Powered Lifting Machines (PLM) Global Workbook

Welcome to the Powered Lifting Machines

Welcome to the Powered Lifting Machines Diploma (PLM) (Global).

The Diploma qualification is essential for anyone engaged in the testing, inspection, examination and repair or maintenance of powered lifting machines.

It is also essential for anyone who is responsible for assessing equipment's suitability to return to service following statutory examination.

The core areas covered in this course are:

- Working On-site
- Examiners' Tools and Equipment
- Types of Examinations
- Lifting Media
- Types of Brakes
- Electric Chain Hoists
- Electric Wire Rope Hoists
- Powered Winches
- Pneumatic Hoists
- Traveling Trolleys
- Power Feed Systems

Learning Outcomes

Upon successful completion of this Diploma course, students will acquire the knowledge that will assist them to perform the 'thorough examination' of specific powered lifting machines in service and validate or otherwise assess their fitness for a further period of service, applying conditions as may be necessary.
Students will be able to refer to and extrapolate information from sources to support their analysis of lifting equipment suitability for continued service.

Working On-site

Notes from the Video:

Video transcript:

As a professional in the lifting equipment industry, there are high expectations of you to perform your role to mitigate risk and keep people safe. This is of paramount importance and should always be the priority focus of your work. Secondly, our stakeholders, customers and employers rightly expect the highest professional standards from all those working in such a high-risk industry. So you are expected to be competent in your technical abilities, but moreover, as a professional you must also manage your standards of service, both internally to your employer, and externally to your customers and other stakeholders.

Lifting and height safety industries which has eliminated accidents, injuries and fatalities.

LEEA's Vision Statement

TEAM Card

On successful completion of this training course and the associated end-point assessment, you will be awarded the LEEA Diploma in Powered Lifting Machines (Global), and where applicable, the LEEA TEAM Card.

As a TEAM Card holder, there is an expectation that you will perform your role to the very best of your ability, meeting the requirements of a 'competent person' as defined by LEEA in its COPSULE.

Our industry 'end-users' are actively encouraged to use LEEA member companies that employ qualified and competent individuals. They are assured that by using LEEA TEAM Card holders, they are putting their lifting equipment into safe hands and minimising their risks as duty holders and owners of such equipment.

In order that we continue 'raising standards in the lifting equipment industry', each of us has our own part to play. As lifting equipment examiner/inspector/tester, employed by a LEEA member company, you share this responsibility and have a very important role!

NOTES:

Pre-Job Information, Representing Your Employer and Signing In

Pre-Job Information

Before we consider travelling to the customer's site, we should pause to think about the following:

Representing Your Employer

To ensure you provide a professional representation of your employer, answer the following questions:

1. ____
2. ____
3. ____
4. ____
5. ____
6. ____

Reporting and Signing In

- Signing In:

  ___

  ___

- Meet:

  ___

  ___

- Exchange of Information:

  ___

  ___

- Agree:

  ___

  ___

- Communication:

  ___

  ___

IMPORTANT

LEEA Members LEEA Members represent the highest standards within our industry. You are an Ambassador for your company and your profession; it is essential that your personal behaviours are exemplary, and your competencies are consistently maintained through your active participation in continuous professional development (CPD).

During the Job

Firstly, you must consider the basic requirements for the examination to be effective:

- The area should be clean and clear of contaminants which may harm the examiner or the equipment
- Adequate access to the equipment shall be provided
- The equipment should be reasonably clean, and the examiner should have the means to clean local areas
- The examiner should have visual aids and tools required for the examination, including adequate natural or artificial lighting
- Conduct your job safety analysis/risk assessment review before starting work – make sure any changes are recorded as they arise
- Is a permit to work required?
- Confirm the identity of the equipment against the defined scope of examination (worksheet instruction) or users record of the lifting equipment
- Isolation (lock-out/tag-out) and cordoning off the work area as necessary

- Tool-box talk with colleagues if applicable before starting the job
- Talk to equipment operators/user. Are there any issues they may have noticed with the equipment?
    - This is particularly important for lifting machines as the operator is usually the first to recognise intermittent faults or other issues arising)
    - Update the defined scope of examination according to any concerns, as necessary

- Make sure all information is recorded regarding the equipment (e.g. location, serial numbers, ID numbers and safety marking)
- Check the equipment against the defined scope of examination and detail your findings for the report together with any defects found
- Maintain the safety of the area you are working in through awareness of your surroundings and what is happening.
    - You may need to change the JSA/risk assessment if new control measures are needed due to changing hazards

Why is it important to pre-arrange a sign off meeting with your customer prior to starting work on site? (Select one answer)

☐ To ensure that checks can be made of the work area and customer is happy

☐ To ensure customer is available for you to present your report summary

☐ To ensure that work permits and control measures are removed

☐ To ensure that the customer can carry out operational checks of the equipment

NOTES:

Completing the Job

Returning equipment back to service	1. Have you ensured any isolated equipment has been put back into service? 2. Have all machinery guards been replaced? 3. Did you carry out post-examination running checks on equipment, where necessary? Operational checks? 4. Do you need to colour-code equipment? What colour is needed? 5. Has equipment been stowed in designated storage areas or parked in a safe area? 6. Have all barriers and signs been removed from cordoned areas?
Communication	1. Let equipment users know that you have finished your work and that the equipment has been returned to service 2. Complete your reports, identifying any issues and your recommendations; safety-critical issues are your priority, and the owner of the equipment must be notified of these immediately. If the equipment is to be removed from service, ensure it is suitably quarantined and marked, “DO NOT USE”. 3. Identify and detail any repairs that may need carrying out and a timescale in which this should be completed
Leaving the site	1. Have your debrief meeting with the site contact to present your report summary 2. Ensure your customer is completely satisfied before you leave the site

Equipment for Carrying Out On-Site Thorough Examinations

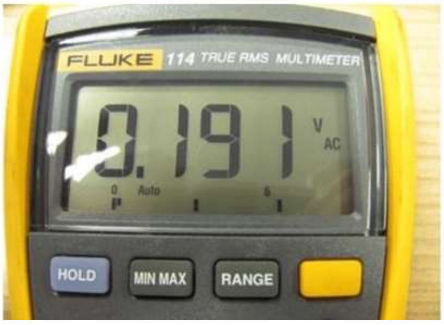
Tools

For the lifting equipment examiner/inspector/tester, a selection of hand tools will be required at work, which may be for a thorough visual examination of lifting accessories such as shackles and chain slings, or perhaps lifting appliances such as gantry cranes or electrically operated chain hoists fitted to slewing jib cranes. The selection of tools will therefore depend on the nature of the job.

A broader perspective on tools required may include access equipment (MEWP, scaffolding etc.) You may also need to consider the types of lifting equipment you need to hoist/lower spares, lubricants, and cleaning or test equipment.

You should be appropriately trained to use all equipment you are supplied with and have the appropriate PPE. Both hand and power tools should be maintained in a safe and operable condition.

Measuring Equipment: Calibration of measuring equipment should be carried out in accordance with relevant standards, and this is a mandatory LEEA technical requirement, verified by LEEA during routine audits.



Lighting

It is very important that the area of inspection is well lit with natural or artificial light so that defects can be identified. Torches or portable lighting stations may be required to help you.

It is recommended that you carry basic cleaning materials such as rags, dustpan and brush, a wire brush and PH neutral cleaning fluids in the event that you have to clean the item(s) being inspected.

Cleaning

The area where you are carrying out the inspection should be reasonably clean and free of contaminants that may affect the equipment you are inspecting.

Ensure any data sheets and chemical warnings are adhered to for the use of such products and your JSA/risk assessment reflects this.

NOTES:

Examination

Types of Examination

There are 3 levels of inspection:

1.____

2.____

3.____

Pre-Use Inspection	The pre-use inspection is normally carried out by the operator before operating the equipment. The operator will visually check for any signs of obvious defect or damage that give cause for concern. If such an issue is found, the operator must report their findings to the appropriate maintenance/inspection personnel for further investigation before operating the equipment.
Interim Inspection	The interim inspection (sometimes referred to as the 'frequent inspection') is determined by risk assessment as to how often, and to what extent the inspection is performed. This level of inspection normally focuses on critical components that may become problematic prior to the next periodic thorough examination. The number and frequency of these inspections are also determined by the risk assessment and the manufacturers' literature. Interim Inspections are often done at the same time as planned maintenance or following a repair.
Thorough Examination	A thorough examination (sometimes referred to as the periodic, or thorough inspection) is a visual examination of lifting equipment that is carried out by a competent person. The examination should be performed carefully and critically, supplemented by testing and measurements required by the competent person to ascertain the equipment's fitness for a further period of service. It is also used as a check of the suitability of the equipment and the inspection/maintenance regime. This means that the thorough examination should not find any defect affecting the safety of the equipment, if it does, this may suggest that there is an issue with the inspection/maintenance regime, the competency of the inspectors or maintainers or the product's fitness for purpose, etc. In essence, it is a safety net, used to identify inadequacies in the inspection/maintenance regime and thereby provide a means of improvement and prevent a reoccurrence. This means that the root cause of any defect found following a thorough examination should be investigated and rectified with appropriate measures to prevent reoccurrence.

Key notes:

- **Testing:** the term 'testing' includes, for example, proof load testing, operational testing at lower loads and non-destructive testing.
- **Examination Frequency:** the period between thorough examinations must be established by the competent person on the basis of statutory requirements for the equipment.

LEEA recommends that the following maximum intervals between thorough examinations are used as best practice:

12 Months: ____

6 Months: ____

- **<u>Thorough Examination:</u>** shall be carried out following installation and after exceptional circumstances, i.e. substantial repair or modification, following a collision, etc.

- **<u>Issues and Actions:</u>** the examination should identify issues that could become a danger in the period before the next thorough examination and the subsequent report should advise the appropriate action to be taken.

NOTES:

Defined Scope of Examination

Irrespective of the type of examination the competent person should always be working to a predefined scope of examination or inspection. A predefined scope of the examination should be established with a clear documented list, of everything that needs to be checked, complete with acceptance/rejection criteria, which should be considered as the maximum permitted and used as a means of reaching a conclusion as to the fitness for service of the equipment.

The examiner should take into account:

1. ____

2. ____

3. ____

4. ____

5. ____

It should also specify the intervals at which the equipment, or its individual parts, should be thoroughly examined in accordance with the legislative requirements and, where appropriate, intervals for specific supporting reports and tests. These intervals should reflect the anticipated rate of deterioration and the likelihood and potential consequences of failure.

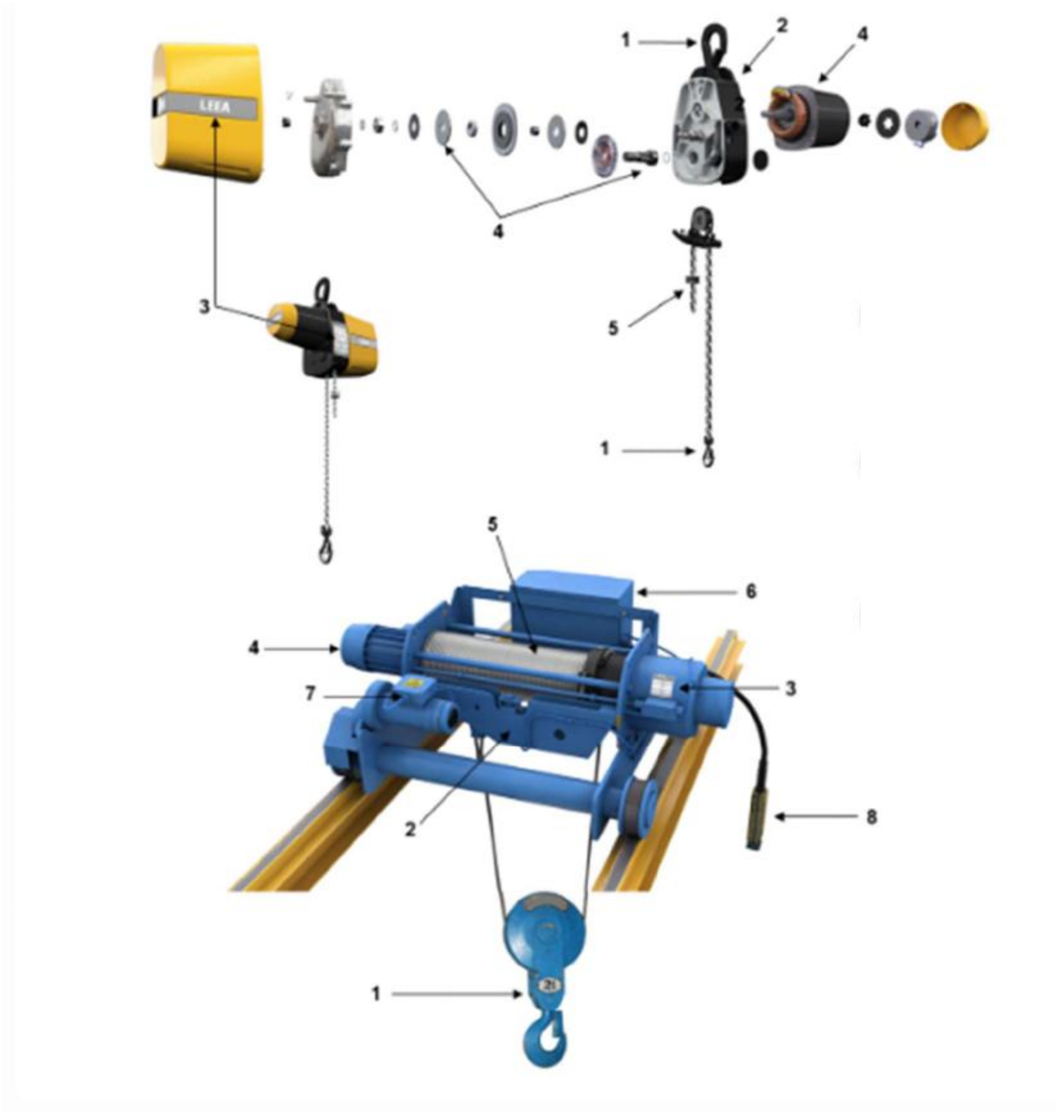
In all cases it is recommended that the scope of examination is drawn up specifically for the particular item of lifting equipment, however, generic scopes of a thorough examination can be written for specific models and make of lifting equipment. Either way, the scope should also include any dedicated ancillary equipment, such as wire ropes.

Powered Operated Equipment	For power-operated equipment, the scope of examination should include the power supply system which is considered to start at the point of isolation,i.e. isolator, switch fuse or shut-off valve.

Further reading: LEEA Lifting Equipment Examiners Handbook

An example scope of examination for a powered lifting machine may include, but is not limited to the following items:

Notes:



1. ______________________________

2 ______________________________

3. ______________________________

4. ______________________________

5. ______________________________

6. ______________________________

7. ______________________________

8. ______________________________

9. ______________________________

Note: A defined scope of examination should also include the assessment criteria.

The following extract from BS 7121-2-7 (s8.5.3 provides this criteria which are recommended by LEEA**:**

- Alignment – within the manufacturer's tolerance
- Corrosion – affecting strength or functionality
- Cracks - affecting strength or functionality
- Damage - affecting strength or functionality
- Distortion - affecting strength or functionality
- Functionality – as intended by the manufacturer
- Leaks – affecting strength, functionality and slips
- Lubrication - adequacy
- Markings – presence, accuracy and condition
- Mode of operation – as intended by the manufacturer
- Rope fit – as specified by the manufacturer
- Rope reeving - as specified by the manufacturer
- Rope specification - as specified by the manufacturer
- Rope condition (See ISO 4309)
- Obstructions – impeding safe access
- Security - attachment of components and sub-structures, fasteners and welds, etc.
- Seizure – full or partial seizure of rotating components
- Tidiness – general housekeeping
- Wear – affecting strength or functionality

This list is not exhaustive!

NOTES:

Supplementary Testing and Documentation

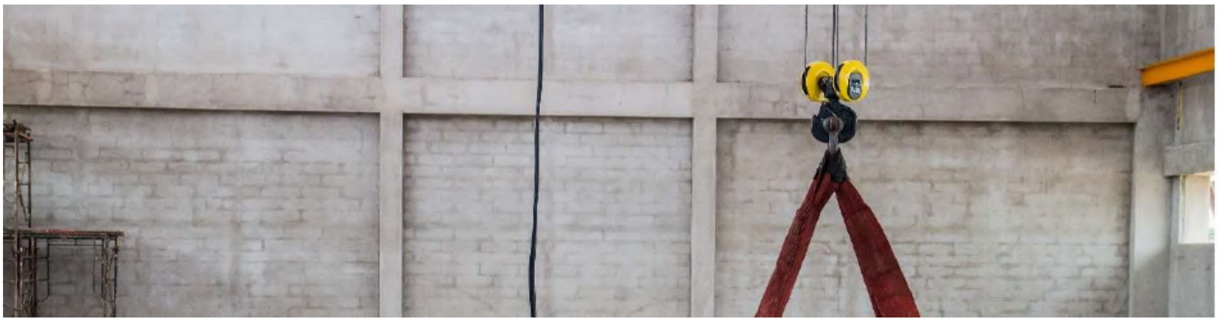
Supplementary testing

Supplementary testing is carried out in support of a thorough examination and the extent and nature of any testing are specified by the competent person carrying out the thorough examination. These tests should be carried out in accordance with the manufacturer's instructions, the relevant standards and statutory requirements.

Test areas should be carefully selected, and steps are taken to protect personnel and property. In particular when load testing, ensure a clear area to facilitate the lifting and movement of test weights with a minimum of ground clearance.

Supplementary testing of power-operated hoists will largely depend upon the nature of the examination.

Common tests used to supplement a thorough examination include:	▪ Operation testing ▪ Proof load testing ▪ Non-destructive testing, i.e. Electromagnetic wire rope examination, magnetic particle inspection etc. ▪ Calibration checks and functional tests of RCI/RCL ▪ Insulation testing ▪ Earth continuity test



Documentation and records

Following every examination, a formal report is drawn up. However, the examiner should always make a record at the time of the examination on the job paperwork or in a notebook etc. This contemporary record should always be authenticated and dated by the examiner and retained for reference purposes. If the formal report is authenticated by someone on the examiner's behalf, the contemporary record should be available to the authenticator so that the accuracy of the formal report can be checked.

When an examination reveals a defect, the user should be notified promptly so that appropriate action can be taken and, if the defect is of immediate or imminent danger, further use is prevented. In some countries, it is also necessary to inform the enforcing authorities of certain defects.

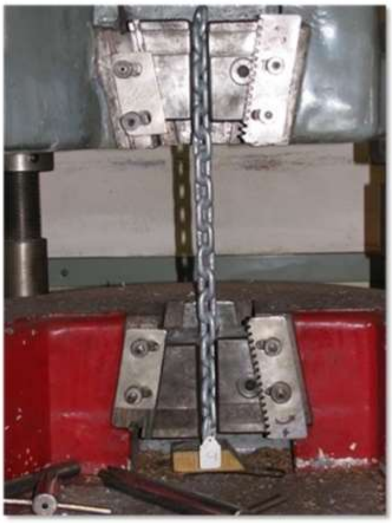
Lifting Media

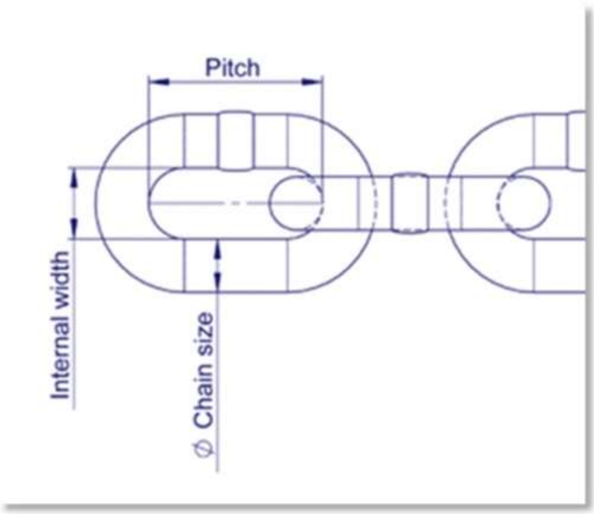
Load Chain

Link Chain

Short link, fine tolerance chain, type T, DT and DAT possess a surface hardness greater than core hardness and are used for power-driven chain hoists to offer greater resistance to wear. It is therefore less ductile than chain used in chain slings.
In use it tends to show evidence of damage better than wire rope or textiles, consequently, an examination is more reliable. Therefore, it remains the principal component of much lifting equipment. In this lesson, we will consider the various grades of chain in use in our industry today.

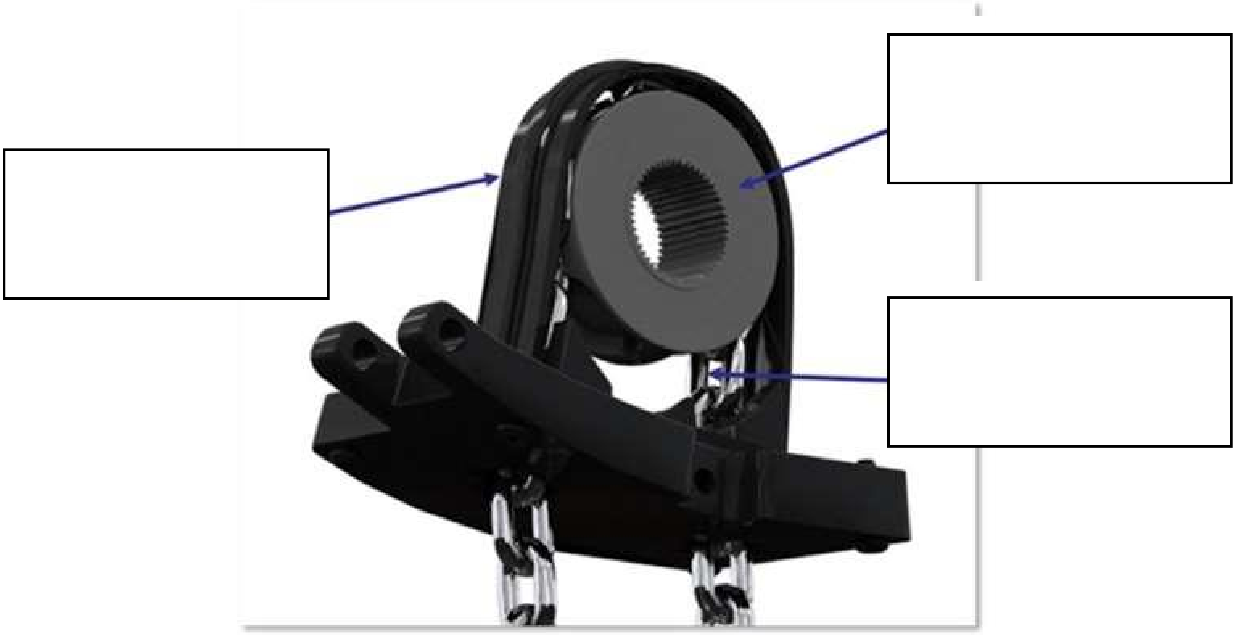
It is manufactured to precise dimensions for use as a load chain in lifting appliances. The pitch of the chain has to be exact as it has to mate with other moving components. This is achieved during manufacture when the chain is pulled under tensile force to achieve the precise pitch dimensions.





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.

The picture below shows the chain path over the chain sprocket in a typical electric chain hoist:



The comparative WLL of each type of chain is different for any given size of chain link. Here are examples of a 8mm diameter chain link:

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.

Chain Usage

- Type DAT: ____________________

- Type DT: ____________________

Case hardened chains type DAT and DT are not suitable for use in hand chain blocks.

Various finishing treatments are given to the fine-tolerance chain to increase wear resistance.

- 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

Chain recognition	Fine tolerance chain may be recognised in two ways: The calibrating process has the effect of removing all of the residual scale from the heat treatment process and many of the finish treatments include corrosion resistant finishes. As a result, it has a **bright finish** and of course there is also the **grade mark**.This includes a marking to show the material grade (T, DT or DAT) and the manufacturer's traceability code at the placement of every 20th link or 1 metre, whichever is the lesser. **Nominal size:** the nominated size of the round section of steel wire or bar from which the chain is made. That is, for example a nominal 7mm chain has a link diameter of 7mm. **Material diameter:** this is the measured diameter of the chain link, or its actual diameter. **Pitch:** this is the internal length of a chain link as measured. **Grade marks – ISO 3077 Load Chain** ISO 3077 states that the markings on the chain shall be in accordance with ISO1834 (originally BS4992) which is a placement at every 20th link or 1 metre, whichever is the lesser. This will also include a marking to show the material grade (T, DT or DAT) and the manufacturer's traceability code. For serial type hoists, please note that ISO 3077 also refers to the following standard: FEM 9.671[3] section IX, serial hoists – chain grades, criteria for selection requirements.

Advances have been made in material development and chains of much higher breaking loads have entered the marketplace in recent years.

Manufacturers have followed the spirit of the standard with regard to marking, and grade '10' load chains marked 'V' are becoming common.

Manufacturers' Test Requirements

Manufacturers' test requirements are clearly stated for link chain. The national standards specify the proof load/force to be applied by the chain manufacturer. In the case of chain manufactured to some standards the manufacturer's test force is higher than the customary 2 x WLL being set at 2.5 x WLL. It is intended that this is the initial test, which is not intended to be repeated. Random tests are also carried out to destruction, by tensile loading, bend test and by fatigue testing to ensure the properties and qualities of the finished chain have been achieved and remain consistent.

Following the completion of all the manufacturing processes, chain manufacturers test the chain and issue a master test certificate, which also gives the traceability back to the production, heat treatment and finishing batch.

The overall Factor of Safety (Breaking Force) for load chain is 4:1.

NOTES:

Operating temperatures

Type T	For manually operated blocks, or slow speed power hoists, in environments where there are no abrasive conditions. Used no lower than -40˚C.
Type DAT	For power hoists with high speeds and working capacity, giving good wear resistance for a longer working life. Used no lower than -20˚C.
Type DT	For power hoists in abrasive conditions. Used no lower than -10˚C.

Hoist Chain Type	Lower Temperature Limit °C
T	-40
DAT	-20
DT	-10

Exposure to Acidic/Alkaline Conditions

Hoist chain types T, DAT and DT should not be immersed in acid solutions or exposed to acid fumes.

Surface finish

The `finished' condition for load chain can be of different types depending on the standard to which it is manufactured. For example, chains are supplied with various surface finishes including natural black (i.e. furnace scaled), de-scaled, electroplated or painted.

