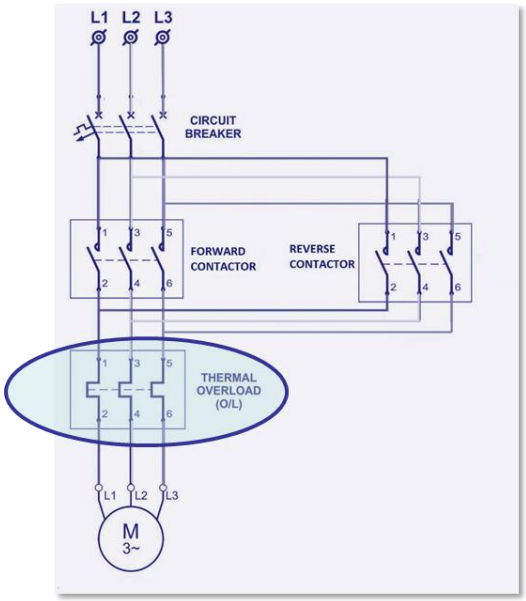
Some hoist motors have thermistors embedded into their stator windings during manufacture.

The thermistors are connected via a terminal strip to a relay wired in the control circuit of the contactors. In the event that the temperature of the motor rises to an unacceptable level, the thermistors will trip the relay and render the motor inoperative until it has cooled sufficiently.

When the hoist motor has been de-energised by either an electromagnetic or a thermal device it cannot be restarted until the relay has been reset, normally by a push button.

In-Line Thermal Overload

Thermal overload relays can be fitted in line between a motor contactor and the terminals of the motor. The thermal overload contains three contacts which are essentially bi-metallic strips. If the current increases beyond set limits in the overload relay, it will trip the circuit (as shown in the illustration below).



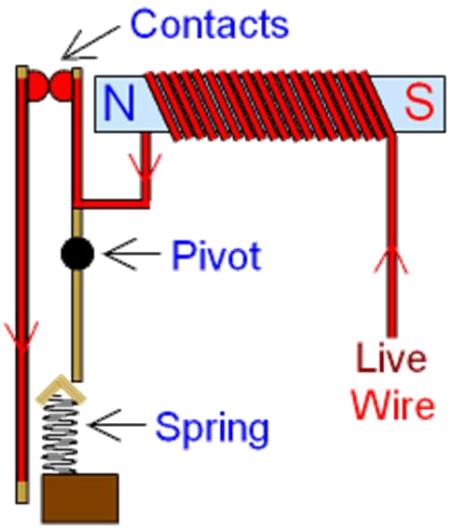
Fuses

- A safety device in a circuit that acts as a weak link
- The fuse breaks the circuit if a fault in an appliance causes too much current flow
- This protects the wiring and the appliance if something goes wrong
- The fuse contains a piece of wire that melts easily. If the current going through the fuse is too great, the wire heats up until it melts and breaks the circuit

- Must be situated in the live conductor, never the neutral conductor
- Rated in accordance with their current carrying ability, e.g. 13-amp fuse
    - The rating is the maximum current, which the fuse can carry continuously without deterioration
- Fuses used with electric hoists should be of the high rupture capacity type (HRC)
- They have good non-ageing characteristics and they have a high breaking capacity (i.e. will clear short circuits before the equipment is damaged)
- If equipment is 'earthed' to prevent the machine frame becoming live and causing possible electrocution, it is necessary that a fault current 3 times that of the fuse rating can occur in order to blow the fuse quickly. This requires that the earth path resistance must be very low