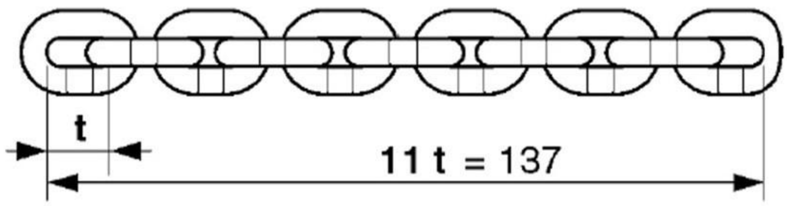
NOTES:

Examination of Chain

Preparation for the examination	• Hang the item from a suitable suspension point • Chains should be cleaned (no strong alkalis or acids should be used as it could lead to hydrogen embrittlement) • Markings - grade mark as per chain grade
Operate hoist	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
Link by sling examination of the load chain	Link by sling examination of the load chain in adequate light. • Check for cracks, cuts, nicks and gouges, wear, elongation and other damage including a build-up of debris in the chain or load wheel

Key Issues:

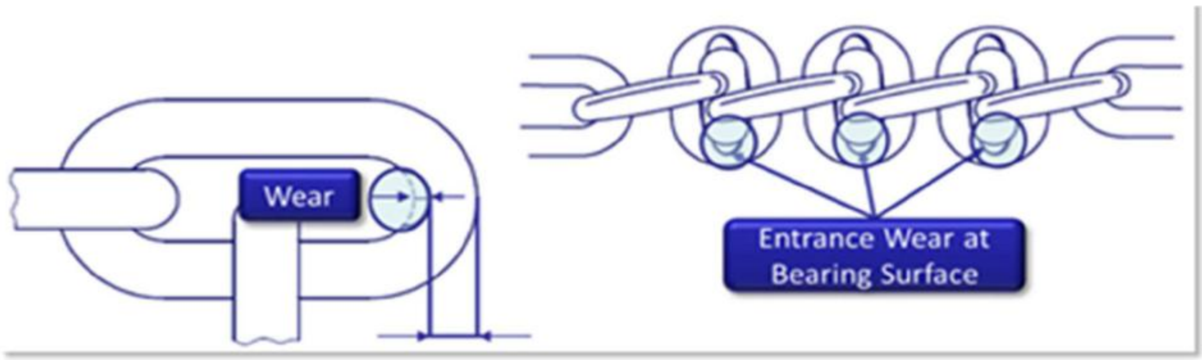
- There should be no signs of deformed or twisted links
- Articulation: ensure that the links of the load chain and coupling devices are free to articulate
- Weld structure/integrity
- Heat (direct or indirect)
- Weld splash or bluing
- Lubrication
- Chemical damage
- Heavy corrosion (cannot be removed easily with a wire brush and does not leave heavy pitting of the load chain
- Nicks/cuts/cracks/gouges (stress raisers)
- Markings - grade mark as per chain grade
- Increase in gauge length which exceeds that manufacturer's recommendations. In the absence of the manufacturer's recommendations, the chain should be replaced if the gauge length measured over any 5, 7, 9 or 11 links exceeds that of the unused chain by 2%. (reference ISO 7592)
    - The illustration below shows a manufacturer's specified length for a piece of chain over 11 links, where 11 x t = 137mm:



- Wear - in the absence of the manufacturer's specific information regarding discard criteria, LEEA recommend that when a maximum of 8% reduction in material diameter for the chain is reached it should be removed from service and discarded

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 chain 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 the 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 appliances, 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.

NOTES:

Manufacturer's Certification

Notes from the video:

Video Recap
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 the date of issue of the certificate and authentication
- Number and parts of the relevant standard
- 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)

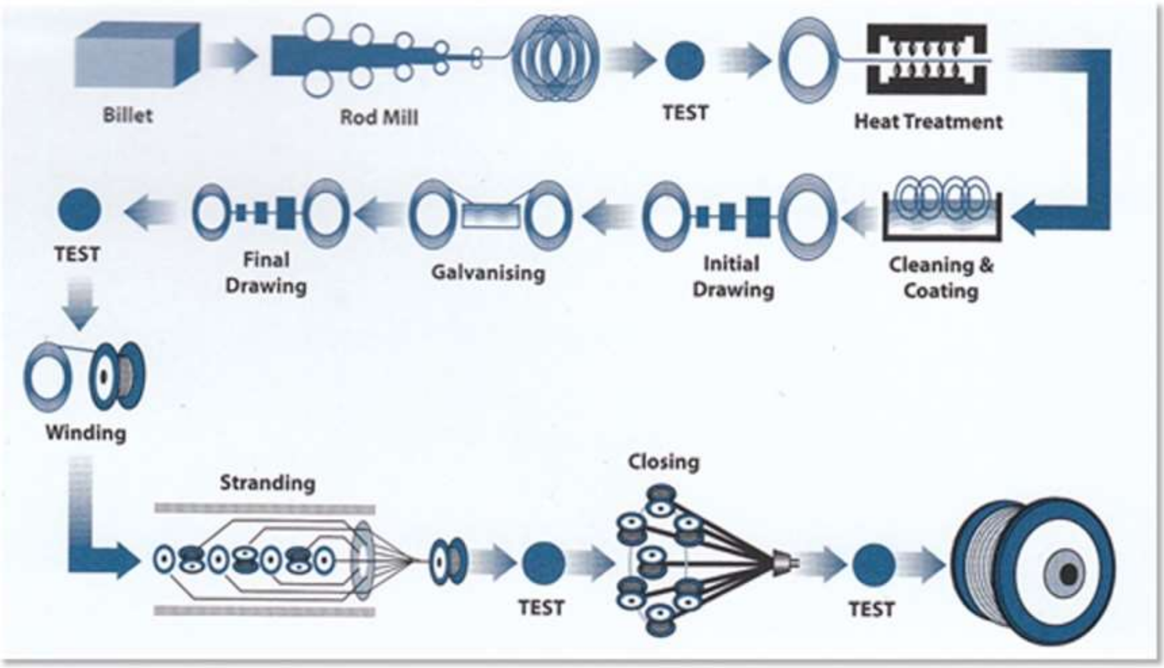
NOTES:

Lifting Media: Wire Rope

How is wire rope is made?

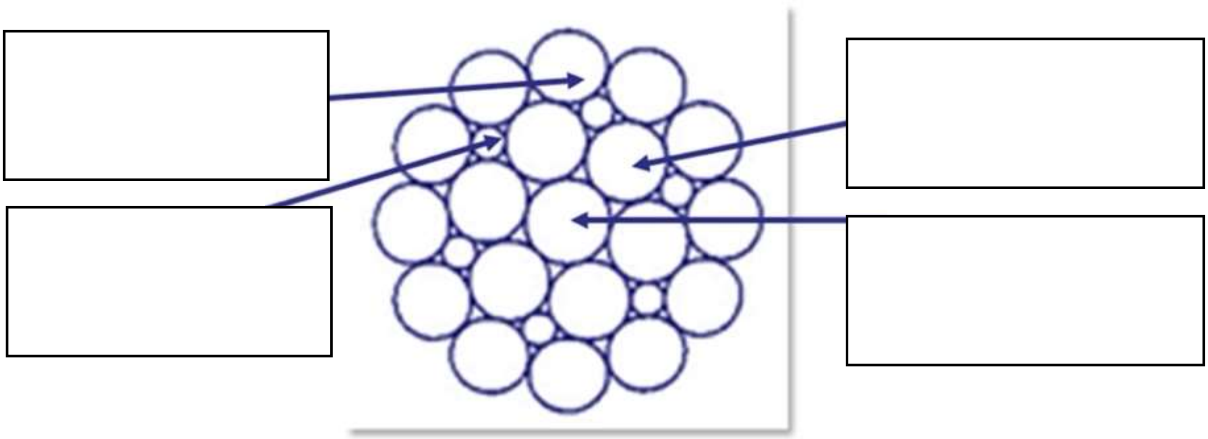
Wire rope is flexible enough to run around pulleys making it ideal for manual winches, where the mechanical advantage is often required. However, it is also the most rigid of the lifting media. Its rigidity allows it to be passed easily under loads and through apertures, which would not be possible with any of the more flexible lifting media. When in long lengths, it is stored on reels or coiled and must be handled carefully or it may become damaged.

Wire rope construction means there are many small wires at the surface, so it is more susceptible to damage than chain. If a wire rope is bent around a corner of the load, or repeatedly used to lift identical loads, the rope can easily take on a permanent set.



Elements of a Wire Rope

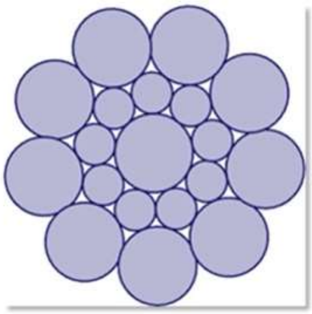
Outer Wires	
Inner Wires	
Filler Wires	
Centre Wires	



Strand Construction

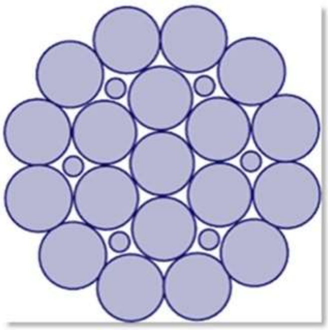
Seale Strand Construction

This is a parallel lay strand with the same number of wires in both layers.
In the example, the construction consists of 1 x centre wire, 9 x inner wires and 9 x outer wires.



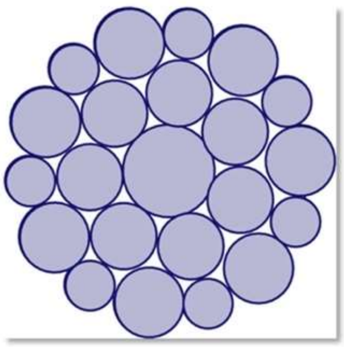
Filler Strand Construction

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, the construction consists of 1 x centre wire, 6 x inner wires, 6 x filler wires and 12 x outer wires.



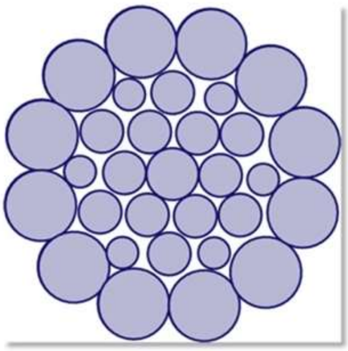
Warrington Strand Construction

A parallel lay strand having an outer layer containing alternately large and small wires.
In the example, the construction consists of 1 x centre wire, 7 x inner wires and 14 (7 large and 7 small) x outer wires.



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, the warrington-seale construction consists of 1 x centre wire, 6 x inner wires, 12 warrington wires and 12 x outer wires.

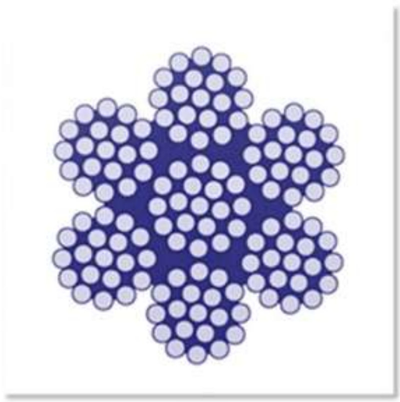


NOTES:

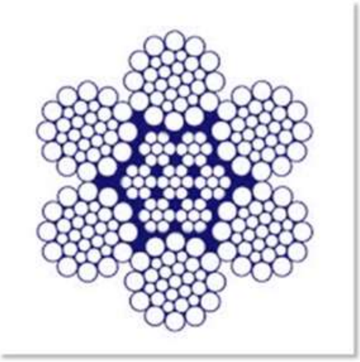
Wire Rope Cores

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

Wire Stranded Core (WSC)



Independent Wire Rope Core (WRC)



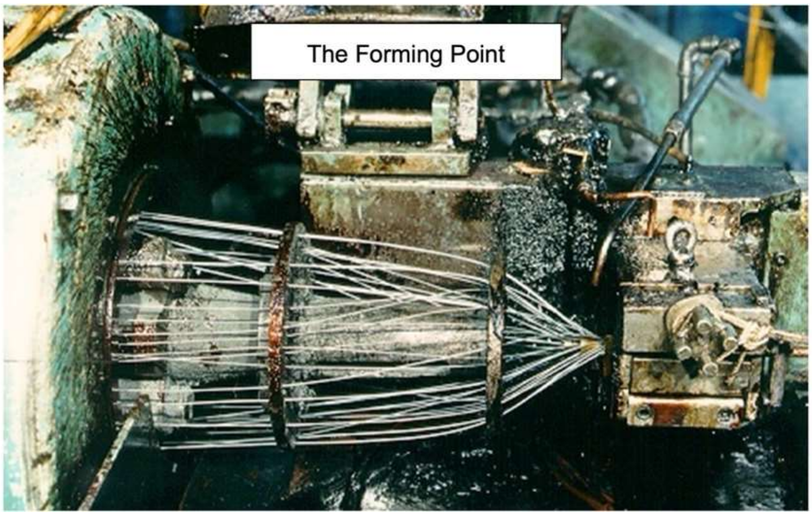
Wire Rope Grades

Wire Tensile Strength/Grade: the grade of the wire rope which is 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

Stranding

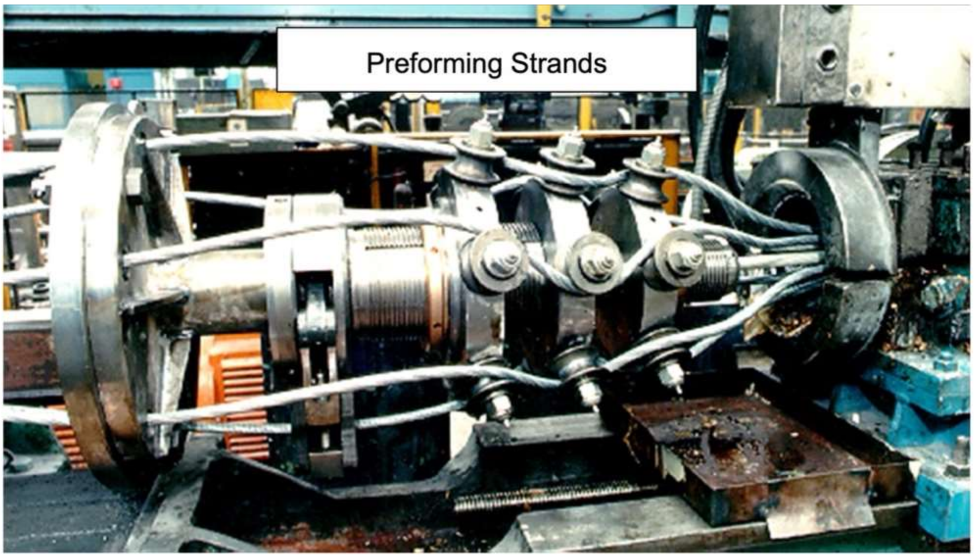
The stranding operation takes place when all the wires are brought together at the forming point. Note that the wires during this and the closing operation are spun into the correct helical shape, this process is called preforming. This reduces the internal stresses in the strands and the rope meaning 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. This results in a relatively inert (dead) rope with other benefits:

- Rope is more flexible and resistant to kinking
- Easy to handle so when such a rope is cut the wires will stay in position, the broken wires do not stick out making it less dangerous to the user



Rope Lay

Rope lay refers to how the wires are laid when forming the strands and how the strands are laid when forming the rope. There are 2 types of lay: ordinary (regular) lay and Lang's lay:

1. **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.

NOTES:

2. **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.

Both ordinary lay and Lang's lay ropes are usually supplied right-hand lay, but left-hand lay is available for special applications.

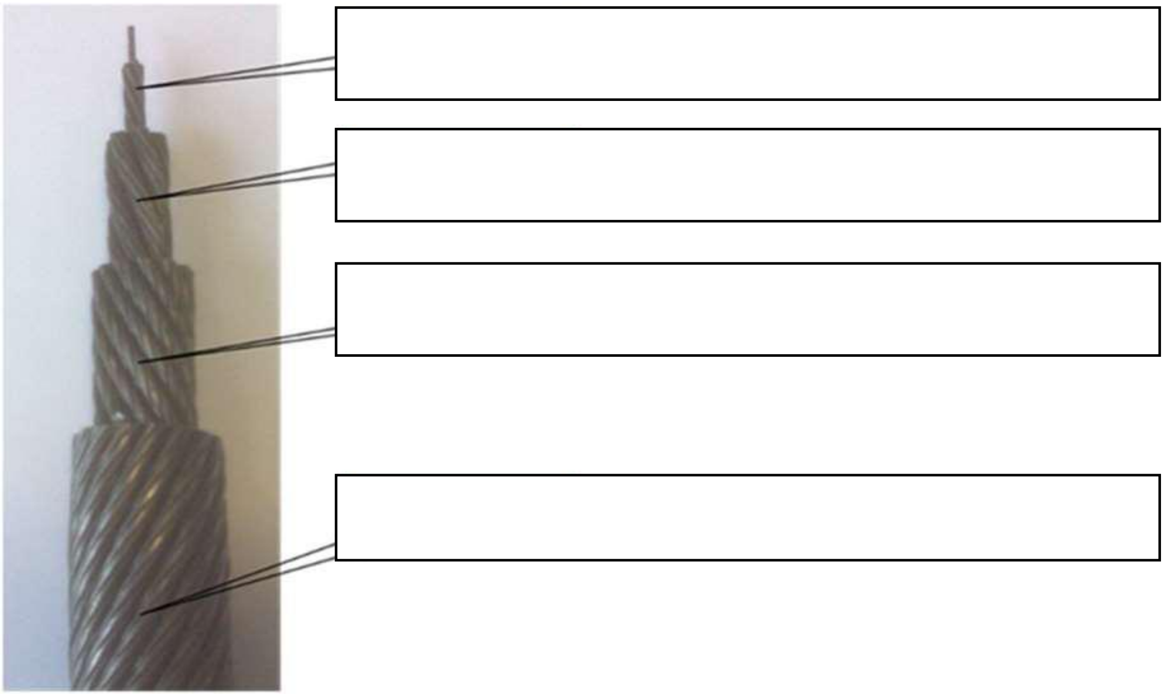
Advantages of Lang's lay	
Disadvantages of Lang's lay	

Both ordinary lay and Lang's lay rope are usually supplied right-hand lay, but left-hand lay is available for special applications.

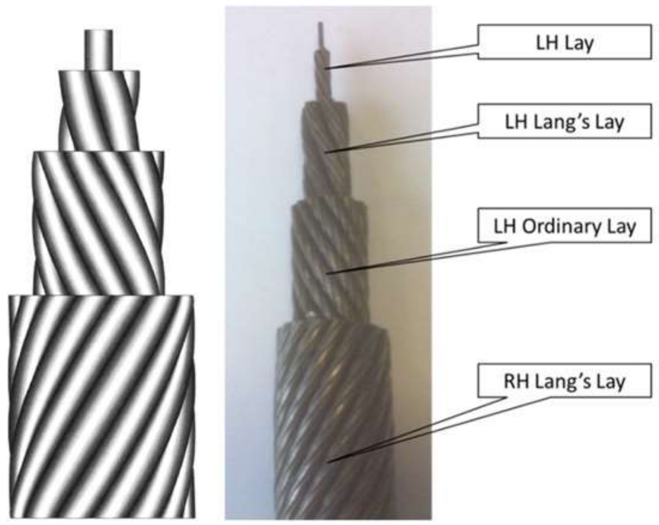
Low-rotating rope

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 strands laid in opposite directions.

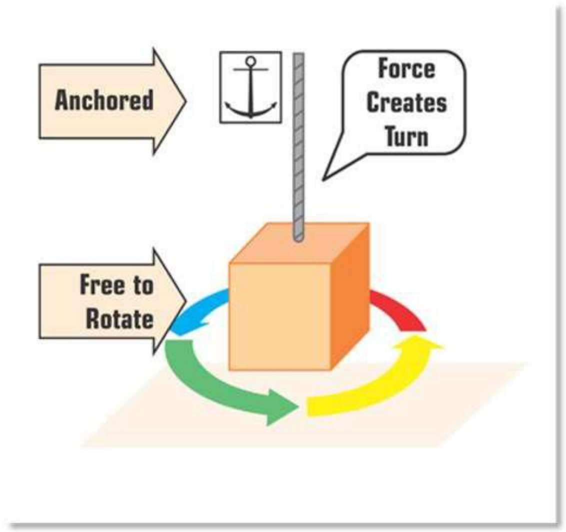
The most common type is the 17 x 7 (1-6), which has an outer layer of 11 strands laid over an inner layer of 6 strands, which in turn is laid over a core strand. The construction is 11 strands/6 strands/1 strand all 7 wires 1-6. The layers of strands are laid in opposing directions to prevent the rope from spinning under load.

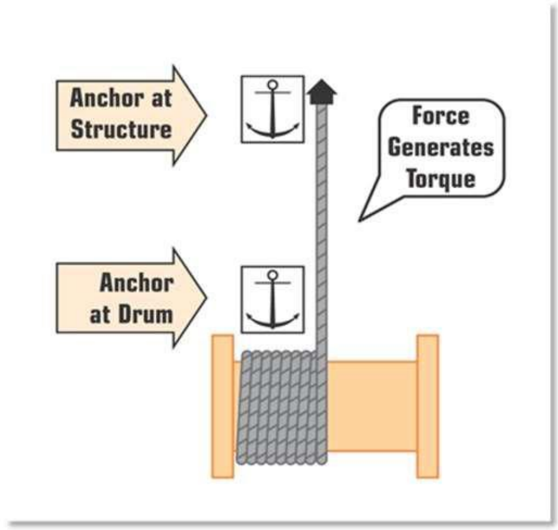


A more flexible version is the 34 x 7 (1-6), which is simply a 17 x 7 with an additional layer of seventeen strands laid around it. The construction is 17 strands/11 strands/6 strands/1 strand all 7 wire 1-6. The layers of strands are laid in opposing directions to prevent the rope from spinning under load.



Effects of Rope Rotation

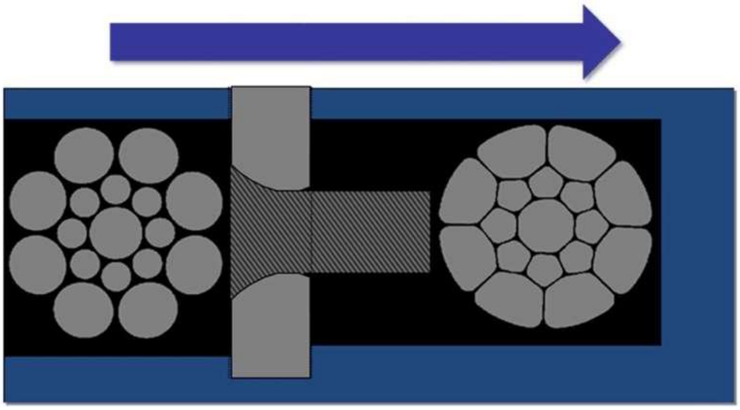




Compacted (Dyformed) rope (K designation)

The rope is fed through dyes that compress it around its circumference, reducing its overall diameter. This provides a compacted rope having the following benefits:

- Increased steel surface area
- Increase in strength
- Crush resistant
- Diameter stability
- Reduced stretch
- Smooth surface
- Increased fatigue life
- Lower contact pressures
- Accurate diameter
- Improved spooling - twin rope systems



Rope finish	• Typically, the symbol 'U' is used to denote an uncoated or bright finish • For zinc finishes the symbol will depend on the class of the coated finish • Class A zinc finish is designated 'A' • Class B zinc is designated 'B'

Wire Rope Periodic Inspection

Periodic Inspection
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 appliance and/or by the manufacturer of the rope; these criteria should never be exceeded.

When correctly applied, the discard criteria given in full in ISO 4309 are aimed at retaining an adequate safety margin. Failure to recognise them can be extremely harmful, dangerous and damaging.

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.

Safe operation of powered lifting machines incorporating wire rope depends, to a large extent, upon the level of detailed examination that is carried out by the Competent Person during the periodic inspection, not with-standing that daily operator checks by the user also have a significant bearing on the 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.

The aim of the periodic inspection is to determine whether the rope:

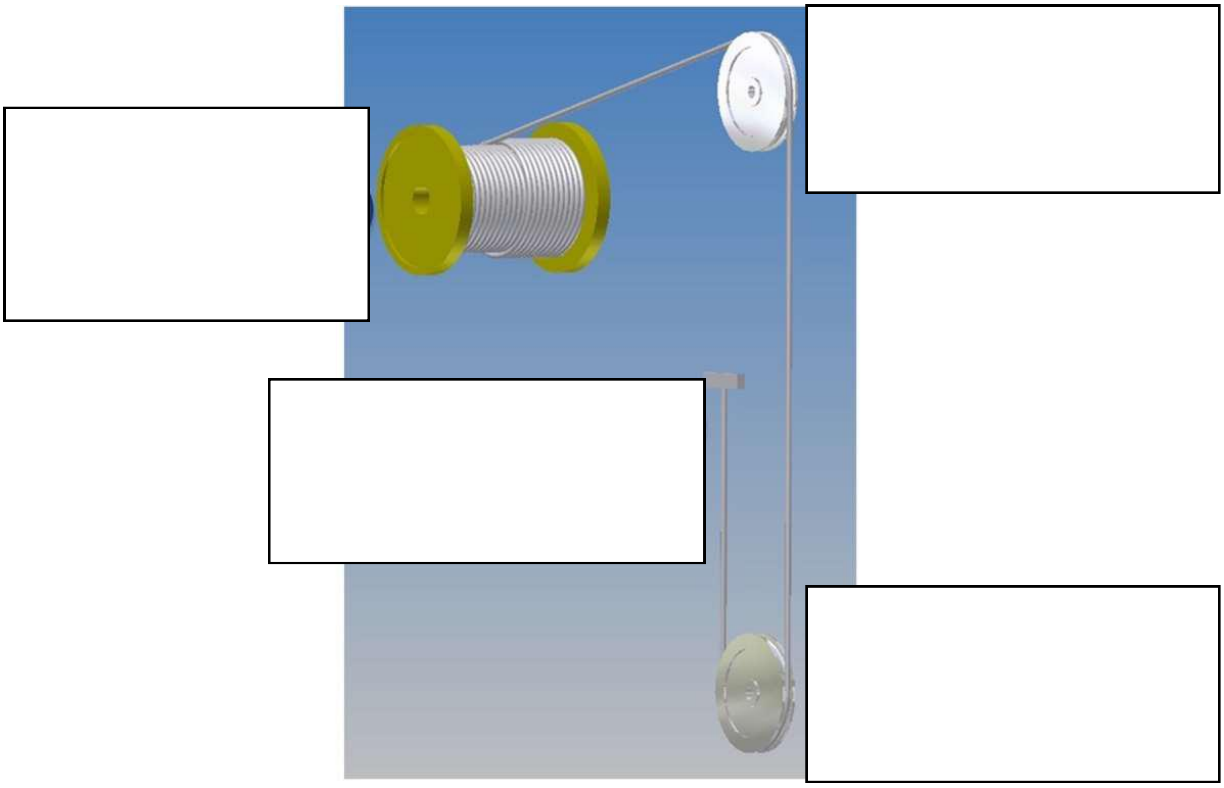
- Can safely remain in service and the latest time on which the next inspection is to be carried out
- Needs to be withdrawn immediately, or within a specified time

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

ISO 4309	In the absence of the original equipment manufacturer's criteria, ISO 4309 criteria may be used to determine the serviceability of the load rope fitted to a manual appliance. The relevant series of standards should be referred to for terminations in steel wire ropes.

The inspection 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
- Check entry of rope into detachable terminations such as wedge sockets for broken wires but also the correct orientation of the rope through the socket
- Rope within the area of a termination point, particularly where it enters the termination point, where it is typical to find broken wires
- 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
- Spooling/cross-over damage
- Slippage in ferrules (evidence of the rope pulling through the ferrule)



Inspection Frequency:

As we know, the periodic inspection for lifting appliances is each 12 months, or 6 months for any people carrying machines.

The Competent Person may however decide that more frequent inspections are required for certain appliances due to several factors, which may include:

1. Any specific national statutory requirements in the country of use
2. Type of hoist and environmental conditions
3. Classification group of the machine
4. Results of previous inspections
5. Experience of other similar types of hoist in similar use/conditions
6. How long the wire rope has been in service
7. How frequently the hoist is operated
8. Original manufacturer's recommendations

Inspection Record:

A record of each and every inspection should be made by the Competent Person.

ISO 4309 states that a running record of crane rope inspections is maintained. An example of this is available in the standard in Appendix E.

Notes from the Video:

<u>Video recap: Combined Effect Assessment</u>

As we have seen, there are several areas of the rope that need to be checked during the visual examination. There are many faults that may exist in a wire rope, and this is not limited to broken wires!
The examiner therefore needs to be aware of the many different defects that will affect a wire rope's performance and service life, which we will explore in this module.
It is important to note that a visual examination of a wire rope should produce a 'combined effect assessment', which takes into account all the deterioration that is identified.

Assessment from the Inspection

The extent and severity of deterioration are to be assessed and provided as a percentage **(%Severity Rating**) for example 20%, 40%, 60%, 80%, or 100%, for each individual type of discard criteria. This can be expressed in words as, 'slight', 'medium', 'high', 'very high' and 'discard'. This assessment can be drawn from different visual inspections and/or measurements, and Magnetic Rope Testing (MRT).

The **combined effect assessment** is an overall assessment of the condition of the wire rope. The examiner will record his findings using a report format similar to the one shown below:

<table>
<tr><th colspan="6">Crane Ref:</th><th colspan="6">Rope Application:</th></tr>
<tr><td colspan="12">ROPE DETAILS</td></tr>
<tr><td colspan="12">Brand name/manufacturer:</td></tr>
<tr><td colspan="12">Nominal diameter (mm):</td></tr>
<tr><td colspan="12">Construction:</td></tr>
<tr><td colspan="3">Core type:</td><td colspan="3">WSC</td><td colspan="3">IWRC</td><td colspan="3">FC</td></tr>
<tr><td colspan="6">Wire finish:</td><td colspan="3">Uncoated</td><td colspan="3">Galvanized /Zinc</td></tr>
<tr><td colspan="12">Direction and type of lay:</td></tr>
<tr><td colspan="8">Permissible number of broken outer wires in 6d:</td><td colspan="4">and 30d :</td></tr>
<tr><td colspan="12">Reference diameter (mm):</td></tr>
<tr><td colspan="12">Permissible decrease in diameter from reference diameter (mm):</td></tr>
<tr><td colspan="6">Date installed:</td><td colspan="6">Date Discarded:</td></tr>
<tr><td colspan="4">Visible broken outer wires (Visible broken outer wires)</td><td colspan="8"></td></tr>
<tr><td colspan="2">Number in length of</td><td colspan="2">Severity Rating</td><td colspan="3">Diameter</td><td>Corrosion</td><td colspan="2">Damage and/or deformation</td><td rowspan="2">Position in rope</td><td rowspan="2">Overall combined assessment rating at position</td></tr>
<tr><td>6d</td><td>30d</td><td>6d</td><td>30d</td><td>Measured Dia (mm)</td><td>Actual decrease ref (mm)</td><td>Severity Rating</td><td>Severity Rating</td><td>Severity Rating</td><td>Nature</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="12">Other observations and comments:</td></tr>
<tr><td colspan="12">Performance to date (cycles/hours/day/months etc.)</td></tr>
<tr><td colspan="12">Date of inspection:</td></tr>
<tr><td colspan="6">Name of competent person (PRINT):</td><td colspan="6">Signature:</td></tr>
</table>

Note that the examination record requires the examiner to enter a '% severity rating' in:

- The number of broken wires (6xd and 30xd)
- Decrease in diameter
- Corrosion
- Damage and/or deformation

The examiner then adds together the individual severity ratings and enters a total (combined) severity % in the end column. Note that this is for the deterioration that has occurred in the same location in the rope.
Alternatively, the examiner may consider all the deterioration factors and enter a degree of severity in words, as shown in the table below:

%	Definition
20	Slight
40	Medium
60	High
80	Very high
100	Discard

The overall objective is for the examiner to determine whether the rope is safe to continue in service. Where this is the case, the examiner may wish to choose a reduced period of time before the next examination takes place due to the current level of deterioration.
By way of example, the following table shows examples of combined effect assessments:

Example	*Severity rating of individual modes of deterioration*					Combined severity rating %	Comment
	Wire breaks		Decrease in diameter %	Corrosion			
	Visual	MRT LF		External	MRT LF		
1	0	N/A	20	20	N/A	40	Safe to continue in service
2	20	N/A	20	0	N/A	40	Safe to continue in service
3	20	N/A	20	20	N/A	60	Safe to continue in service
4	40	N/A	20	20	N/A	80	Examine more frequently
5	0	N/A	80	0	N/A	80	Consider discard if reduction in diameter is mainly due to external wear
6	60	N/A	0	0	N/A	60	Inspect (especially for broken wires) more frequently
7	60	N/A	20	0	N/A	60	Inspect (especially for broken wires) more frequently and prepare to replace the rope

Note: MRT (LF) is a 'local fault' or 'local flaw', such as a wire break, welded wire (from production) corrosion pitting or nicked (pinched) strands.

NOTES:

Deterioration

Modes of Deterioration

This table shows the common types of deterioration whether or not they can be either counted or measured or if visual or MRT inspection would be required for each type:

Mode of Deterioration	Assessment Method
No. of broken wires (including randomly distributed, localised groups, valley wire breaks and those that are at, or in the vicinity of the termination	By counting
Loss of metallic area caused by broken wires	Visual, MRT
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, MRT
Deformation	Visual and measurement (wave only)
Mechanical damage	Visual
Heat damage (including electric arcing)	Visual

?

What are other circumstances for an inspection to be carried out? (Select all that apply)

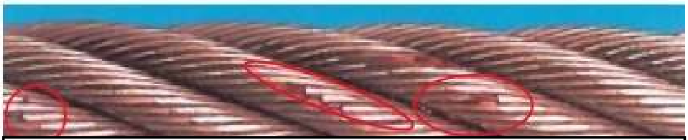
- ☐ Following an incident or exceptional circumstances such as a collision or overload
- ☐ After having lifted people
- ☐ When the ambient temperature is over 35°C
- ☐ If the appliance has been out of action for more than 3 months

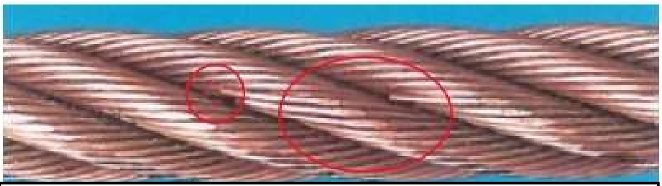
NOTES:

Magnetic Rope Testing (MRT)

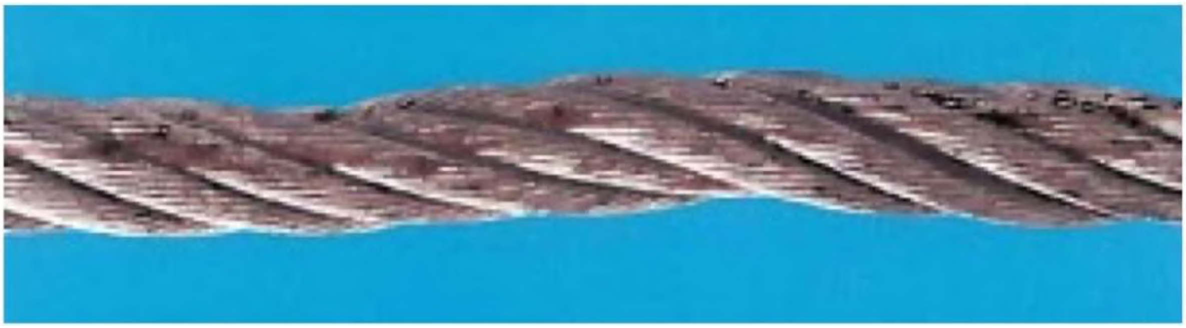
MRT, carried out by a qualified and competent person, may be used to supplement and assist the visual inspection.

ISO 4309 – Wire Rope Discard Criteria





Local reduction in diameter (general or localised)

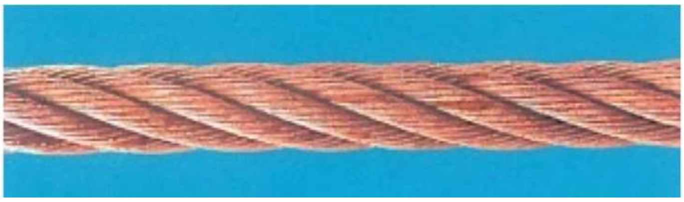


Reduction in Diameter – Possible Causation:

- External wear (contact with sheaves and drums or cross-over areas on multi-layer drums)
- Inadequate or incorrect lubrication, combined with dust and grit etc.
- Internal wear
- Wire indentation
- Wear internally – caused by friction between strands (mainly due to bending)
- Fibre core deterioration or Steel core fracture
- Fractured inner strand layers in rotation-resistant rope

MRT inspection would determine the exact cause of local reduction in diameter.

External corrosion

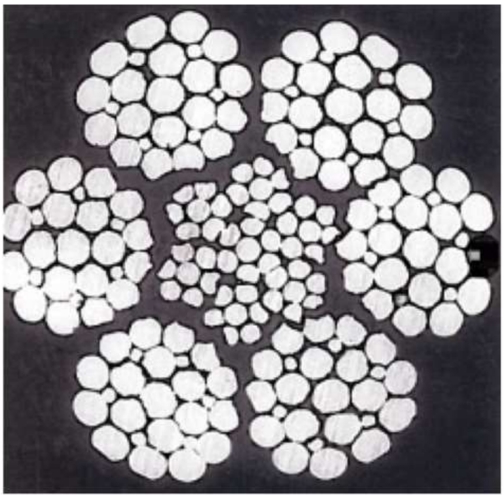


Wire rope corrosion is particularly problematic in the marine industry and also in polluted atmospheres. Corrosion reduces the cross-sectional area of the wires in the rope which can lead to fatigue as the irregular shape of the wires can then be subject to cracking under stress.

Heavy corrosion will have a negative effect on a rope's elasticity.

Galvanised rope should be considered for applications where corrosion is an issue.

Internal Corrosion

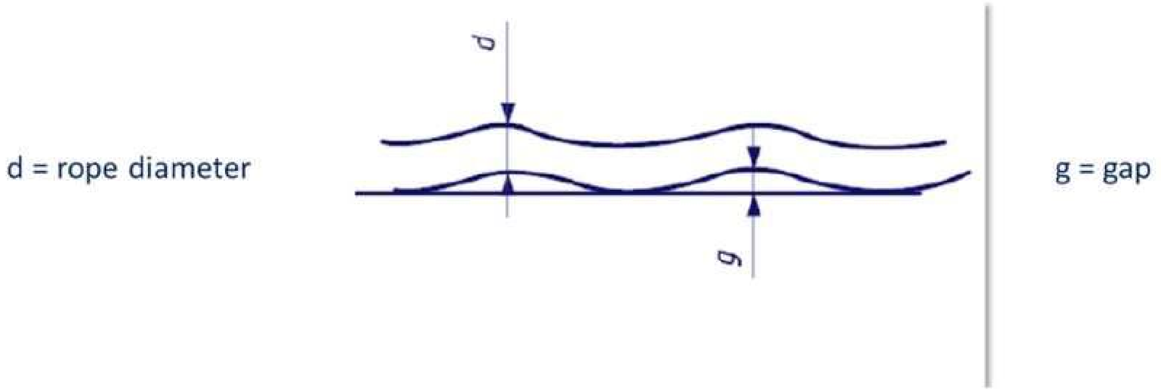


Waviness

Identifiable from a defined 'helix' shape in the longitudinal axis of the rope (along its length), in either a loaded or unloaded state. The helix shape can lead to abnormal stresses which lead to broken wires. Severe waviness can have an adverse effect on other components in contact with it, such as sheaves and rope guides. It is recommended to check that the sheave and drum diameter is large enough for the rope.

The rope shall be discarded if, under any condition, either of the following conditions exists (see image below):

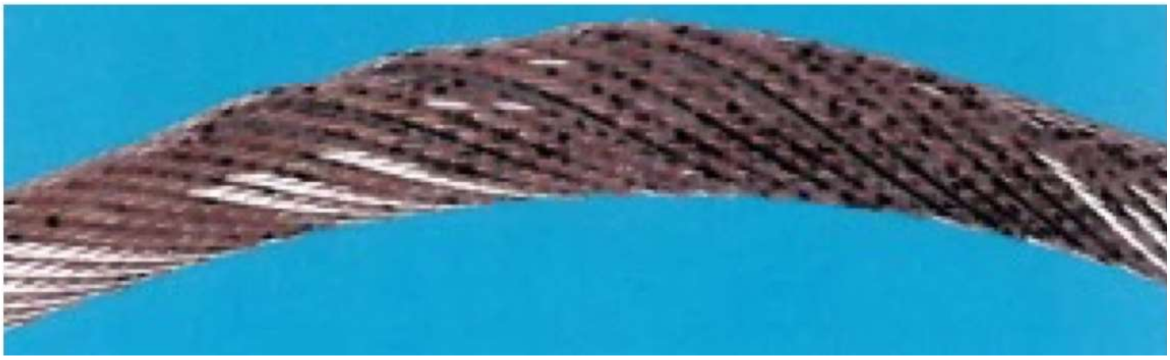
1. On a straight portion of the rope, which never runs through or around a sheave or spools onto the drum, the gap between a straight edge and the underside of the helix is 1/3 x d or greater
2. On a portion of the rope, which runs through a sheave or spools onto the drum, the gap between a straight edge and the underside of the helix is 1/10 × d or greater



Basket Deformation

Sometimes referred to as ‘birdcaging’.

This is representative of a difference in length between the outer strands of the rope and its core. Causation can be high fleet angles and running in tight sheaves.
Opening of strands in Rotation Resistant ropes - in extreme circumstances the rope may develop a "birdcage distortion" or protrusion of inner strands.



Note: Rotation Resistant

Rotation resistant ropes are designed with a specific strand gap which may be apparent on delivery in an off tension condition. These gaps will close under load and will have no effect on the operational performance of the rope.

Core protusion (single layer ropes)

Indicative of repetitive shock-loading.

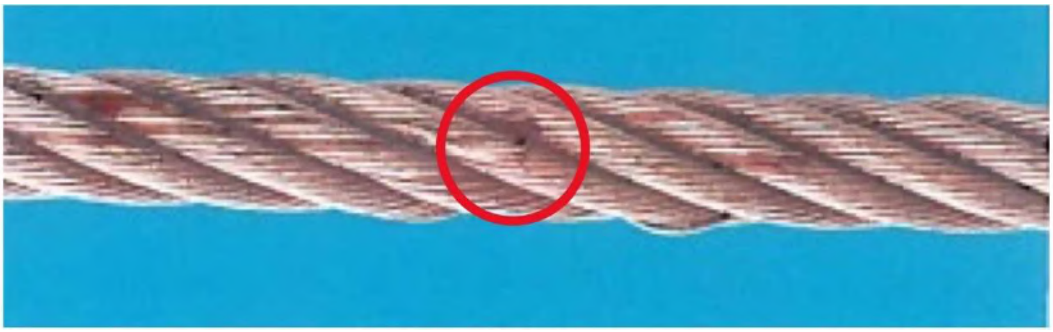
Protrusion of inner rope in a rotation-resistant rope

This is likely to be caused by induced turning (twisting) of the rope along its axis.

Strand protrusion/distortion

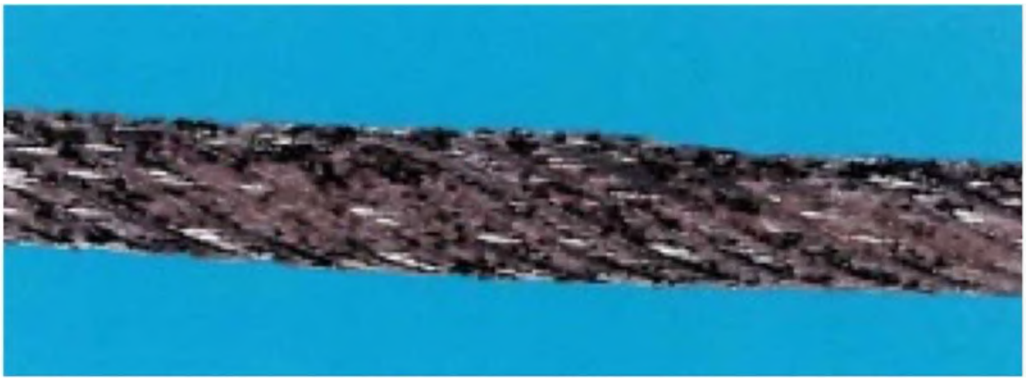
Sometimes referred to as 'basket' or 'lantern' deformation.

Wire protrusion



Individual wires or groups of wires stand out from the rope in loops. This is commonly at the opposite side of the rope to the side which is in contact with sheaves.

Local increase in rope diameter due to core distortion



Can be caused by the degradation of the rope's core. Eg. When a fibre core is subjected to excessive moisture, or the build-up of corrosion debris in a steel core wire rope.

Flattened portion

Normally caused by continual running through sheaves. Particular attention should be given to broken wires in these areas which may even damage the sheave(s).

Kinks (Positive and Negative)

Positive

Negative

Kink

Kinks and tightened loops are cause for immediate discard.

Heat or electric arcing damage	Can be shown by a 'blueing' of the steel in the area affected. MRT is the preferred method for further investigation.
Mechanical damage	Usually caused by the rope coming into contact with the structure of the crane on which it fitted or an external structure/load.
Decreased rope elasticity	This is often caused by: • A decreased rope diameter • Elongated ropes • Insufficient clearance between strands and wires A decrease in elasticity is normally identified by fine powder coming from the valleys of the rope (known as fretting corrosion) and a notable stiffening of the rope as it is being handled.
Deterioration	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. It is therefore the reason why the allowable number of visible broken wires for a rotation-resistant rope is less than allowable in a single-layer rope.

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

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 must consider these individual factors, recognising the particular criteria.

Note 1: One line of broken wires - ____

____

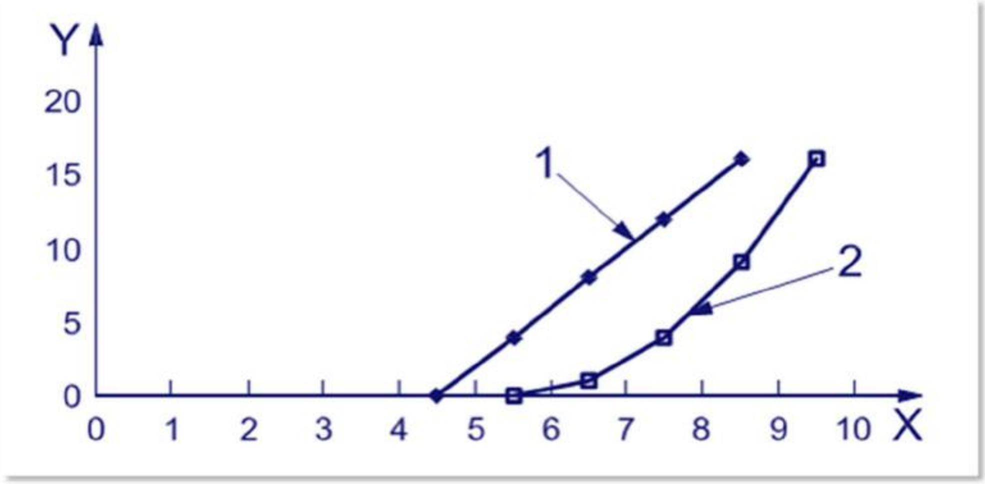
____

Note 2: Fatigue breaks – ____

____

____

IMPORTANT!
Wire ropes are known to increase the rate of broken wires the longer they are in service.

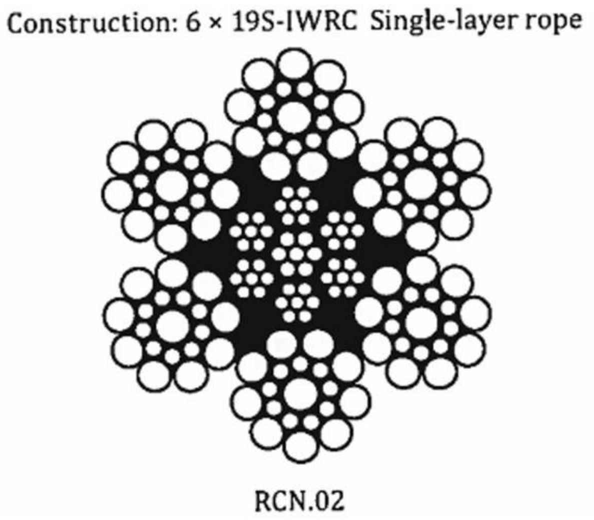


Key:

X = time (in cycles)

Y = number of randomly distributed broken wires per unit length

Multi-Layer Drum Spooling	Powered lifting machines utilising a multi-layer rope drum where the rope is spooling on top of itself, layer after layer tend to suffer from broken wires and deformation where the ropes cross each other. These areas should be the main focus of attention for the examiner.
Valley Wire Breaks	The examiner should pay particular attention to broken wires in the valley of a wire rope as these could indicate that internal rope deterioration, particularly in smaller diameter ropes. Such breaks can be exposed by flexing the rope from its natural position under no tension. **IMPORTANT:** If 2 or more valley breaks are discovered in one lay length, it is likely that the core is no longer supporting the outer strands. An MRT inspection would be able to confirm this. BS ISO 4309 details the discard criteria for the allowable number of broken wires, depending upon the ‘***Rope Category Number’*** of the rope (RCN). Before determining the discard criteria for load ropes under BS ISO 4309ns, it is necessary to identify the ropes RCN. By way of example, we are going to look at an RCN 02:



Viewing the example from ISO 4309 above, we can see that it is an ordinary-lay rope, categorised as an RCN 02 (single-layer or parallel-closed rope).
The extract from Table 3 in ISO 4309 below shows that an RCN 02 rope of this construction may have a maximum of 3 broken wires over a length of 6 x its diameter, or 6 broken wires over a length of 30 x its diameter, fitted to an electric wire rope hoist, M3 duty, using a single-layer drum.

Rope category number (RCN) (see Annex H)	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) Classes M1 to M4 (ISO 4301-1:1986) or class unknown[d]				Sections of rope spooling on a multi-layer drum[c] 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	$n \leq 50$	2	4	1	2	4	8
02	$51 \leq n \leq 75$	3	6	2	3	6	12
03	$76 \leq n \leq 100$	4	8	2	4	8	16
04	$101 \leq n \leq 120$	5	10	2	5	10	20

Important note 1 – Seale construction ropes with less than 19 wires in each strand:	In the example provided above (RCN 02 rope), you may have noticed that the illustration represents a Seale construction rope. The total number of load-bearing outer wires in the outer layer of strands in this rope equals 6 x 19, = 114, therefore ordinarily it would be classed as an RCN 04 in the table above, having between 101 and 120 outer load-bearing wires. However, ISO 4309 states that for Seale construction rope where the number of wires in each strand is 19 or less, they are placed in the table (shown above) 2 places higher than where they would normally be placed for the total number of outer wires, hence it is moved from RCN 04 to RCN 02.
Important note 2 - M5 to M8 duty classification:	Ropes fitted to machinery having a duty classification of M5 to M8 may have twice the number of broken wires listed in the ISO 4309 tables.

Rope Category Number

If the RCN number of the load rope cannot be found in annex H of 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 H)	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) Classes M1 to M4 (ISO 4301-1:1986) or class unknown[d]				Sections of rope spooling on a multi-layer drum[c] 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	$n \leq 50$	2	4	1	2	4	8
02	$51 \leq n \leq 75$	3	6	2	3	6	12
03	$76 \leq n \leq 100$	4	8	2	4	8	16
04	$101 \leq n \leq 120$	5	10	2	5	10	20

NOTES:

Uniform decrease in diameter

For wire ropes that are fitted to a single-layer rope drum, ISO 4309 provides guidance to the examiner in the form of suggested % severity rating and discard criteria.
The figures in the table below are derived from a calculation which determines the amount of decrease in diameter from the nominal diameter of the rope:

$[(d_{ref}-d_m)/d] \times 100\ (\%)$

Or simply:

$$\frac{\text{Reference diameter} - \text{measured diameter}}{\text{Nominal diameter}} \times 100\ \%$$

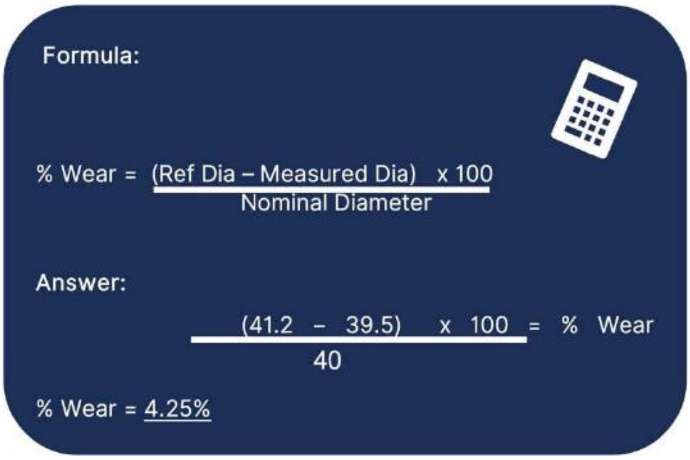
Rope type	Uniform decrease in diameter (% of nominal diameter)	Severity rating	
		Description	%
Single layer with fibre core	Less than 6%	N/A	0
	6% and over but less than 7%	Slight	20
	7% and over but less than 8%	Medium	40
	8% and over but less than 9%	High	60
	9% and over but less than 10%	Very high	80
	10% and over	DISCARD	100
Single layer with steel core or parallel closed	Less than 3.5%	N/A	0
	3.5% and over but less than 4.5%	Slight	20
	4.5% and over but less than 5.5%	Medium	40
	5.5% and over but less than 6.5%	High	60
	6.5% and over but less than 7.5%	Very high	80
	7.5% and over	DISCARD	100
Rotation-resistant	Less than 1%	N/A	0
	1% and over but less than 2%	Slight	20
	2% and over but less than 3%	Medium	40
	3% and over but less than 4%	High	60
	4% and over but less than 5%	Very high	80
	5% and over	DISCARD	100

NOTES:

Example 1:

For a 40mm diameter 6 x 36-IWRC rope having a reference diameter of 41.2mm and measuring 39.5mm at inspection, the percent decrease is equal to?