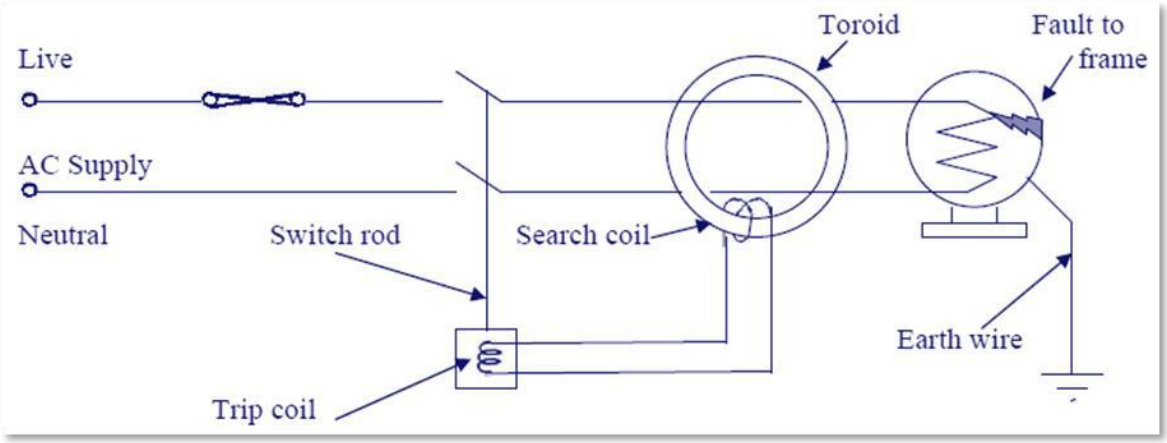
Miniature Circuit Breakers

- The MCBs disconnect the supply if too large a current flow
- When the live wire carries the usual operating current, the electromagnet is not strong enough to separate the contacts
- If something goes wrong with the appliance and a large current flows, the electromagnet will pull hard enough to separate the contacts and break the circuit
    - The spring then keeps the contacts apart
- After the fault is repaired, the contacts can be pushed back together by lifting a switch on the outside of the circuit breaker



Earth Leakage Circuit Breakers (ELCB)

The polarity of the phase winding and neutral winding on the toroid ring is so chosen that, in normal condition of magnetic force one winding opposes that of another. We assume that in normal operating conditions the current goes through the phase wire will be returned via neutral wire if there's no leakage in between. As both currents are same, the resultant emf produced by these two currents is also zero-ideally. The trip coil is connected with another third winding wound on the toroid ring as secondary. The terminals of this winding are connected to a relay system. In normal operating condition there would not be any current circulating in the third winding as here is no flux in the core due to equal phase and neutral current. When any earth leakage occurs in the equipment, there may be part of phase current passes to the earth, through the leakage path instead of returning via metal wire. Hence the magnitude of the neutral current passing through the RCCB is not equal to phase current passing through it.



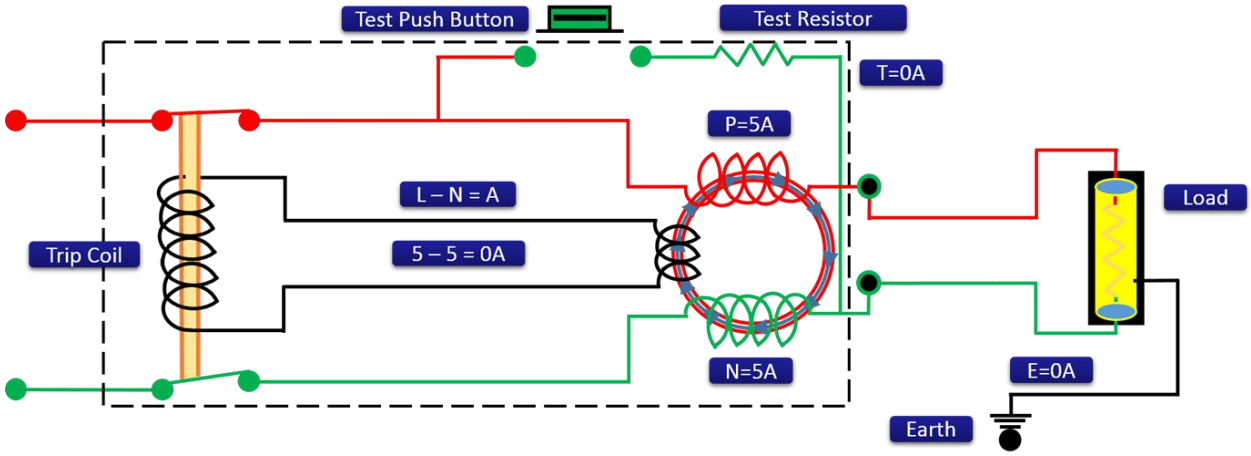
Notes:

ELCB Operation

Normal Condition

Load (L) – Neutral Coil (N) = Current (A)

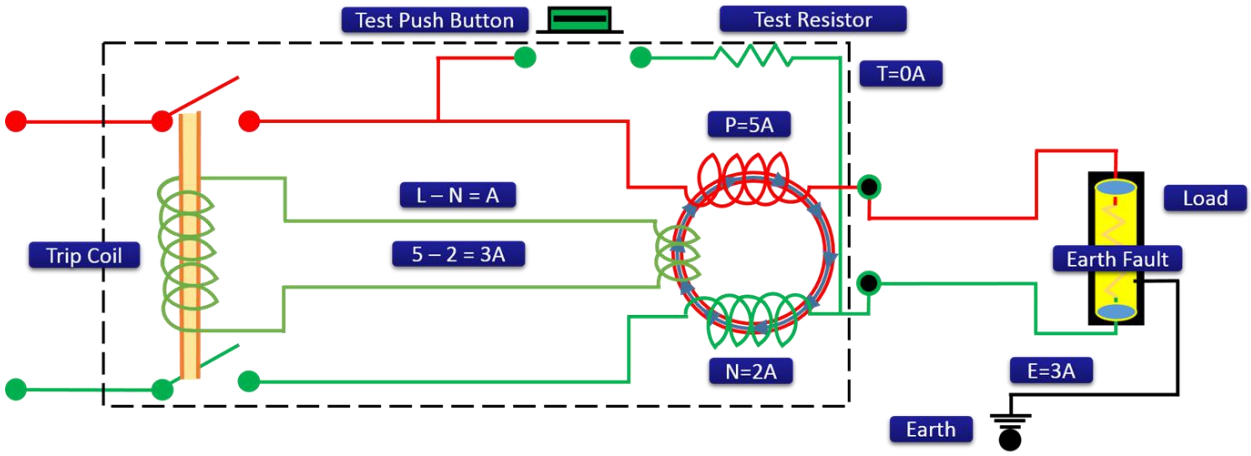
As shown in the circuit below, the line input and output are equal therefore the search coil shows no imbalance.



Earth Fault

Load (L) – Neutral Coil (N) = Current (A)

Due to earth leakage, the line voltage output current will less than that of the input. The search coil registers an imbalance and generates a current activating the trip coil and opening the circuit.



Notes:

17. Safe Use of Powered Hoists

Whist this Advanced Programme course is designed solely for the powered lifting machine examiner in conducting thorough examinations, damage to appliances can sometimes be attributed to a particular way in which the equipment may have been used.

It is important that the examiner is able to recognise such issues related to incorrect use of the equipment so that the client/owner of the equipment can be informed.

This may identify particular difficulties in the operation environment where the operator is limited in selection of lifting equipment, or simply a matter of insufficient training. On rare occasions, deliberate misuse of the equipment may also be identified.

This course content is not designed to provide information on how to use the equipment. It is however LEEA's objective to provide relevant information on common misuse and how this may be attributed to a particular fault(s).

Warning Devices

Travelling or moving appliances can present a hazard to personnel. It is often sufficient to paint or mark them in distinctive colours to ensure that they are clearly visible. In some cases, greater steps are necessary. The use of warning lights and/or audio alarms should be considered and are usually available as optional extras.

Safe Use

The basic objectives of any lifting operation are to move the load to the desired location, land it and to do so safely, efficiently and without damage to the load, the equipment used or the surrounding buildings, plant etc.

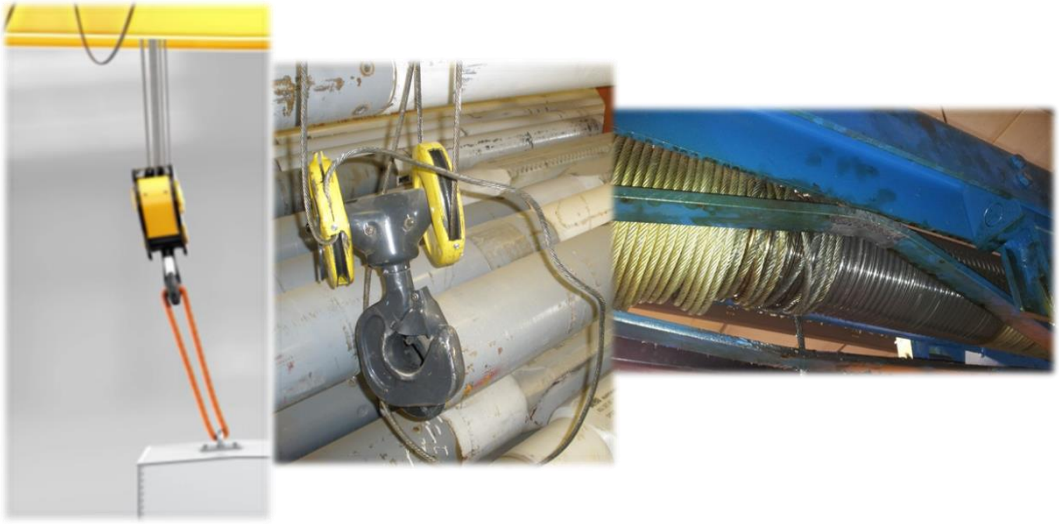
- Having selected suitable equipment, it is important to ensure that it is properly installed/erected and fit for use
- It is also important to ensure that the operatives using the equipment understand how it is designed to be used and follow a good procedure which ensures they remain in control of the load at all times throughout the operation