See formula below.

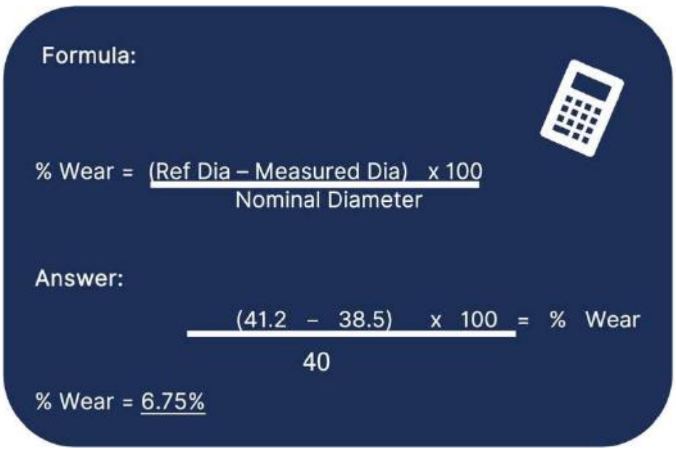


Key Notes:

- From the table above, the severity rating for uniform decrease in diameter is 20% towards discard (i.e. slight)
- Discard is reached when the rope decreases from reference diameter by an amount equivalent to 7.5% of nominal diameter, i.e. 3mm. In this case, diameter at discard would be 38.2mm

Example 2:

For a 40mm diameter 6 x 36-IWRC rope having a reference diameter of 41.2mm and measuring 38.5mm at inspection, the percent decrease is equal to?



NOTE: From the table above, the severity rating is 80% (i.e. very high).

Brakes

Types of Brake

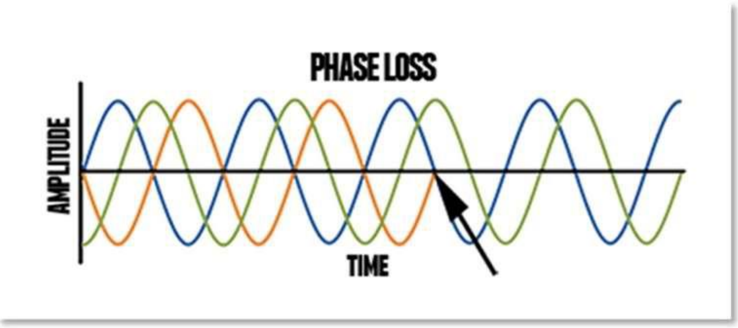
Hoist Brakes

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 movement 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:

- ____
  ____
- ____
  ____
- ____
  ____
- ____
  ____

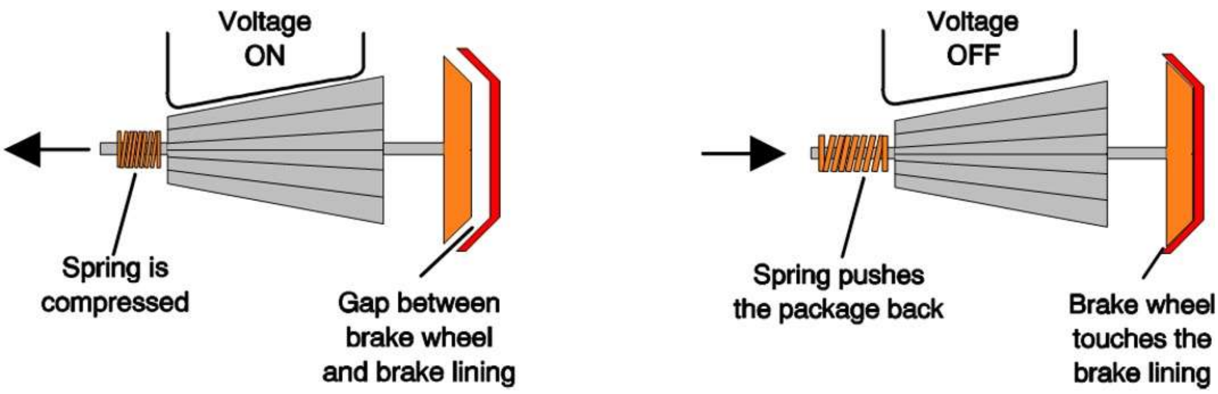
In addition, in the case of 3-phase motors, brakes must engage when two phases of the power supply to the drive (motor) are interrupted.

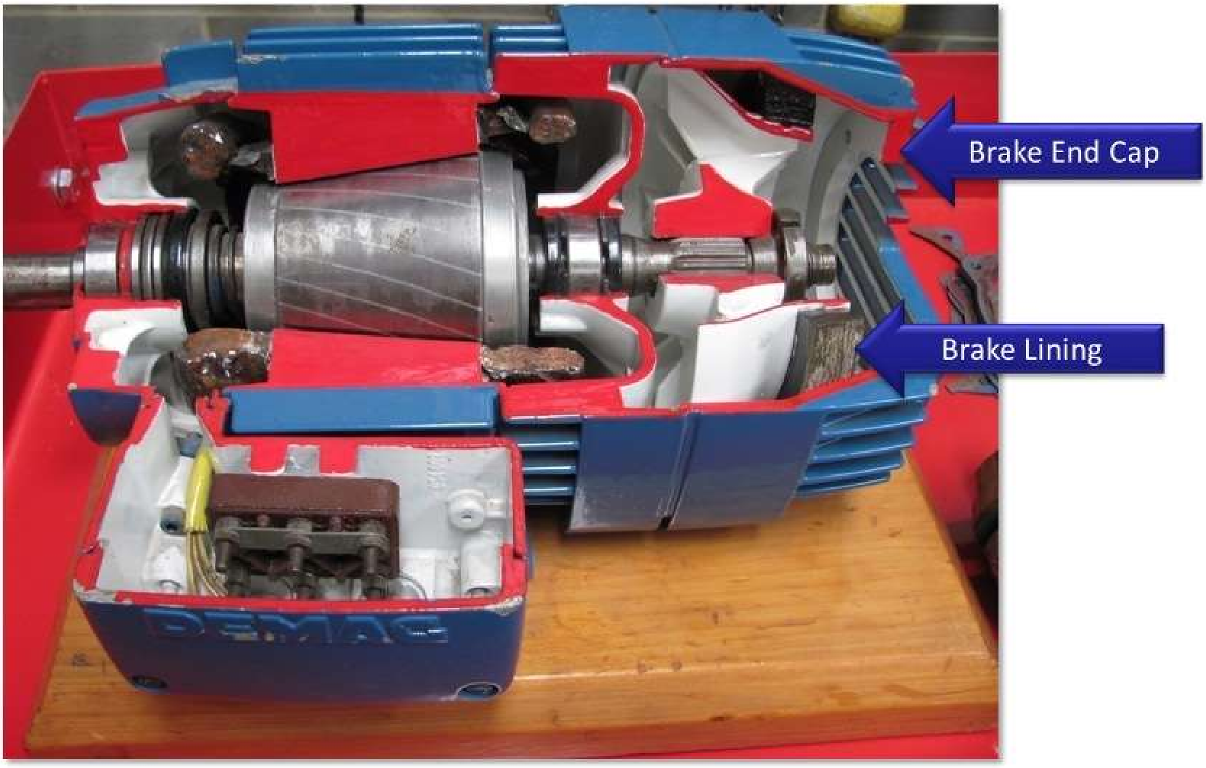


Failure of Power Supply
Electric hoists shall incorporate features so that: • The load cannot lower in an uncontrolled manner if a phase should fail • The load cannot drop if a phase should fail When one phase of a three-phase system is lost, a phase loss occurs. This is also called 'single phasing'. 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.

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.

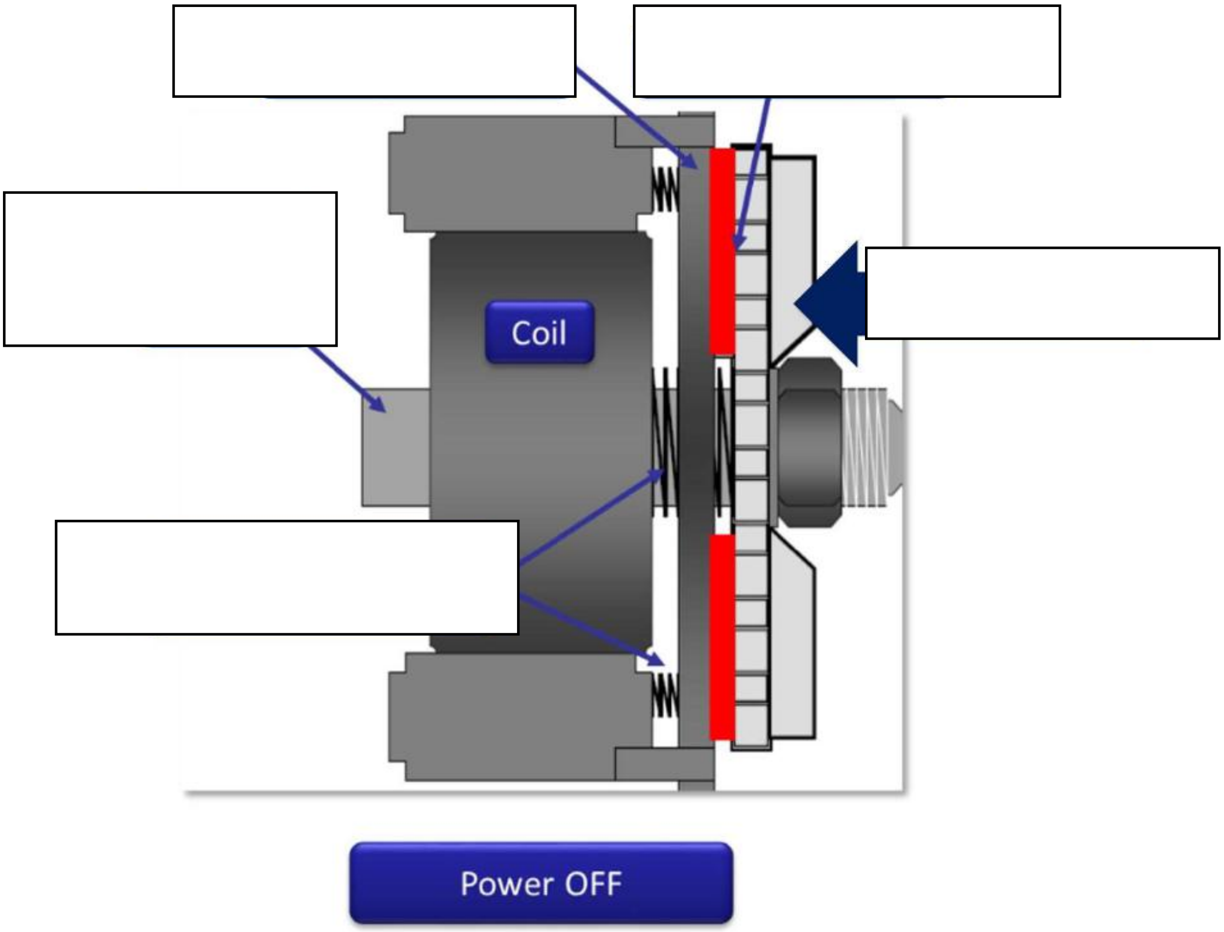




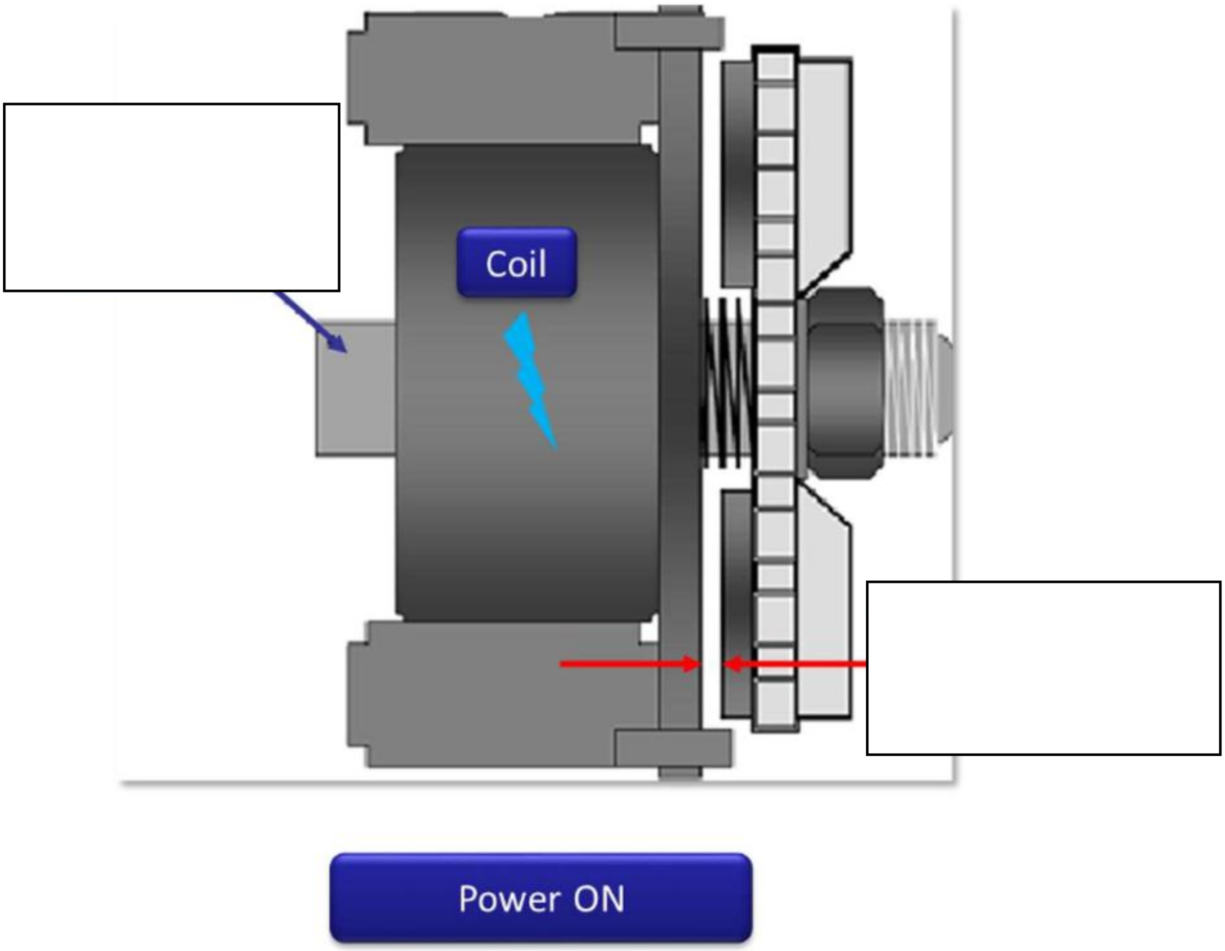
The air gap should be checked by competent personnel to ensure that it meets the requirements of the manufacturer to ensure effective use.

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.

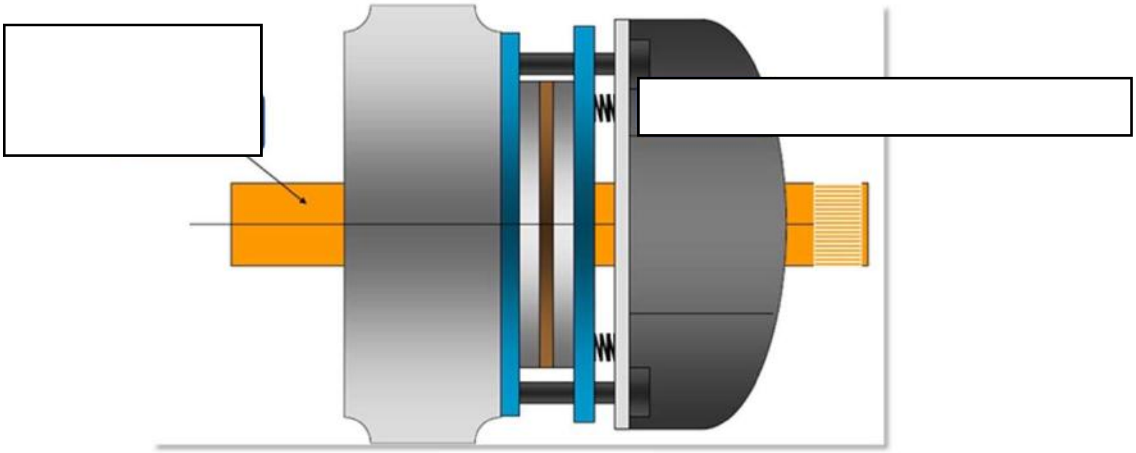


The brake shown is in the power ON / brake OFF position with the coil energised and pulling the armature plate against it. This allows the brake rotor to turn as the motor is powered. The air gap is clearly shown between the brake rotor and the coil. The gap should be checked by competent personnel to ensure that it meets the requirements of the manufacturer to ensure effective use.



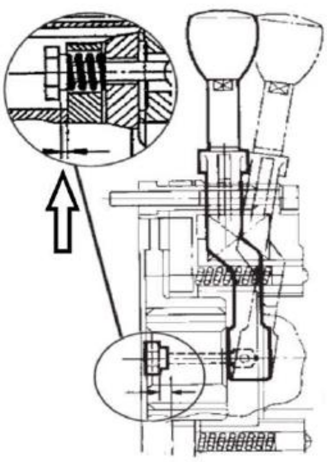
DC Electromagnetic Disk Brake

- 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
    - The image below shows the brake in its de-energised state with the coil springs pressing the armature plate onto the brake rotor which locks the motor drive shaft in position so that it is unable to turn. This is a 'power off – brake on' state

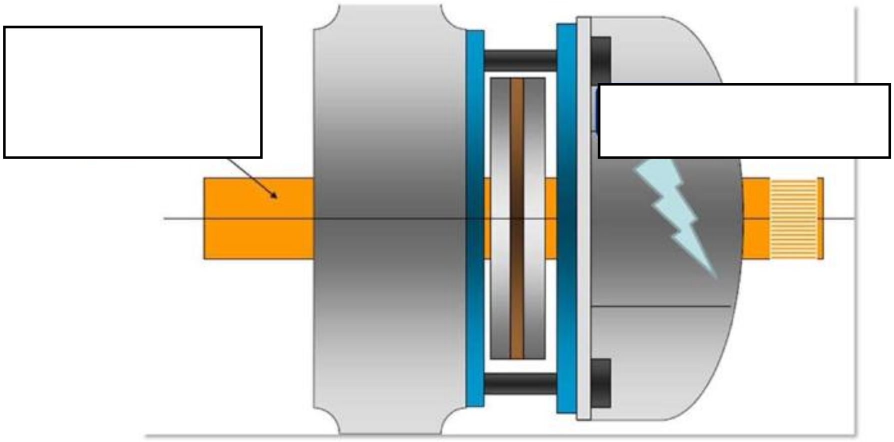


POWER OFF

- 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 lever (shown below) allows the brake to be manually released with power to the machine switched off, resulting in a controlled descent of the load



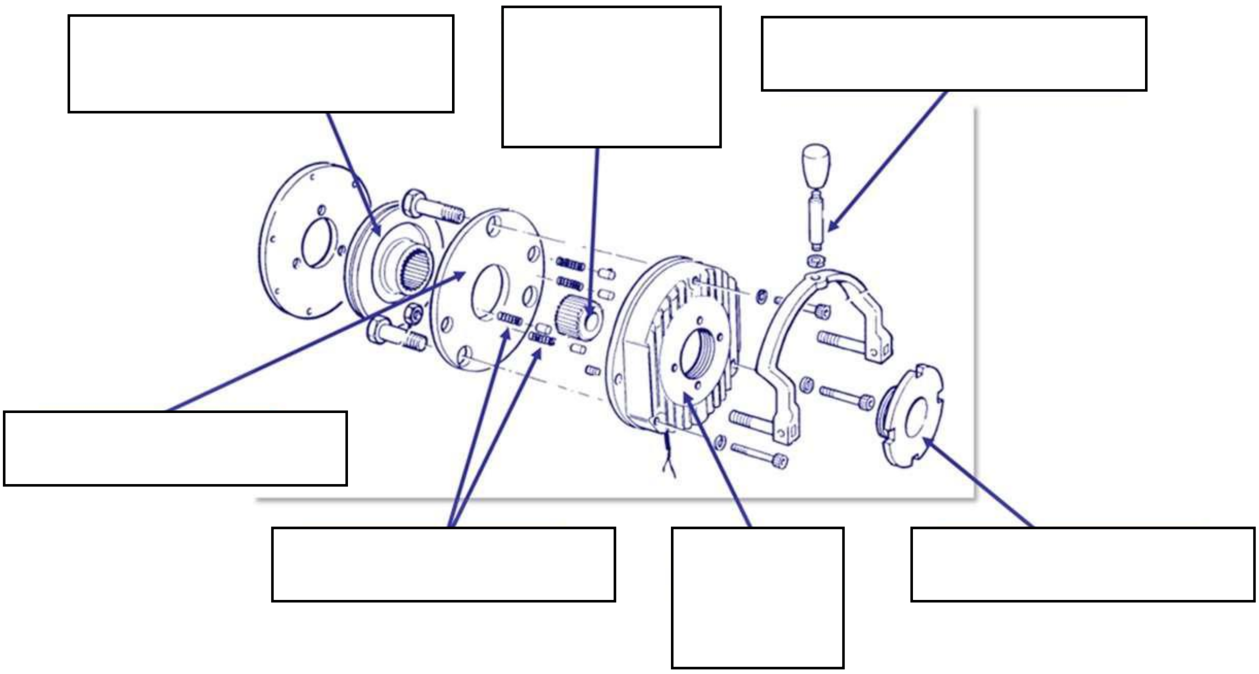
As we looked at in the 'parallel-rotor' brake, when power is supplied to the hoist motor this is also fed to the brake coil which energises and pulls the armature plate back to it, allowing the brake rotor (connected to the drive shaft by splines) to turn on the motor drive shaft.



POWER ON

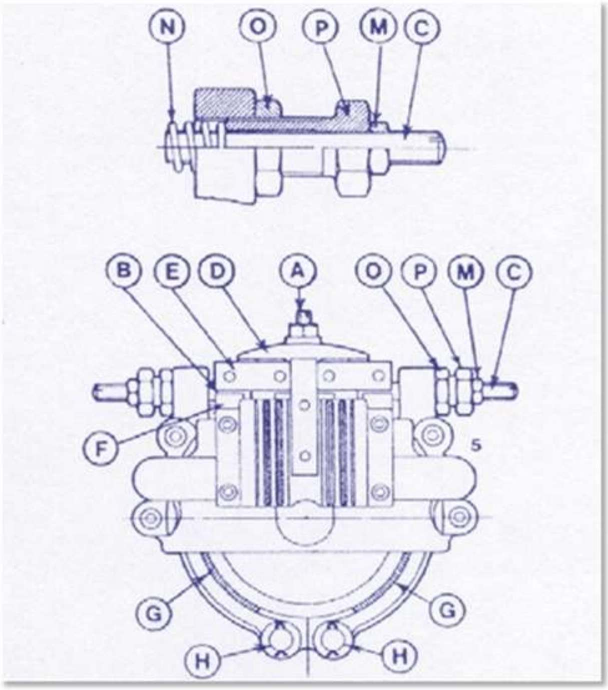
Breakdown of Components

The air gap should be checked by competent personnel to ensure that it meets the requirements of the manufacturer to ensure effective use.



Travel Brakes

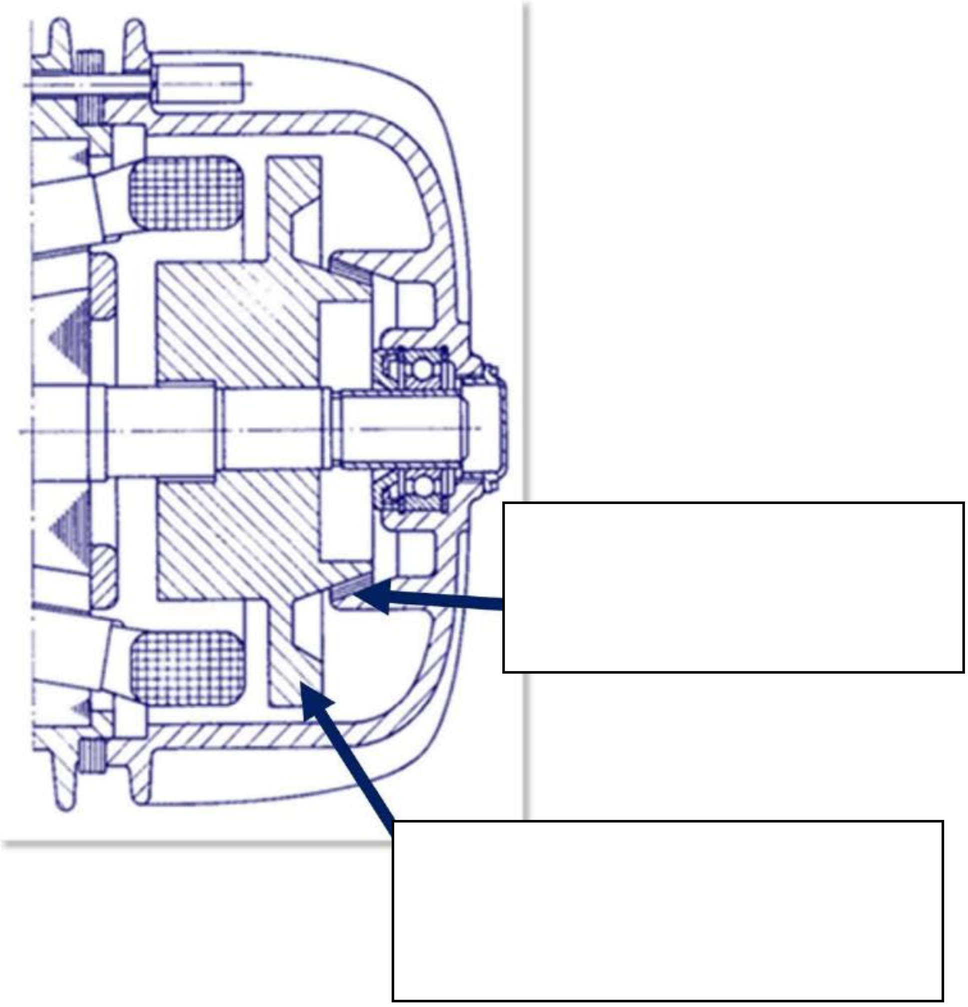
Travel brakes may be either the disc or the drum type but in both cases their characteristics need to be a lot different to a hoist brake.
Braking characteristics have to be finely tuned in order to avoid excessive braking under no load conditions and providing reasonable braking when travelling with a maximum load
The "clapper" brake was fitted to older cranes, providing soft braking characteristics, ease of adjustment and reliability in service.



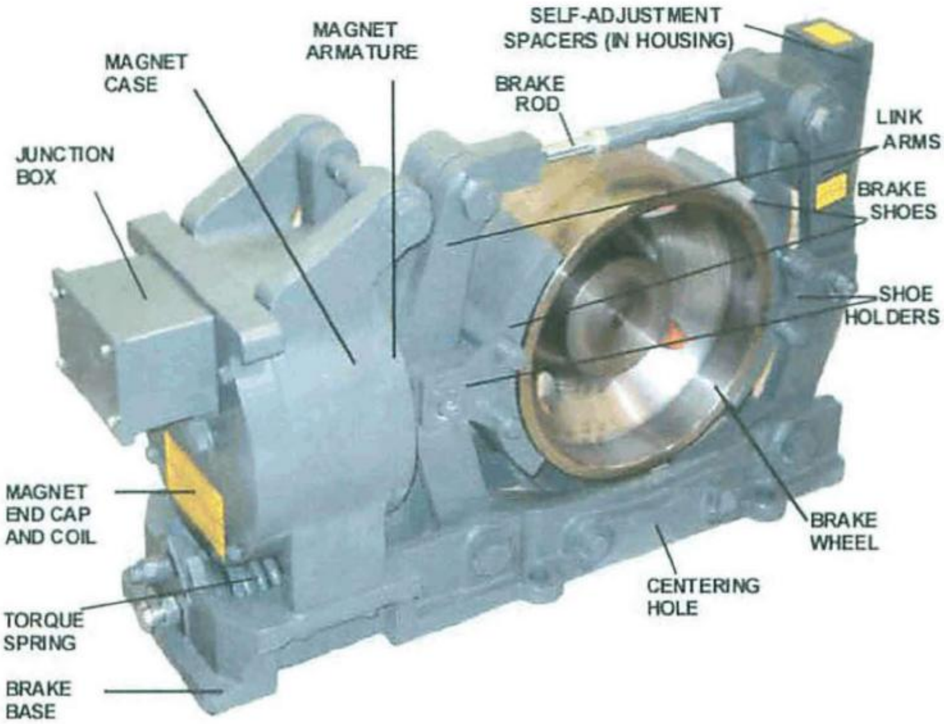
Disc Travel Brake

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

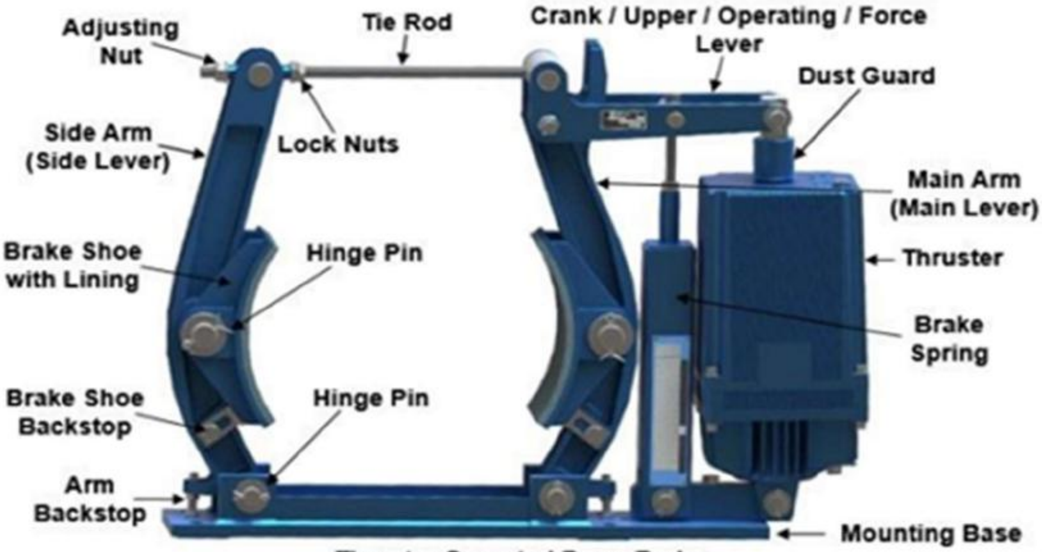


Heavy Duty Brakes	▪ These are designed to slow down the movement of the load and place it accurately in the required position ▪ When the braking force is applied to the brake shoes via a pre-set compression/torque spring, the shoes press on the rotating brake drum retarding its speed and finally stopping it ○ The releasing of the brake drum and compressing of the spring is done by the thruster/coil pack ▪ Used for heavy duty applications ▪ Electro-hydraulic (thrustor) is available and positive action magnetic coil/solenoid brakes are also commonly, where energising the coil pack/solenoid releases the torque levers from the brake linings and allows the brake hub to spin on the motor drive shaft



- 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



Thruster Operated Drum Brake

- Mounting / Base: ____

____

- Brake Shoe and Lining: ____

____

- Rods / Levers:____

____

- Brake Spring: ____

____

____

____

Operation (electro-hydraulic thrustor)

The braking pressure to the brake pads 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 pads is by the 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.

NOTES:

Types of Chain Hoists

Electric Chain Hoists

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 fatigued for operatives, particularly on long lifts
- Operatives may be remote/away from the load

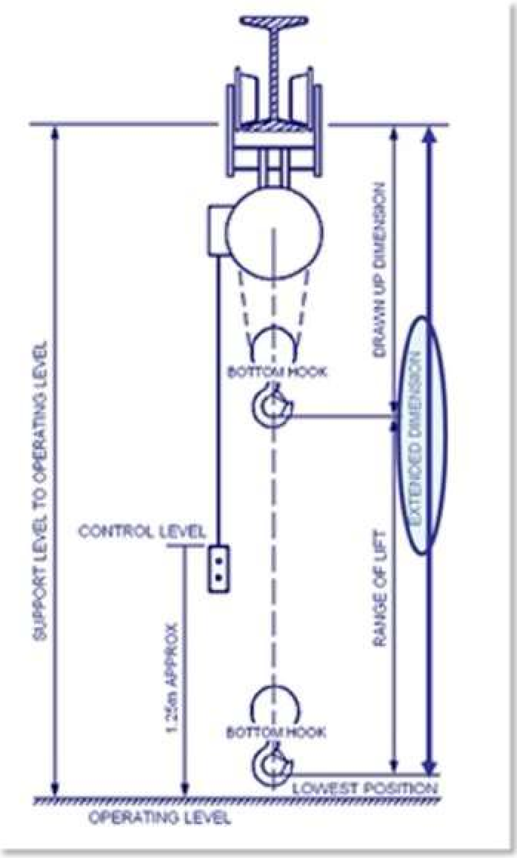
Most manufacturers and suppliers offer a range of accessories such as power feed systems, slack chain collecting boxes, weatherproof covers and remote control units.

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 below:

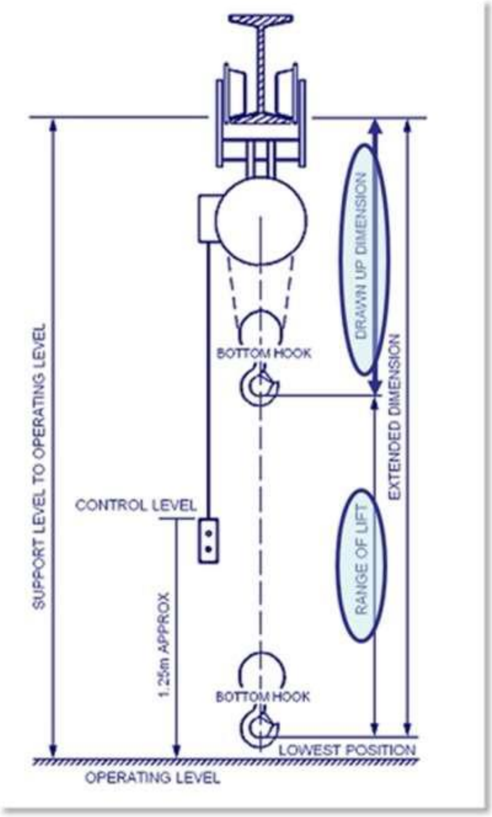


Drawn up Dimension

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 in which the bottom hook travels between the extended and drawn-up positions.

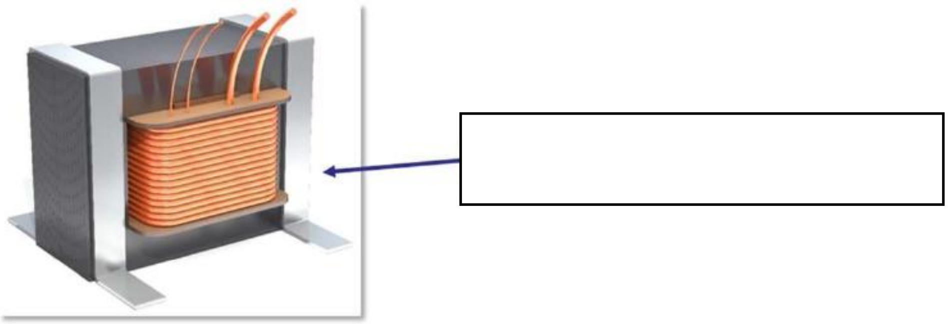


Electrical Supply

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 the 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.

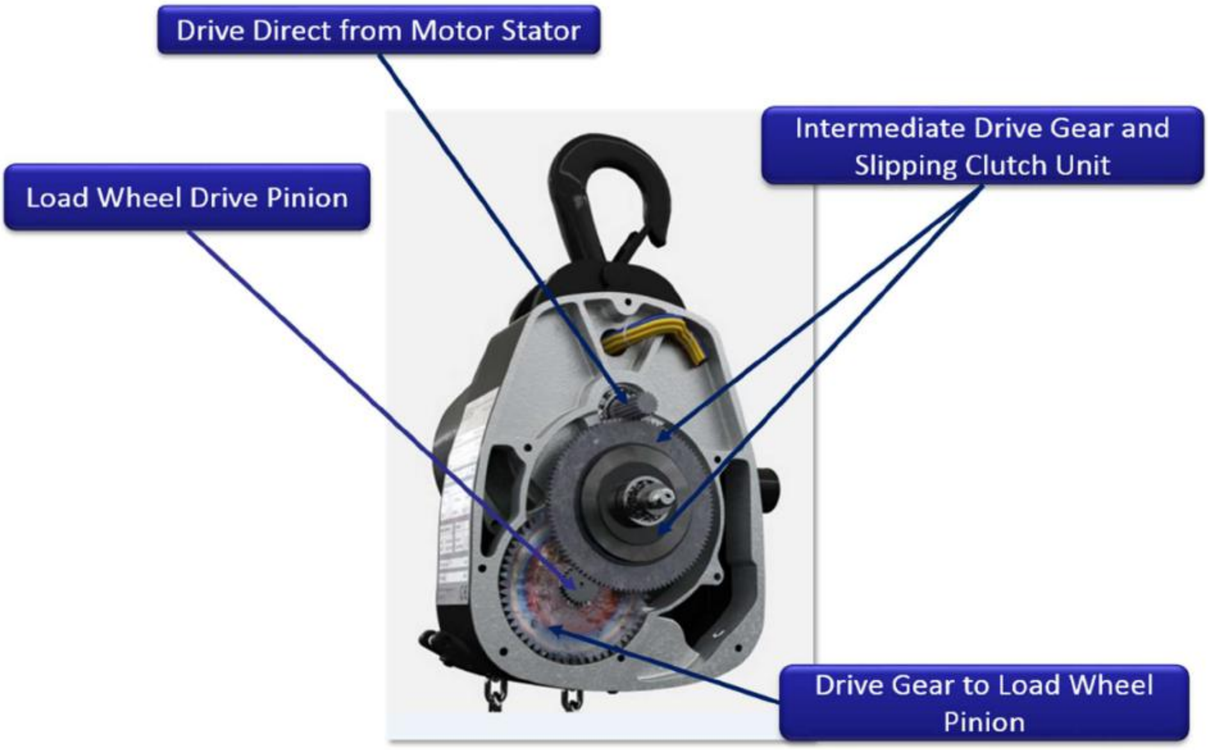


General Operation

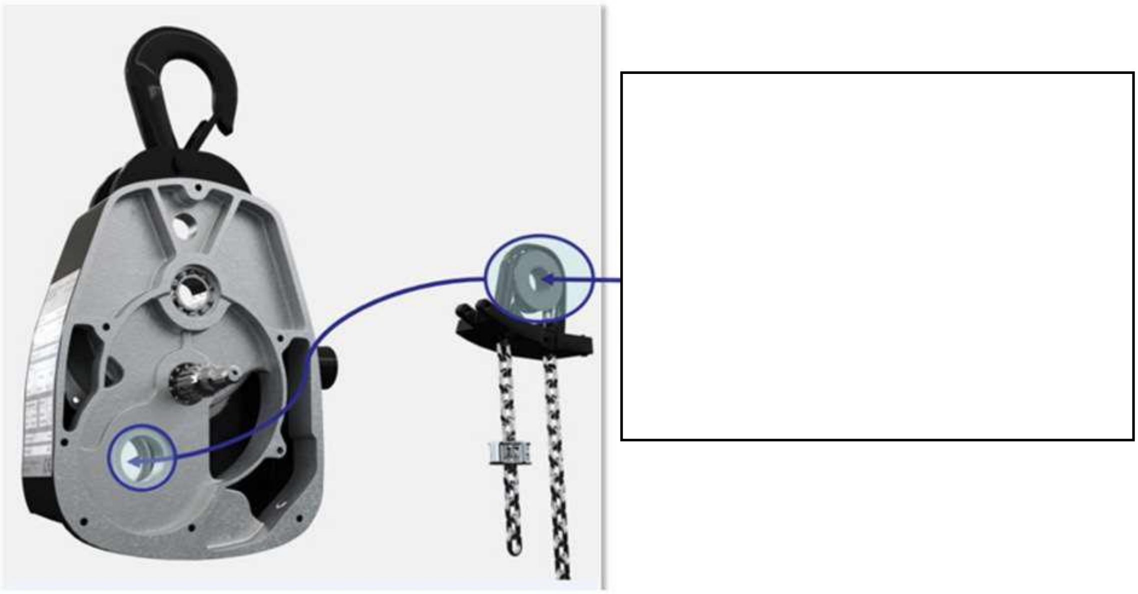
The electric chain hoist, similar to the wire rope hoist, has become a much more compact unit with the passage of time. Although safety is of paramount importance cost has obviously played a major part in this development.
An older type hoist which is still found in service is shown below. Whilst the configuration is different to that of a modern hoist, the general operating principles are similar.
In the model shown below, upper and lower limit protection is only provided by means of a slipping clutch:

NOTES:

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

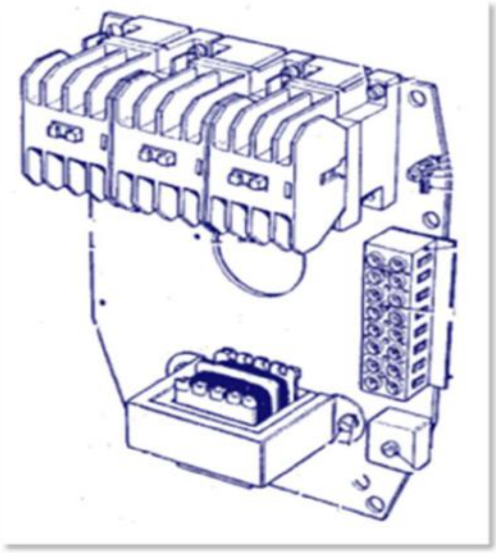


Removing the load wheel and chain guide assembly, it is easy to see how the load wheel is driven by the splined drive shaft from the gearbox.



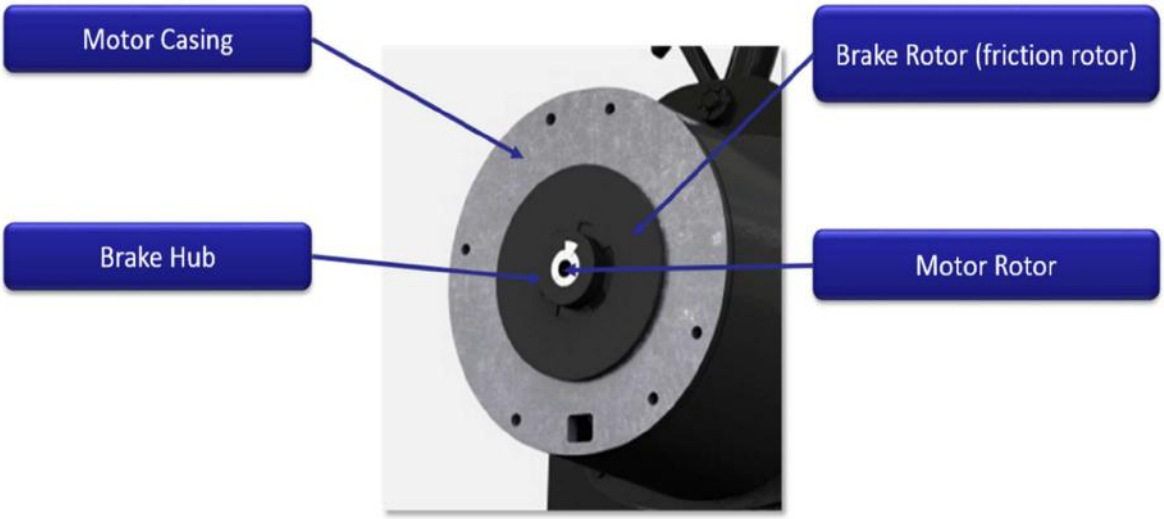
The hoist brake is located on the back of the motor. The brake hub which drives the brake rotor (a rotor with friction linings embossed onto both faces) is keyed onto the motor rotor shaft. Power to the DC electromagnetic brake is provided by cables from the control panel which is mounted to the gearbox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

Hoist Brake

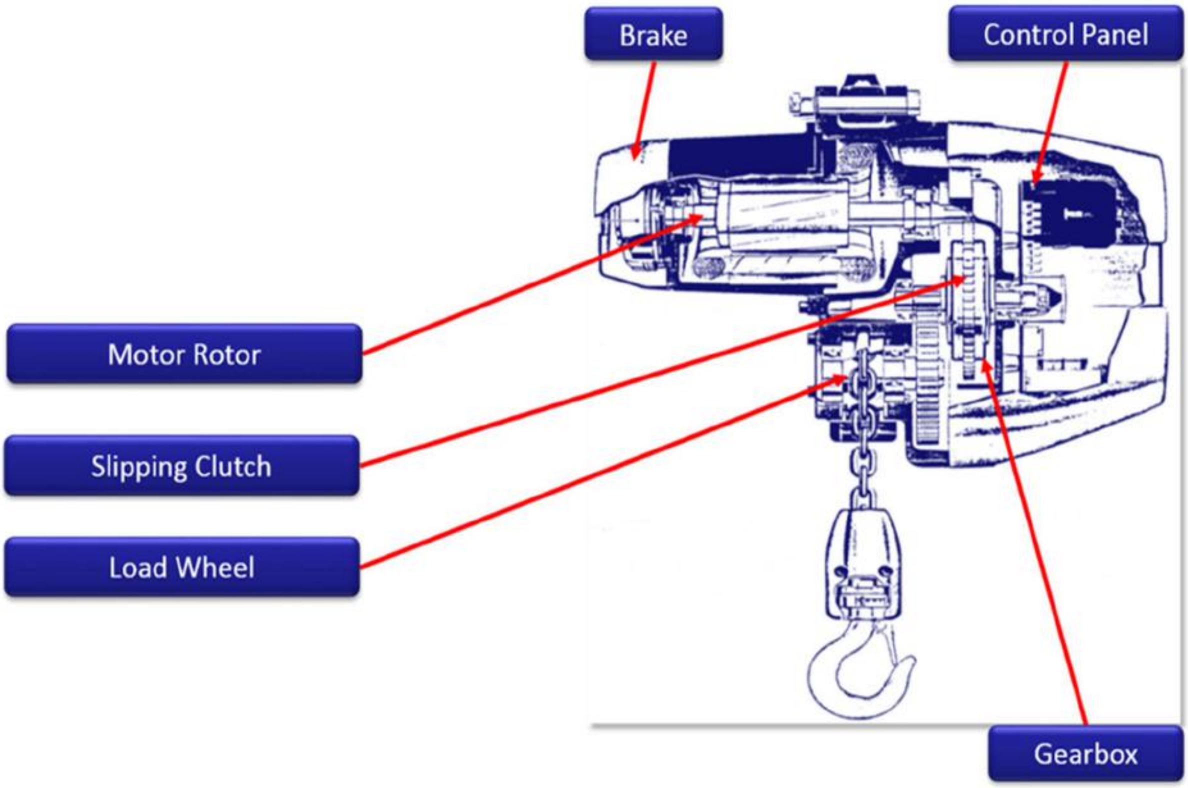


Typical Control Panel

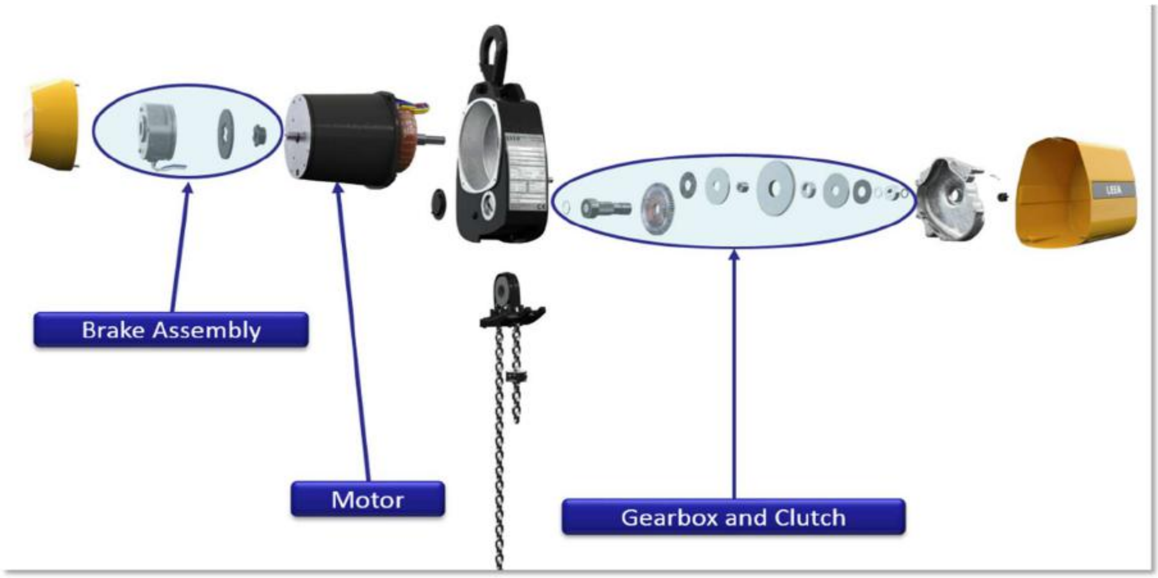
The image below shows the brake hub attached to the motor rotor and the brake rotor (friction rotor).



With the DC electromagnetic disc brake, (covered in an earlier module 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.

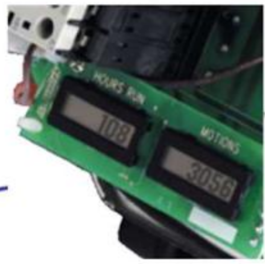


Exploded View:



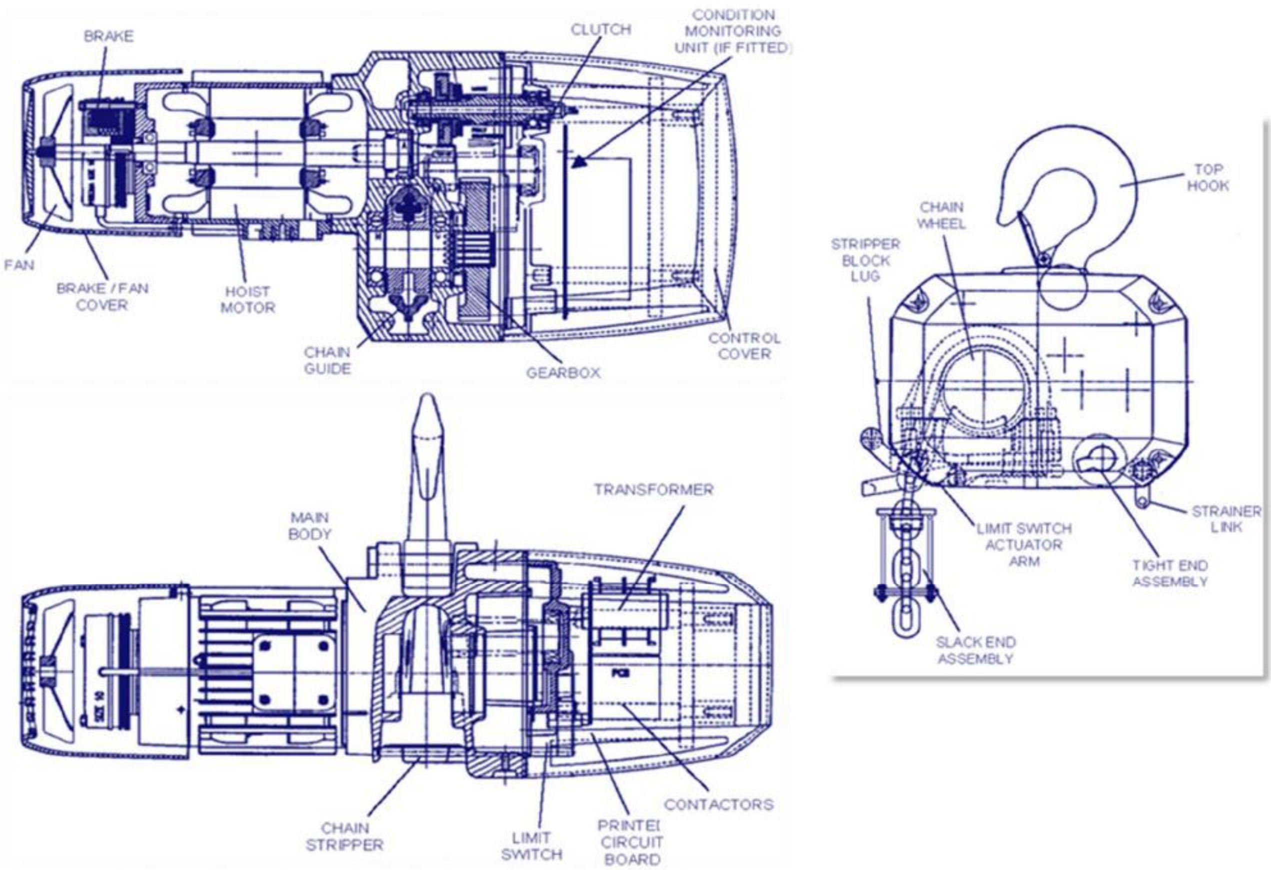
Exploded View (Reverse)

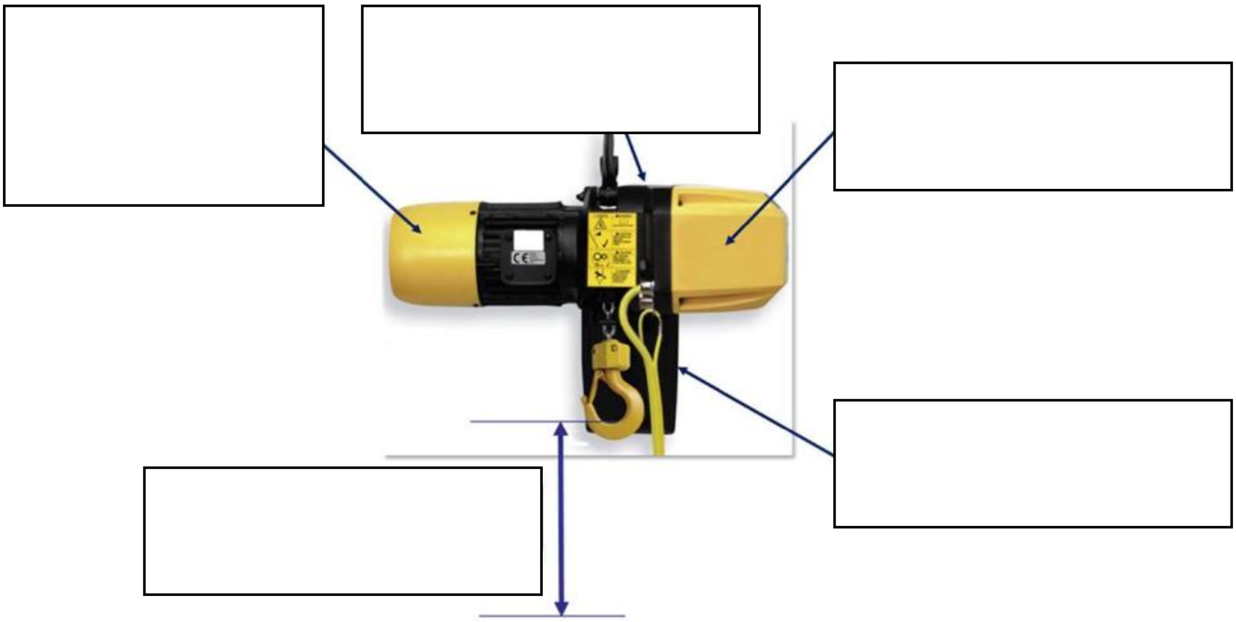
The hoist shown here operates in a similar way to the unit we have previously explored, but its configuration provides better headroom by incorporating a planetary gearbox. A slipping clutch is used for overload protection but also, as this is a fairly modern hoist, features such as additional limit 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.



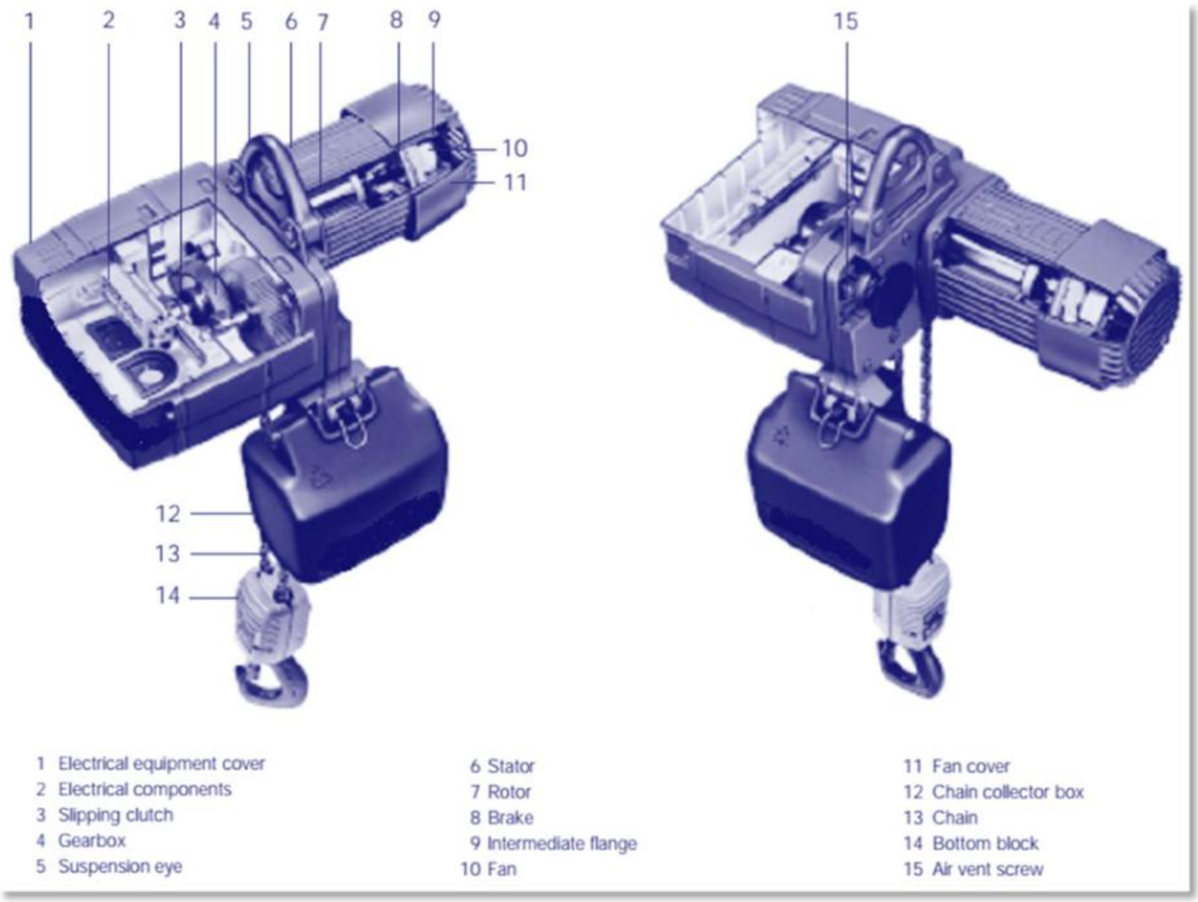
Condition Monitoring – fitted in most new hoists

General arrangement of this type of hoist:





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 (Regional documentation or report of thorough examination as appropriate). If this is not on record refer the hoist to a Competent Person for a 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
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

Heavily corroded load chain

Corrosion inside the cover of an electric chain hoist

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).

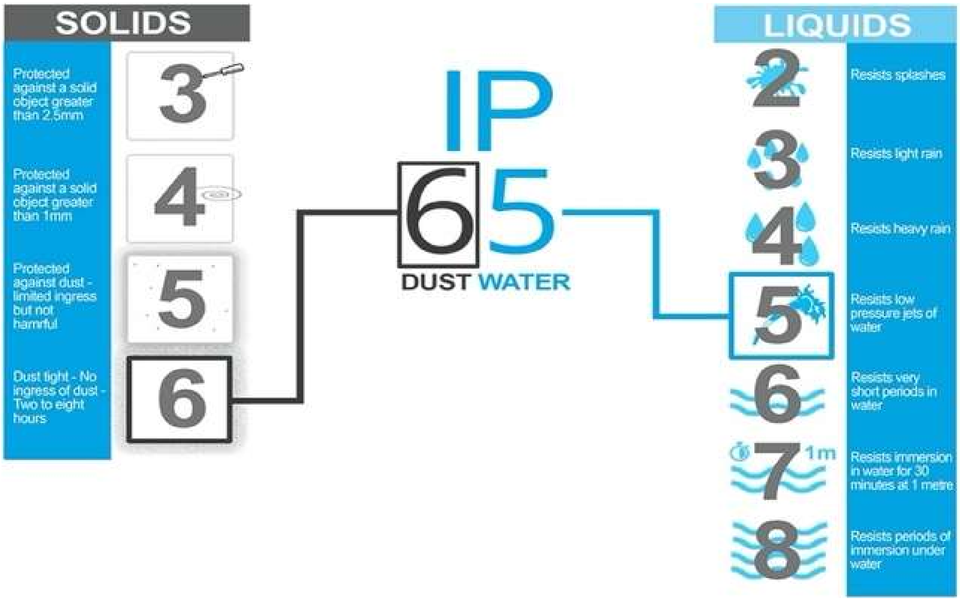
Standards

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 the safety of persons and property, consistency of control response and ease of maintenance. Here are the key points from the standard for the examiner:

<u>Electromagnetic Compatibility</u>
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.

<u>Electrical Supply</u>
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.

<u>Outdoor Use - Protection</u>
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. The table below explains the meaning of commonly used IP (ingress protection) ratings in machinery:



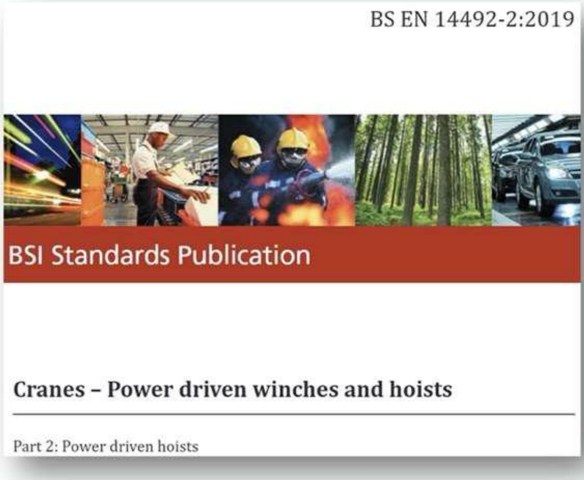
Electrical Disconnection

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

Why does this isolation clamp have many holes for padlocks? (Select one answer)

- ☐ So that each individual working on the equipment can use their own lock
- ☐ As a failsafe incase one padlock doesn't work
- ☐ The other holes are used to accommodate cable ties

Power Driven Hoists



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

General Requirements:

- 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 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 they have become a standard feature of many appliances

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).

Direct Acting: ____

____

____

Indirect: ____

____

____

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.

Limits and Controls

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 14492-2 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

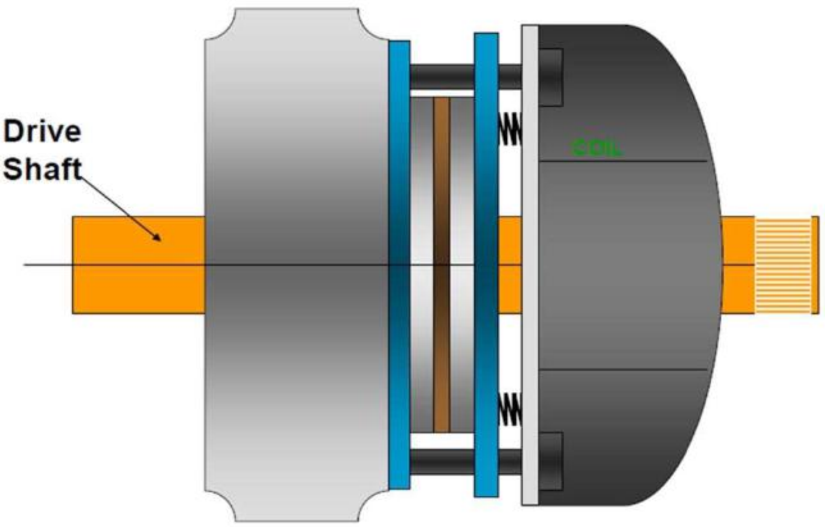
The standard requires the fitting of an emergency stop function which is to be available at all times. The emergency stop must override all other functions and operations of the hoist

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)



Power OFF, Brake ON

NOTES:

Hooks and Chains

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

"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." The ACoP to Regulation 6 (1) of LOLER

Load Chain

Where short-link load chain is used as the lifting medium, it will meet the requirements of EN 818-7. Roller chains should meet the requirements of ISO 606 or ISO 3077 with a working coefficient of 6:1.

Chain Guides

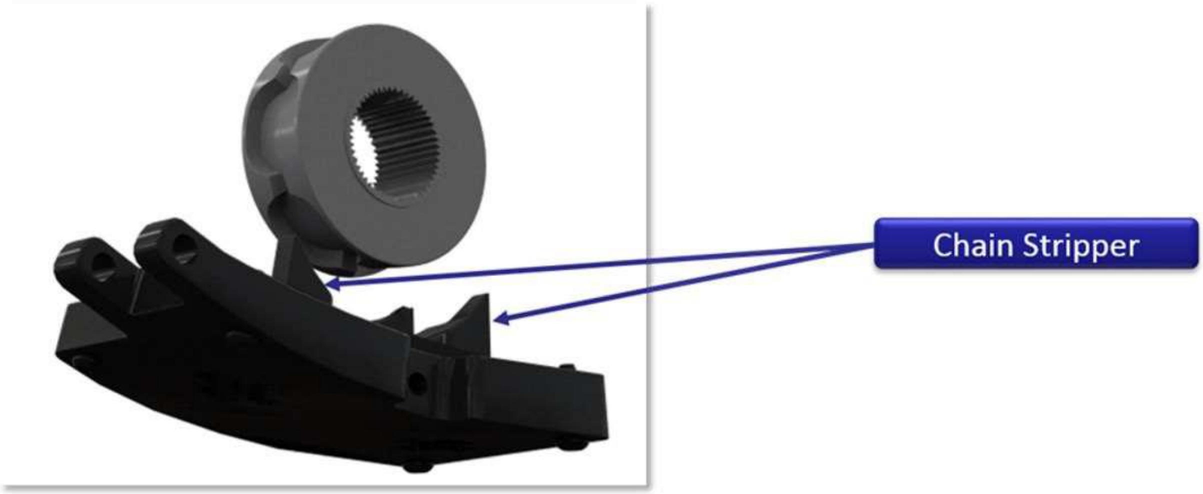
In order that the load chain runs correctly over the load wheel (load-sprocket) a guide must be fitted. The illustration below shows a chain guide sitting over the load chain ensuring it runs smoothly in the load-wheel.

Notes from video:

Video recap: 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.



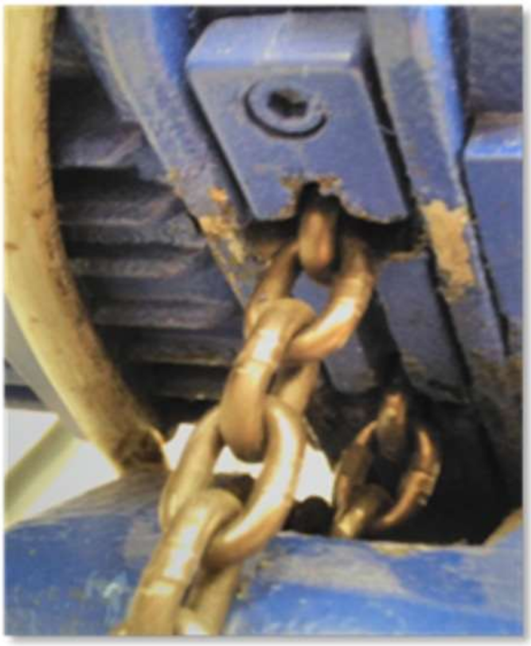
Load Wheel

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 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

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.

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 handset 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

Defined Scope of Examination

Notes from video:

Having completed operational/functional checks, ensure that powered lifting machines are isolated and locked off before attempting to access them for examination work!

The Thorough Examination

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 (where applicable). 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 authorities.

Light: ____

____

Clean: ____

____

Competent Person: ____

____

Standard Procedures: ____

____

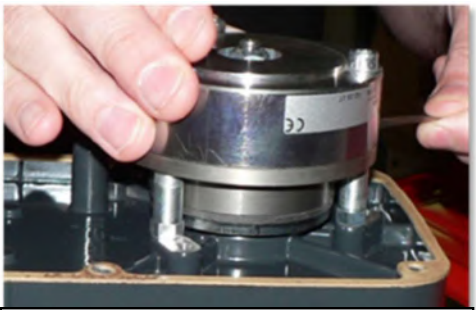
Parts ____

____

Standard Procedures

Further criteria may also be given in Standards, LEEA technical publications and in the LEEA correspondence courses.

The operation of mating parts must be checked and observed, e.g. a load chain, load wheel, brakes and other critical components must be checked for safe and correct operation.



Critical Components

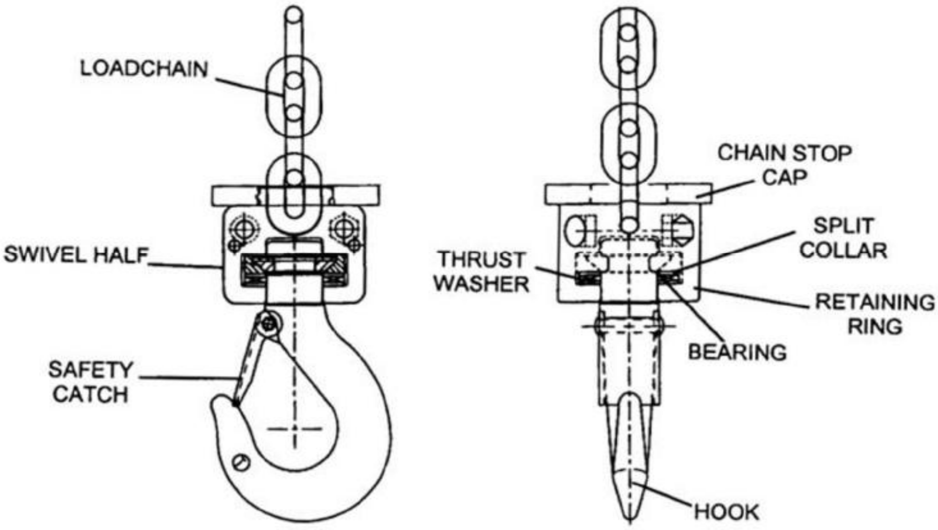
- Hooks (suspension and load)
- Hoist structure
- Hoist brake and associated mechanisms (gearbox, couplings, chain wheel etc.)
- Load chain
- Electrical controls and isolation
- Power feed system
- RCI/RCL and other safety devices
- Marking

Defined Scope of Examination

For each of the components checked in the defined scope and relevant supplementary testing the lifting equipment examiner will have a predefined list of acceptance and rejection criteria. The following is a non-exhaustive list of such criteria:

Hooks, suspension and load

- Corrosion, cracks, damage, distortion, opening of the throat wear affecting the strength or functionality
- Security of attachment points and sub-structures, fasteners, welds, etc.
- Full or partial seizure of rotating components
- Safety catches are fitted and are effective (if applicable)



Hoist structure

- Corrosion, cracks, damage, distortion, wear affecting the strength or functionality
- Security of attachment points and sub-structures, fasteners, welds, etc.

Marking

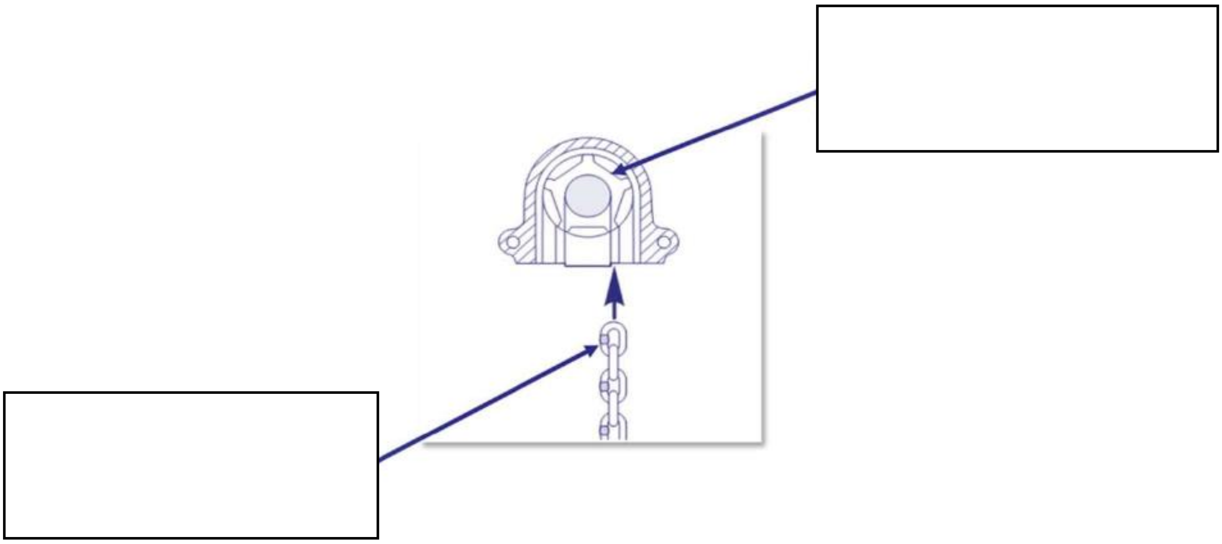
- The presence, accuracy and condition of markings, such as SWL, identification marks, chain grade for example

Hoist mechanism including motor, brake, couplings, gearbox, chain wheel and bearings

- Alignment within the manufacturers tolerances
- Corrosion, cracks, damage, distortion, wear affecting the strength or functionality
- Adequacy of lubrication
- Mode of operation as intended by the manufacturer
- Full or partial seizure of rotating components
- Chain fitted in correct orientation, as specified by the manufacturer

Chain Orientation:

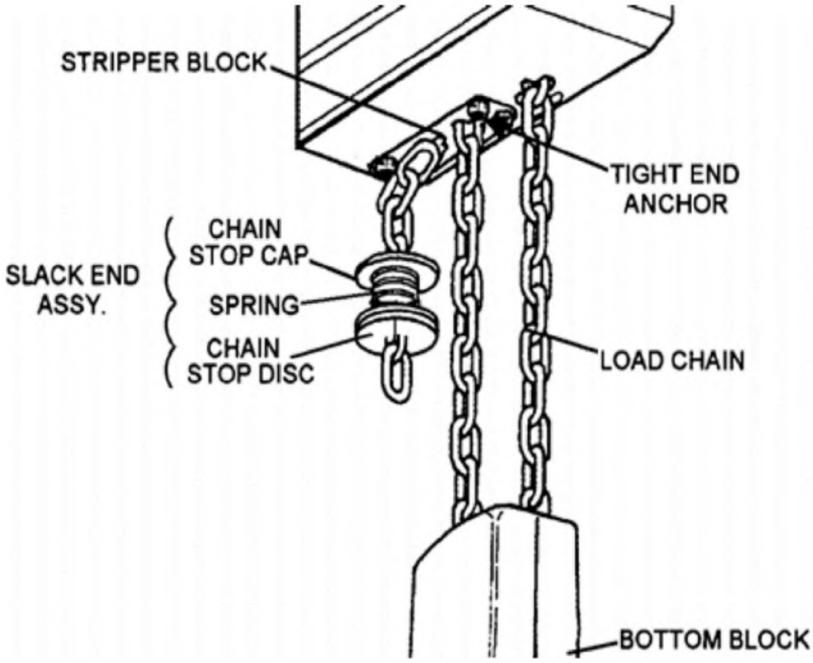
Manufacturers specify which way the load chain should be placed into the load wheel. Generally speaking, most manufacturers specify that the weld on the link of the load chain faces the load wheel, as shown below:



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.

Chain, terminations and anchorages, guides, pins, bearings, bottom block and hook(s)

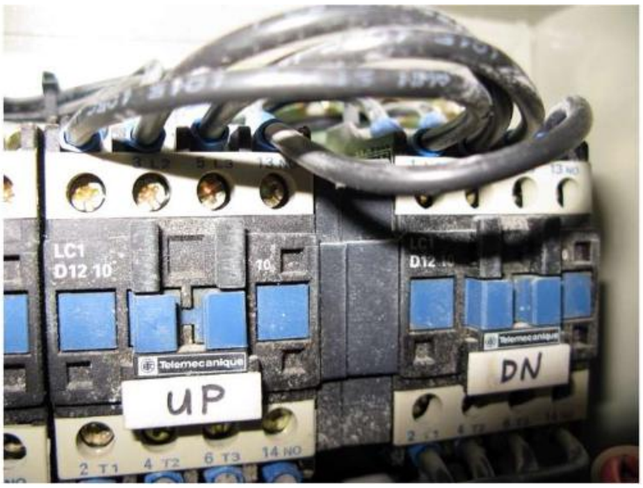
- Corrosion, cracks, damage, distortion, wear, kinks, broken wires, etc. affecting the strength or functionality
- Adequacy of lubrication
- Full or partial seizure of rotating components
- Safety latches fitted and functioning correctly (see image below)
- Security of attachment points and sub-structures, fasteners, welds, anchorages, etc.



- Chain; Corrosion, cracks, damage, distortion, elongation, wear and deposits that cannot be removed affecting the strength or functionality
- Chain; Links articulate freely
- Chain; Increase in gauge length which exceeds that manufacturer's recommendations. In the absence of manufacturer's recommendations, the chain should be replaced if the gauge length measured over any 5, 7, 9 or 11 links exceeds that of the unused chain by 2% (reference ISO 7592)
- Chain; Interlink wear leaves a rough surface

Electrical control panel and wiring

- Functionality and mode of operation as intended by the manufacturer
- Insulation in accordance with manufacturers specification and not less than 0.5MΩ **Electrically qualified personnel only**
- Continuity in accordance with the manufacturers specification and should not be greater than 0.5Ω **Electrically qualified personnel only**
- Electrical connections are secure



Power Feed System

- Functionality and mode of operation as intended by the manufacturer
- Security of hose / wire connections

Operator controls

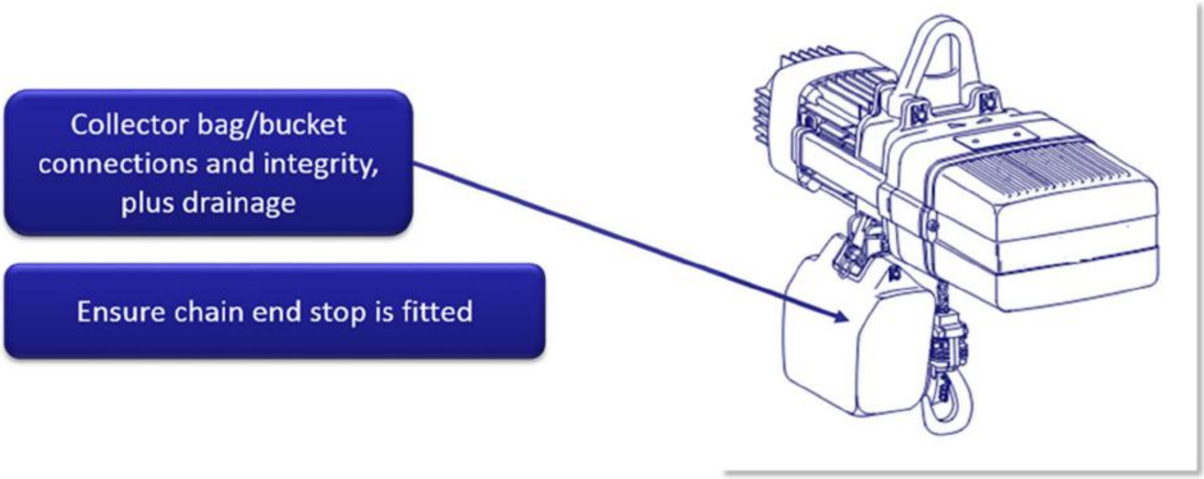
- Functionality and mode of operation as intended by the manufacturer
- Insulation in accordance with manufacturers specification and not less than 0.5MΩ
- Continuity in accordance with the manufacturers specification and should not be greater than 0.5Ω
- Connections are secure
- Cracks, damage, distortion or wear affecting functionality

RCI / RCL devices

- Functionality and mode of operation as intended by the manufacturer
- Calibration and functional tests of the RCI/RCL

General

- 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 (where applicable), and where markings have become illegible be re-stamped or marked



Report of Thorough Examination

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

NOTES:

Types of Wire Rope Hoists

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 relevant standards 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

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

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.

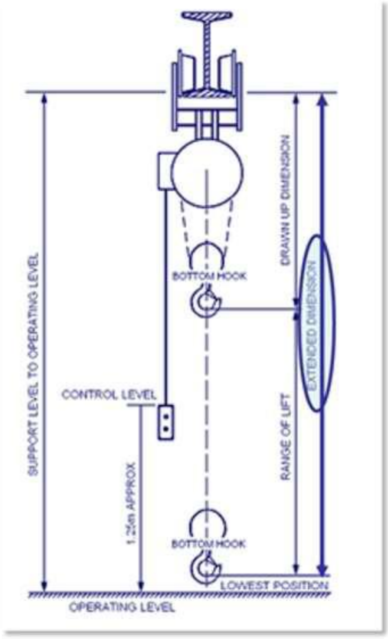
This is sometimes referred to as the 'headroom' as it is the effective headroom taken up by the hoist. However, the term headroom has not been used as it is sometimes used in everyday language to have other meanings.

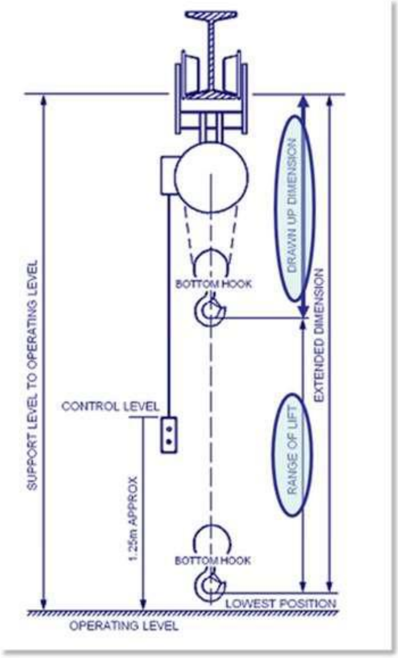
Range of Lift

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

Electrical Supply

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



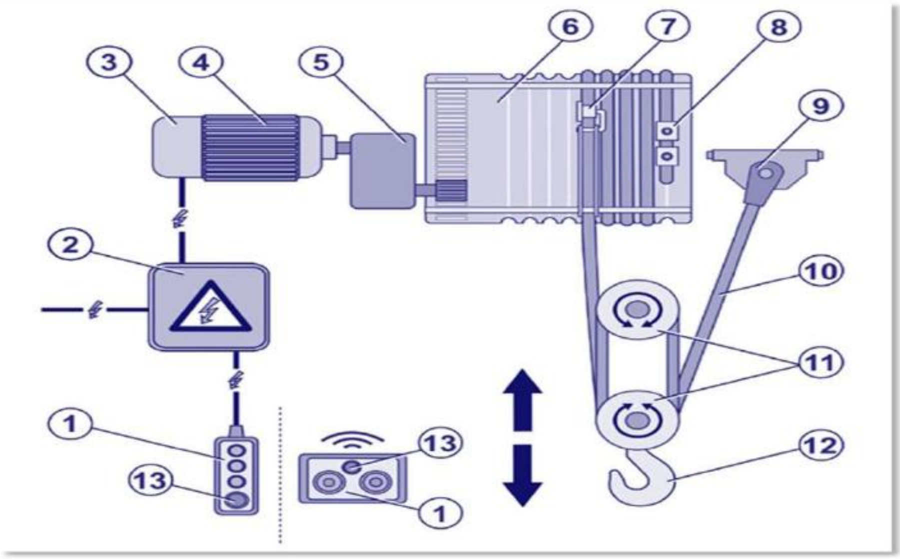


Low Voltage (LV) Control

Modern electric 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 of an Electric Wire Rope Hoist

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

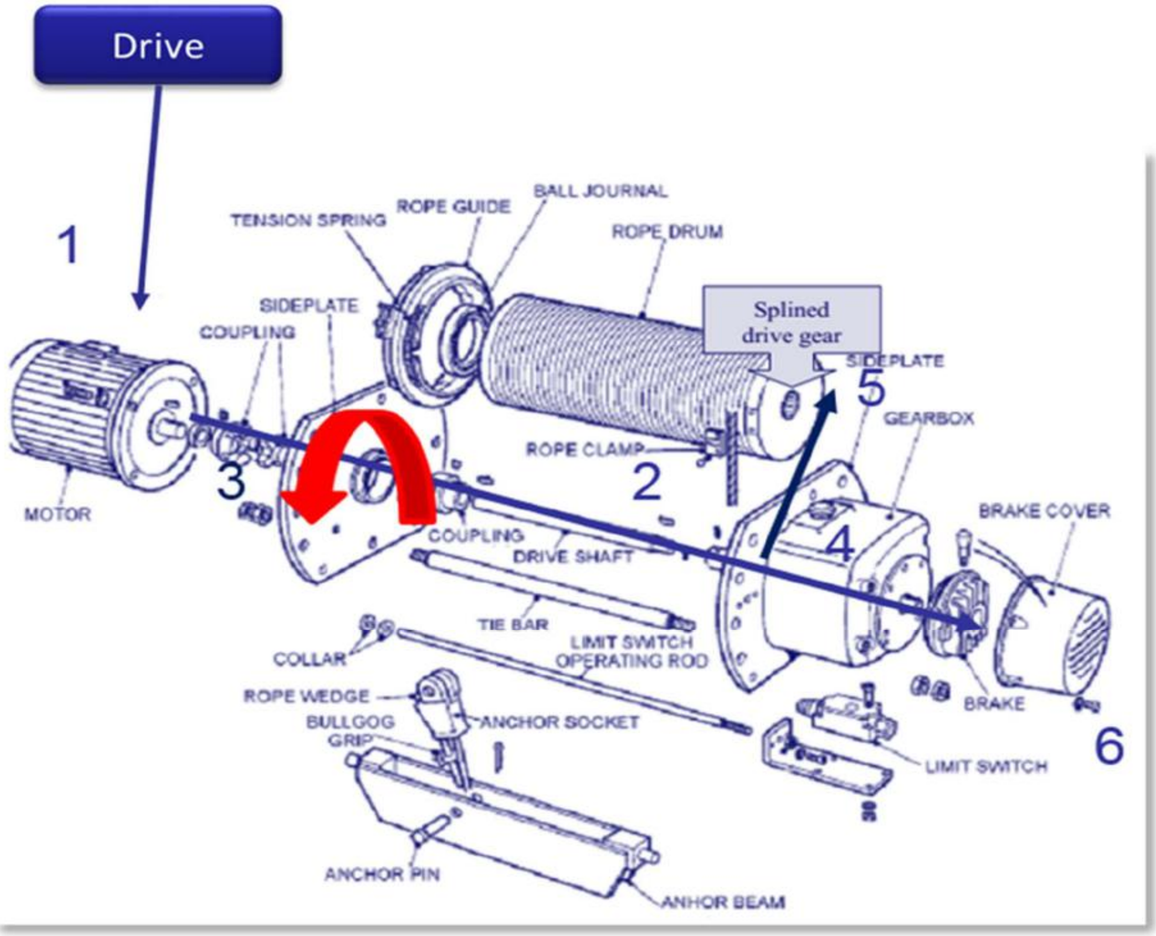
NOTES:

General Principles of Operation

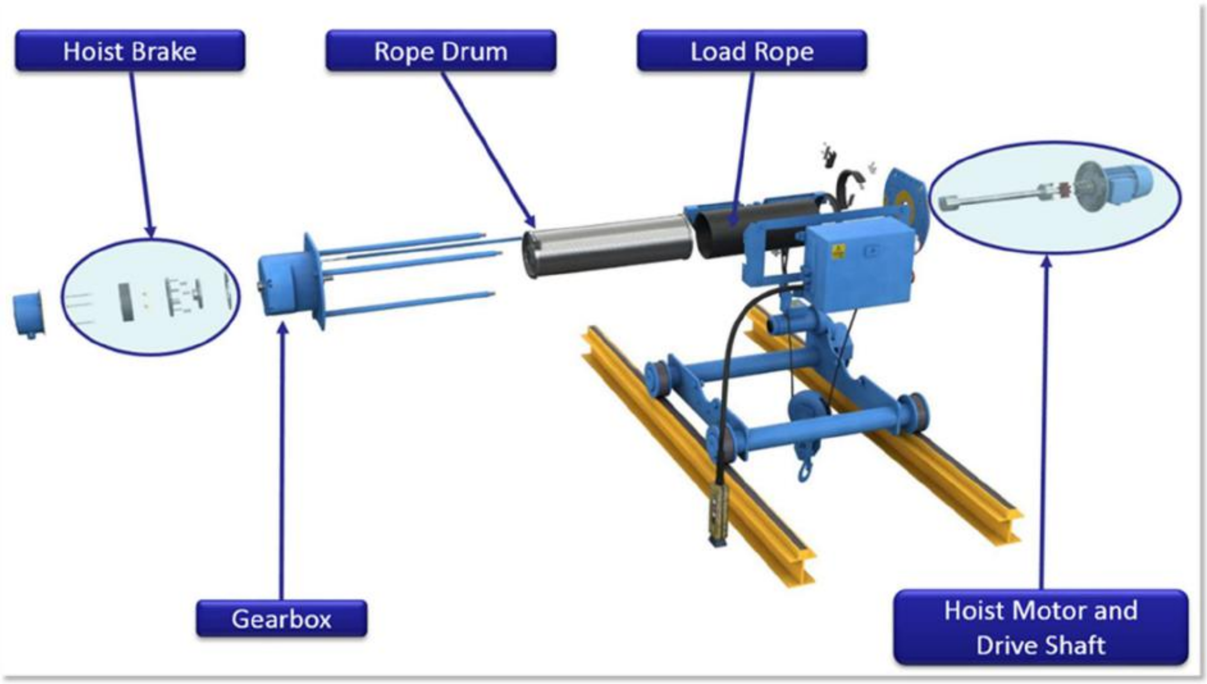
General Operation

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 (Reverse Image)

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, hoists must provide performance, reliability, flexibility, satisfy the EN and ISO requirements and be reasonably priced.
By rotating the component parts around a common axis a very compact hoist unit has been developed.

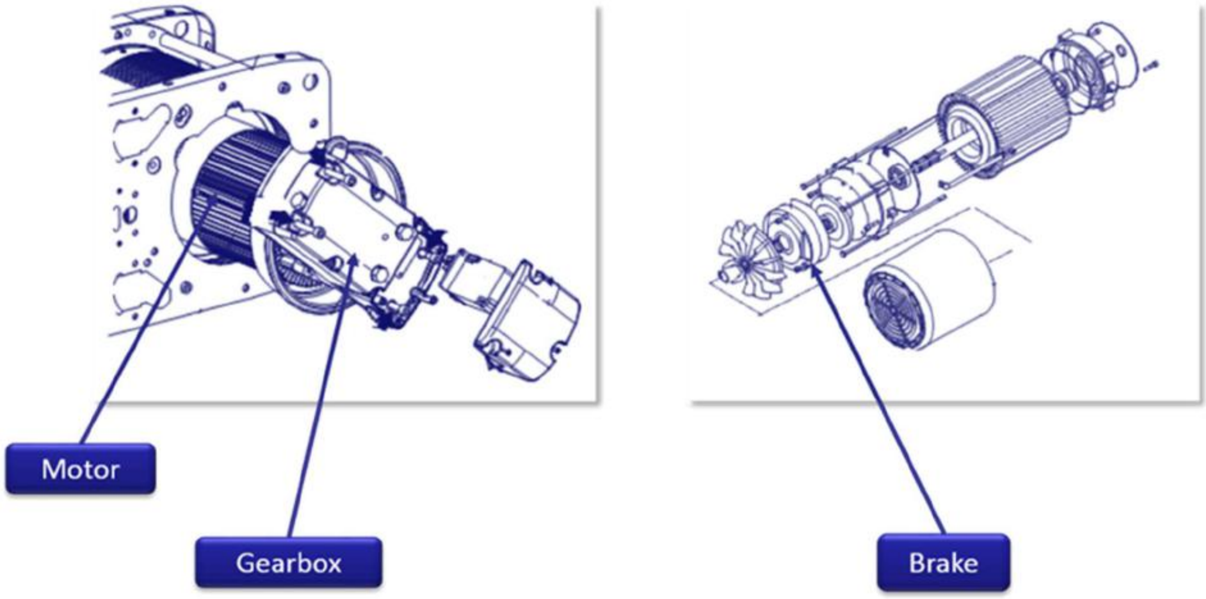
General Operation

Notes from video:

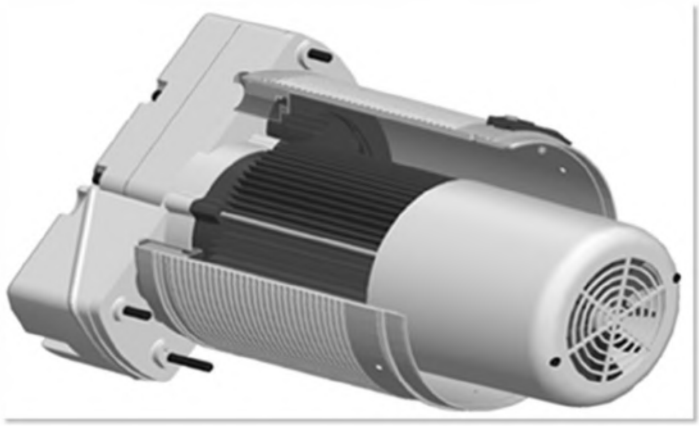
Video recap: The drive motor is mounted inside the hoist drum. The drive is then transmitted via a coupling to the hoist gearbox, which is totally enclosed. On this model, the electro-magnetic hoist brake is of the disc type. Other models may incorporate a tapered rotor motor and conical brake unit.

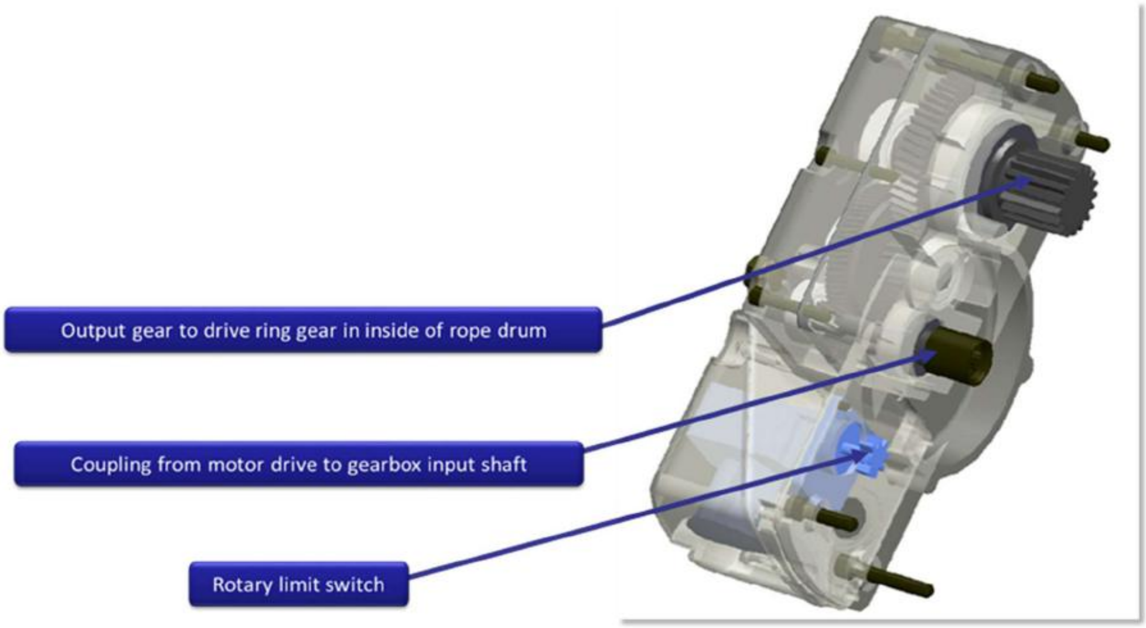
General Arrangement

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.



<u>Notes:</u> Modern hoists typically have enclosed, compact gearboxes that are lubricated with semi-fluid grease, sealed for their service life.

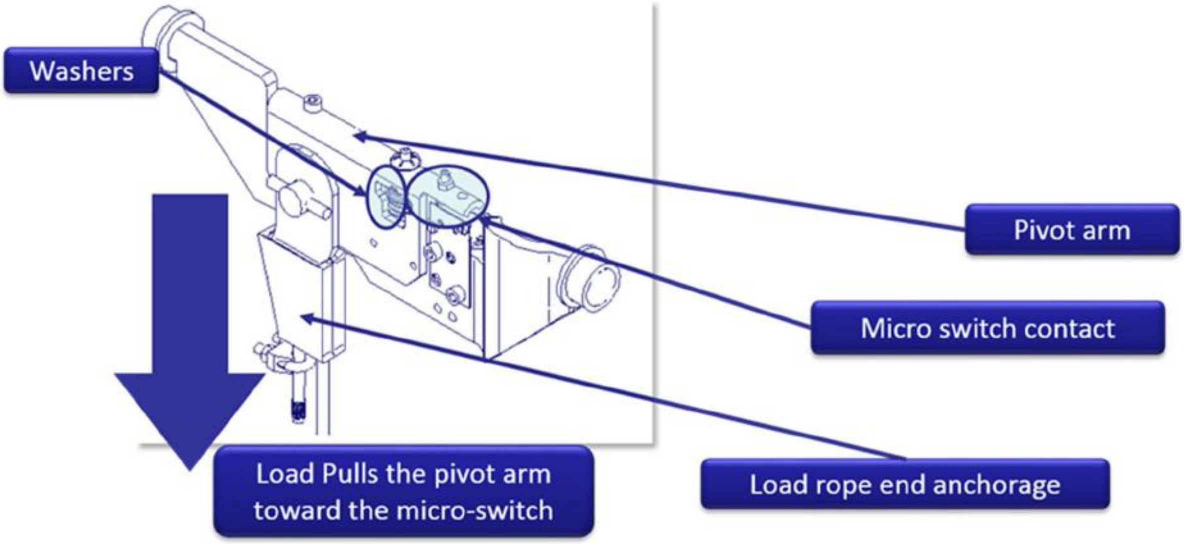




The image below shows a typical load rope end-anchor assembly arrangement which is usually supported by a cross beam incorporating an overload limiting device.

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

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:

- ____
- ____
- ____
- ____
- ____
- ____

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

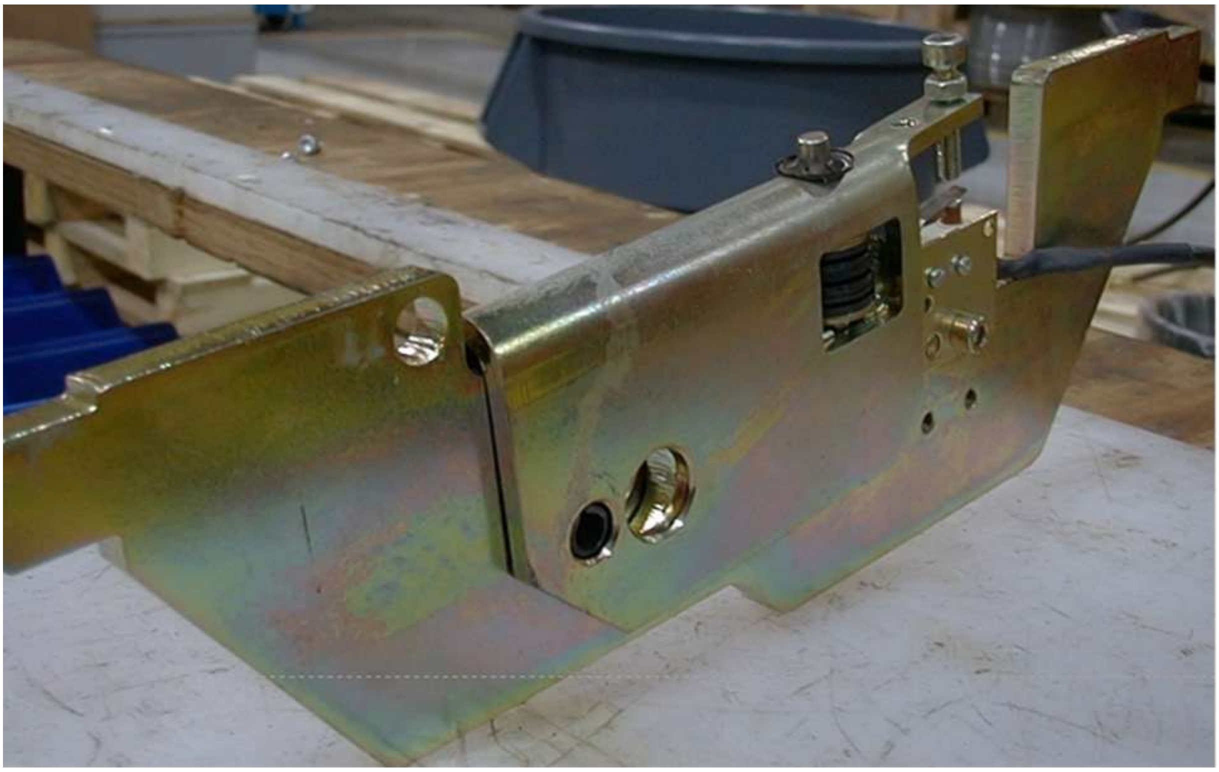
Standards:
EN 60204 Pt 1 and Pt 32 – Safety of Machinery – Electrical Equipment of Machines – general requirements deal with the electrical safety of machines covered in this module. Part 32 deals specifically with hoisting machinery. The standard promotes safety of persons and property, consistency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

Rated Capacity Limiters and Indicators (RCL)

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.

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.

Overload Protection:
Hoists 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.



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).

Direct Acting: ____

____

Indirect: : ____

____

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.

A hoist is designed to operate at full voltage but if a voltage drop is present the hoist will stop. What is this voltage drop? (Select one answer)

- ☐ 10%
- ☐ 5%
- ☐ 3%

NOTES:

Limits and Controls

Hoisting and Lowering Limits

Safety: For safety reasons, to prevent the bottom hook ‘over travelling’ and causing damage to the hoist, a hoisting or upper limit is used.

Modern hoists: 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.

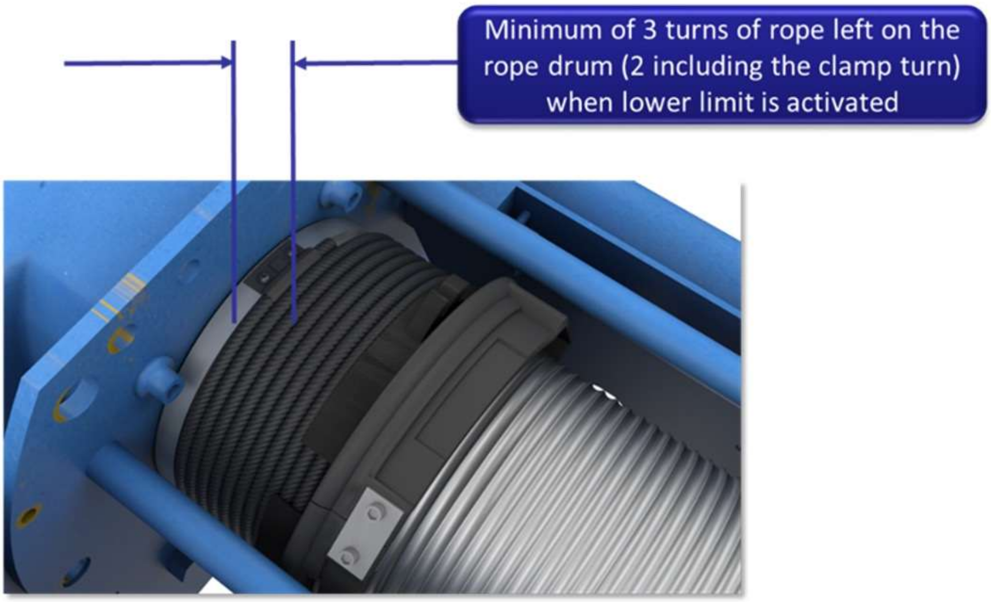
Type of limit: The type of limit used will depend on the hoist design and may be a mechanical device, e.g. a slipping clutch, or an electro-mechanical device which uses a mechanical method of actuating a limit switch.

Safety devices: 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.

Reset: 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

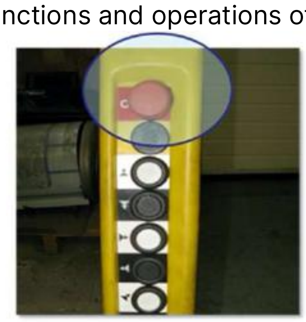
For normal operation a second limiter is not necessary.
A risk assessment based on the particular application may result in the need of a second limiter for certain motions. This second limiter shall not be approached during normal operation, whereas the first limiter can be approached during normal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

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).

NOTES:

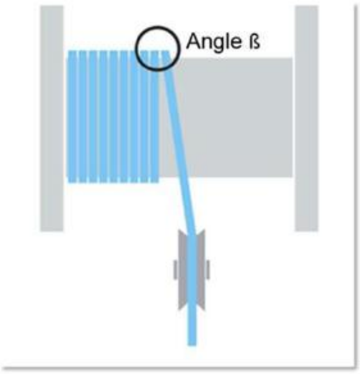
Blocks, Hooks and Ropes
Hooks

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

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.



Fleet Angle

Notes from video:

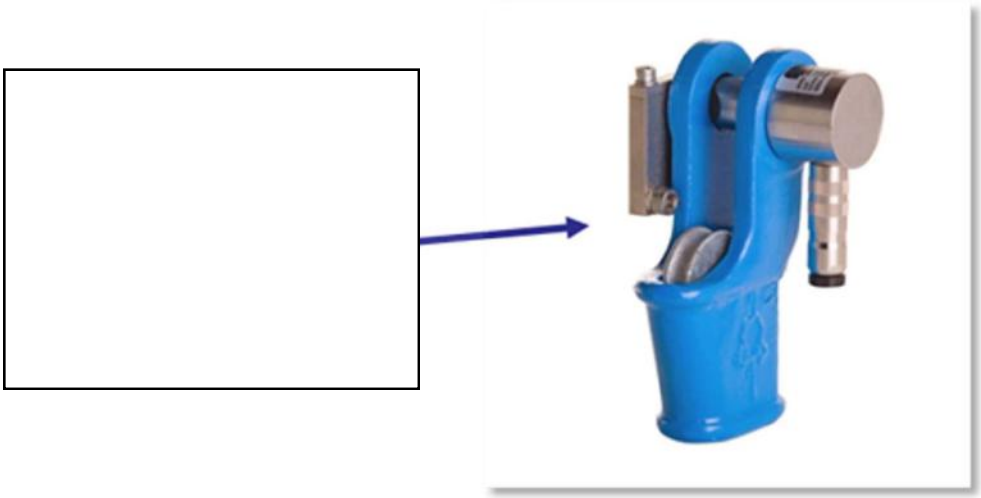
Video recap: If a rope enters a sheave under a fleet angle, it will first touch the flange and then roll down into the bottom of the groove, twisting the wire rope slightly every time.
With increasing fleet angle, the amount of twist increases.
If the rope enters the sheave at a fleet angle of 1° it 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°.
As you can see from the picture, the ropes rotate as they enter and exit the sheave grove.

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.

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

- 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 ISO 4309

Wire Rope Sheaves

Notes from video:

Video recap: Sheaves must be designed to prevent the rope from jumping out of the grooves when the wire rope is slack.
Rope grooves on rope sheaves should have a groove radius of (0.52 to 0.56) times 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 times 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

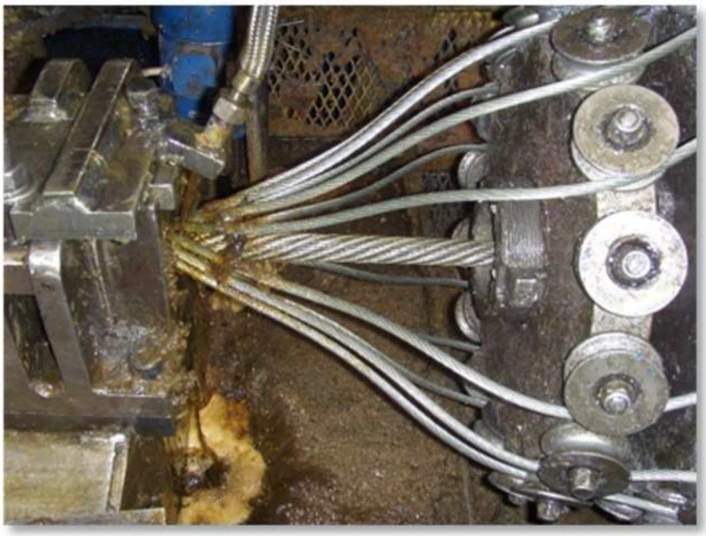
- Anchorages on the rope shall resist 2.5 times the static rope force resulting from the rated capacity of the hoist without permanent deformation
- Terminations can include:
    - Asymmetric wedge socket
    - Symmetric wedge socket for rope diameters up to 8mm
    - Metal and resin sockets
    - Wire rope clamps
- **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



Marking

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

- CE Mark (where applicable)
- 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.

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.

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

Defined Scope of Examination

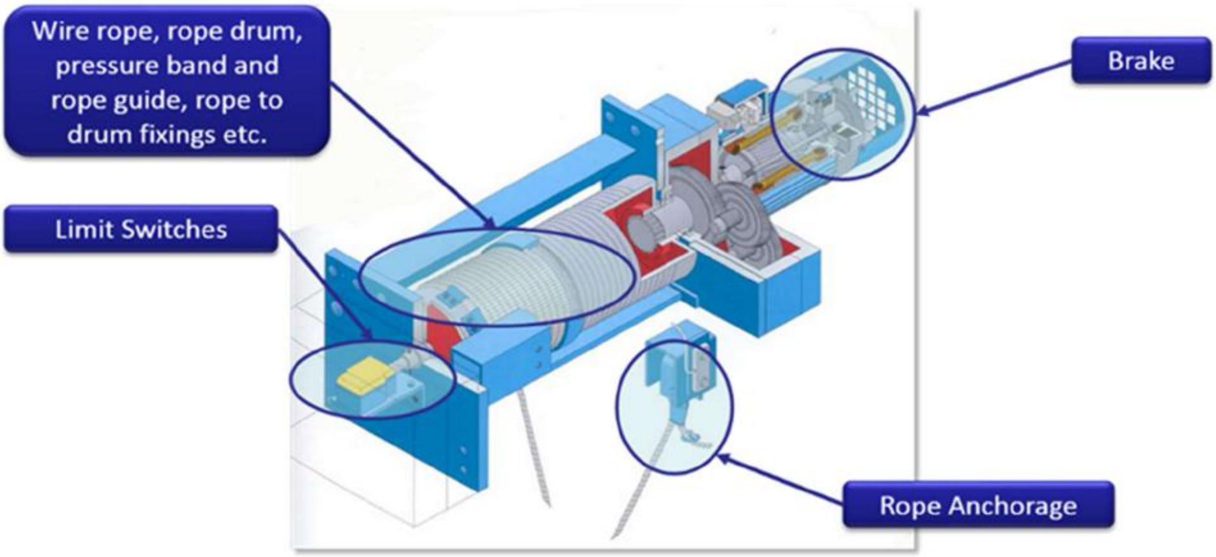
The Thorough Examination

Notes from video:

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 (where applicable). 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 authorities.

- 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 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

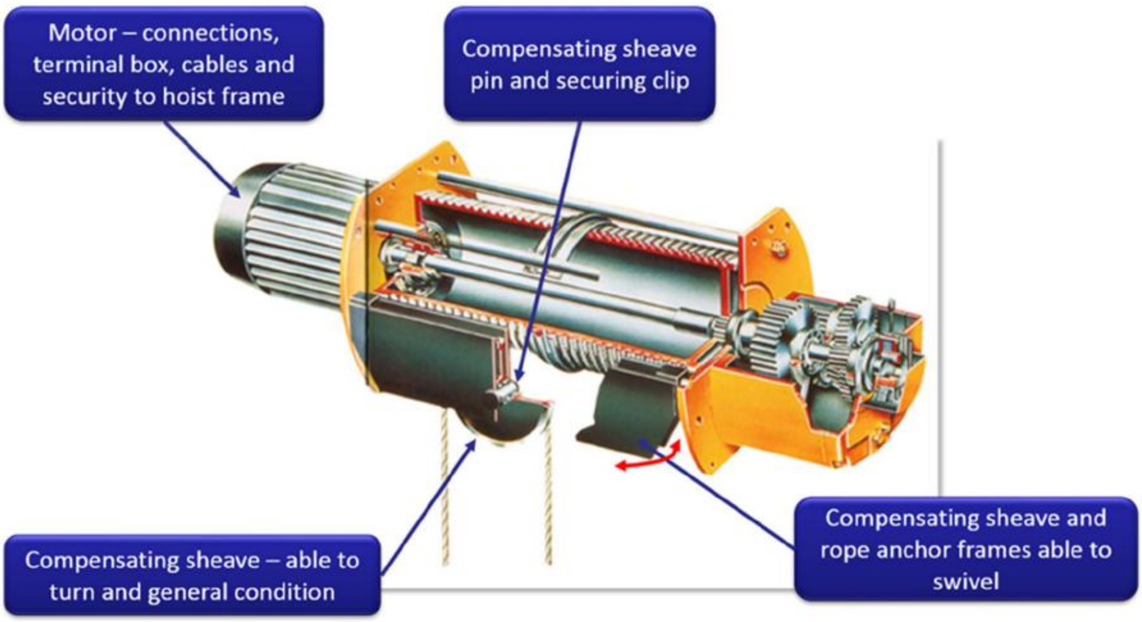
The operation of mating parts must be checked and observed, e.g. a load rope, rope drum, rope guide and pressure band, brakes and other vital mechanisms must be checked for safe and correct operation.



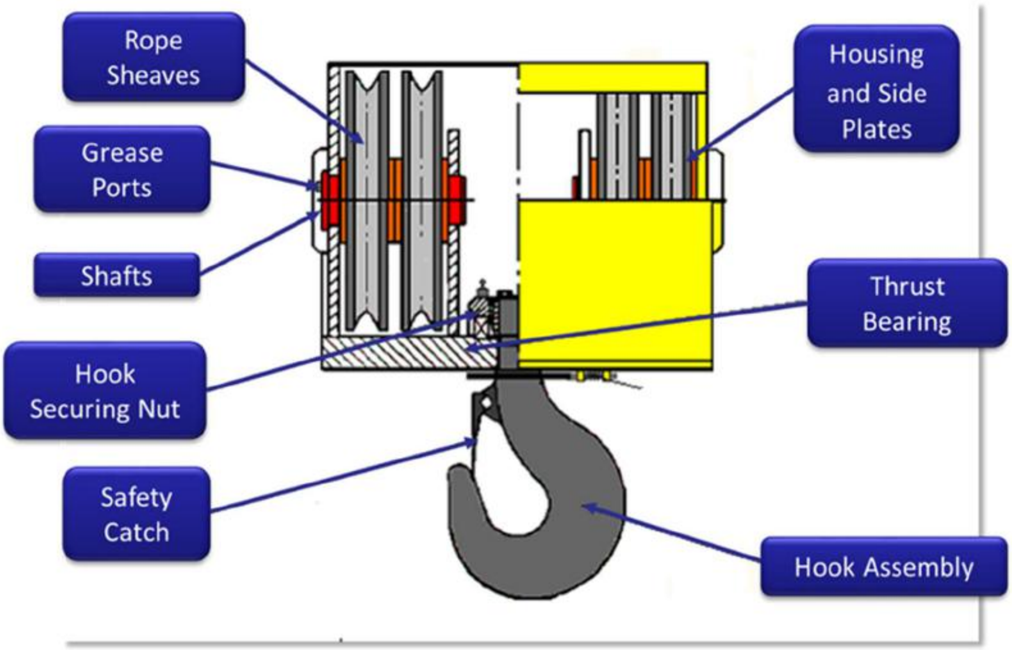
The assembly of parts, reeving and anchorages must be checked for correctness and proper operation and all locking and securing devices must be checked as being sound and in place.

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 – Bottom Block



Report of Thorough Examination

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

Powered Winches
Types of 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.

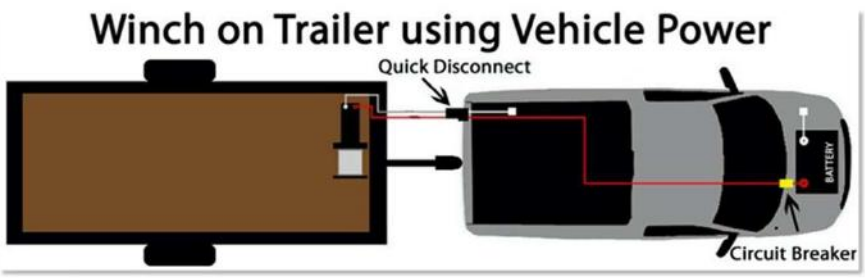
Powered winches are within the scope of EN 14492-1.

This course only covers lifting applications or applications that have an element of lifting.

Note: Mooring winches – not within the scope of this course.

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 me.

Lifting Application	
Pulling Application	

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.

General Principles of Operation
General Requirements of EN 14492-1

Rated Capacity Limiters and Indicators

Winches for lifting and lowering purposes with a **rated capacity of 10,000kg** 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 hall be reduced by following the principles of 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,
    - Aggressive environments and outdoor use
    - Low operating temperatures

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.

NOTES:

Limits and Controls
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.

Limiting devices must be in accordance with the requirements of EN 12077-2:

Cranes safety —
Requirements for health and safety —

Part 2: Limiting and indicating devices

General Requirements of 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	
For 3 phase motors	
For winches using combustion engines as a primary drive	
Requirements for Vehicle Recovery Winches and Boat Trailers	

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 an increasing number of rope layers; the lowest value of the rated capacity must be taken into consideration.

NOTES:

Ropes and Drums
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

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

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

Corrosion protection

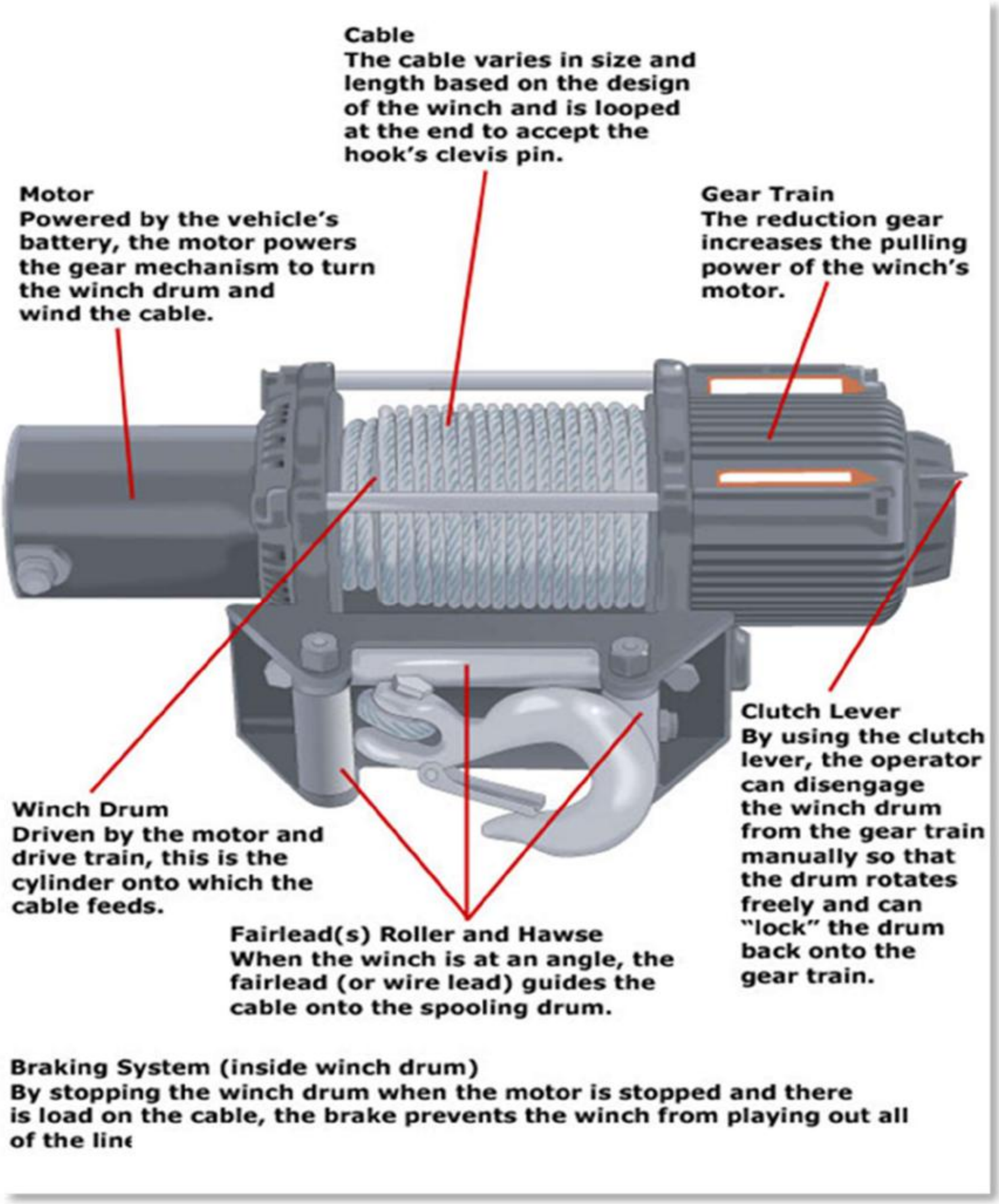
- During manufacture of wire rope, the rope maker applies a dressing which acts both as a lubricant and protection against corrosion.
    - In all cases, winch ropes should be adequately protected from the effects of atmospheric corrosion when in use.
        - In severe conditions, this may call for 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

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

<u>Note:</u> The diameter of the wire rope should not be reduced in order to accommodate a longer length. If the rope storage drum is of insufficient capacity, a different, suitable winch must be used.

Basic Components of a Trailer Mounted 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.

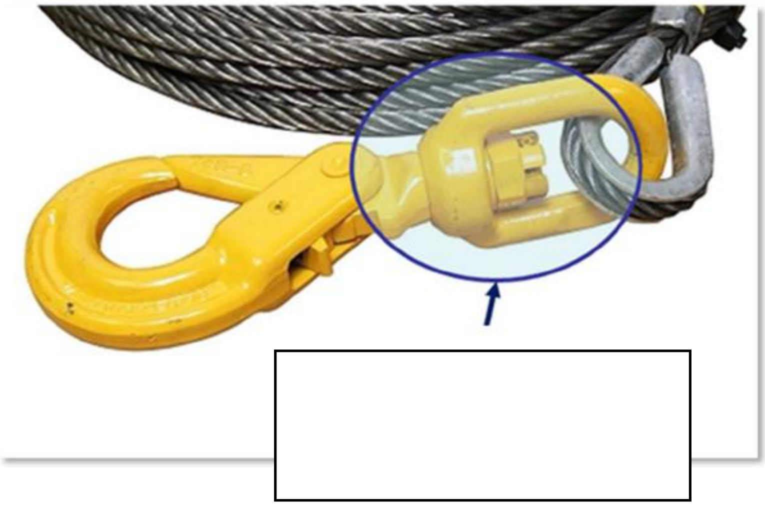
It should be noted that when pulley blocks are used, the load imposed on the supporting structure is increased by the value of the hoisting effort and the effects of friction. This additional load is also imposed on any equipment used to connect the top hook or eye of the pulley block to the structure.

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.



NOTES:

Service Conditions

Generally, winches are manufactured to meet normal service conditions and assume:

Under cover: ____

Ambient temperatures: ____

____

Clean air: ____

____

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:

- ____
- ____
- ____
- ____
- ____
- ____

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

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

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

NOTES:

Defined Scope of Examination
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: ____

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Note 2: ____

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Documentation

Documents to be supplied in accordance with the relevant legislation and relevant standard for example, in Europe, a Declaration of Conformity is required.

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 relevant authority.

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:

In-Service Inspection

- 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

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 relevant authority.

The Thorough Examination

Having completed operational/functional checks, ensure that powered lifting machines are isolated and locked off before attempting to access them for examination work!

- 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 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

Note: Although not required by legislation, new powered 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 (where applicable). This document forms an important part of the record of the winch. It should be retained and cross referenced to the hoists historical records for inspection by the Competent Person or relevant authorities.

NOTES:

Pneumatic Hoists
Types of Pneumatic Hoist

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:

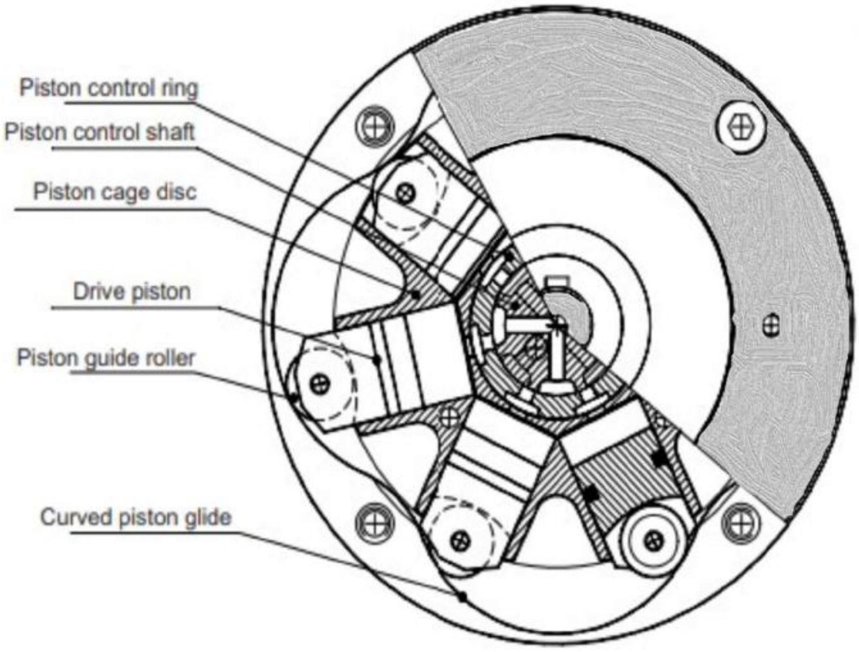
- Air motors are self-purging, that is to say any moisture or small particles that are present in the air supply will be expelled with the exhausting air. They also employ the minimum of moving parts
- These features minimise maintenance and cleaning requirements. However, this does have an associated 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 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.

Piston Motor

Unlike an internal combustion engine, a radial cylinder pneumatic motor has cylinders housing internal pistons arranged in a circular arrangement.

In the illustration below, you will see that the pistons rum on a curved piston glide surface as the motor rotates. This glide surface determines the position of the piston internally.



The compressed air is supplied from the centre through the fixed piston control shaft via the floating piston control ring to the individual pistons providing auto-activation of the pistons. The piston control ring which is connected to the piston air cage, engages with the individual piston control shafts, and when the motor is rotating the pistons will alternatively supply and exhaust air.

For motor directional change, the incoming compressed air supply is reversed.

In this seven cylinder piston motor arrangement, 3 cylinders are continually engaged to generate rotation and torque in the air motor. Pistons at the highest point of the piston glide curve will exhaust and then be pushed to their lowest point again, providing compression.

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

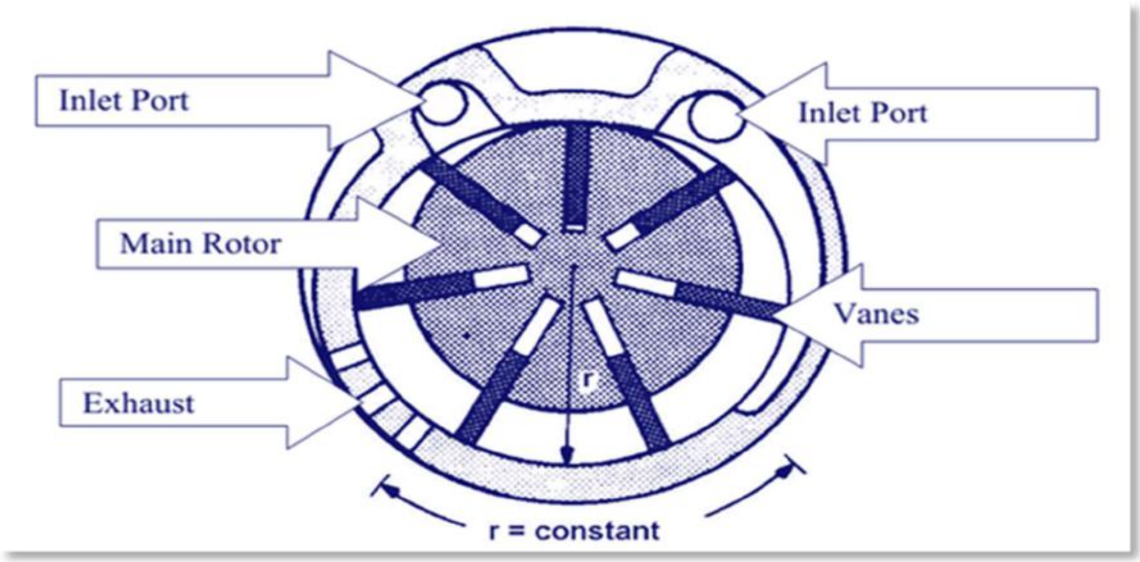
This means that when a vane is working under pressure across the lower section, i.e. when it is transmitting maximum torque to the rotor, it is working at a constant force on the projected area of the vane and eliminates the risk of air leakage.

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.

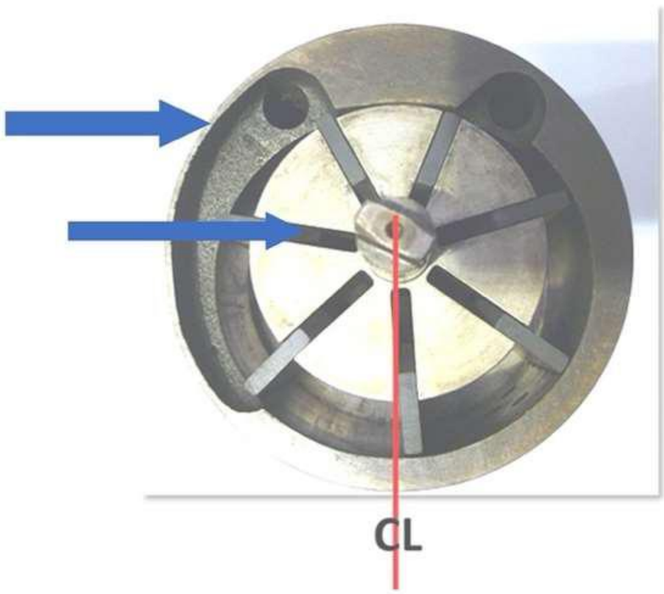
The image **below** is a selection of Motor Vanes.

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.