In addition to any specific instructions relating to the safe use of the lifting appliance issued by the manufacturer, the following points should be observed:

- Lifting appliances must not be used to raise, lower or suspend a load greater than the marked safe working load

- Ensure that the load is directly under the hoist. The line of pull should always be vertical, never side lift or drag a load
    - Side pull using a wire rope hoist can cause significant and dangerous damage to the rope and hoist

Damage caused by side-pulling:



Notes:

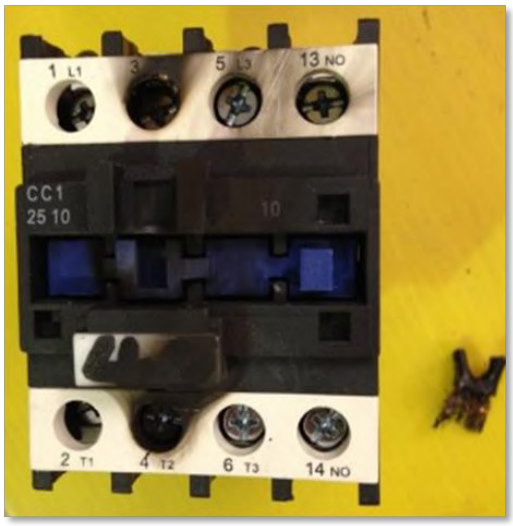
- Do not use the load chain or wire rope to form a sling, i.e. it must not be wrapped around the load and back hooked or choke hitched
    - Often identified by the last metre or so of the load chain being heavily worn, bent hooks/shanks, damaged or missing safety catches and gouged hook saddles

Safe Use of Powered Machines

- Care should be taken to ensure that the hoist is not subjected to shock loading. When using hoists with dual speed, commence the lift in slow speed before progressing to full speed
    - Significant damage to the load rope/load chain and the hoist mechanisms can be caused
    - There is a risk of overloading and breakage of the lifting medium

Damage to load rope from shock-loading

- Never change motions (i.e. lift to lower or vice versa) without first allowing the motor to stop running. Quick reversal of direction causes shock loading and heavy current surges. This may result in burnt contacts, and imposes unnecessary strain on transmission shafts and gears



- Avoid unnecessary inching (repetitive pressing of a motion control to adjust the load position) as this causes burning and pitting of contacts. Excessive inching could result in burning out of the motor

Notes:

- In the case of hoists with push travel trolleys, never attempt to move the hoist by pulling on the pendant cable control. Always pull on the bottom hook of unloaded hoists

- End stops are designed to prevent derailment of the crane/hoist should it collide with them at full speed, carrying full working load, once only. After a collision they need a thorough examination to determine their continued fitness for service
    - Do not run the hoist/crane continually into the end stops as thus will damage the hoist/crane and the end stops

Training

Operator training should take into account the manufacturer's instructions for installation and use and, in particular, operatives must fully understand the controls of the hoist, with special attention being paid to remote controls and emergency stop procedures.

Notes:

Training

Operative training for all the equipment covered in these step notes should always take the manufacturer's information and instructions for use into account.

Notes:

We would be grateful for your feedback regarding these Step Notes, after completing this training course. Please make your comments known to us – you can use the note box below to list anything you would like to bring to our attention.

We value your views and will use your comments to help our continual improvement of our learning and development materials.

Thank you in advance for your participation.

Andrew Wright
LEEA Learning and Development Manager

Step Notes - feedback to LEEA: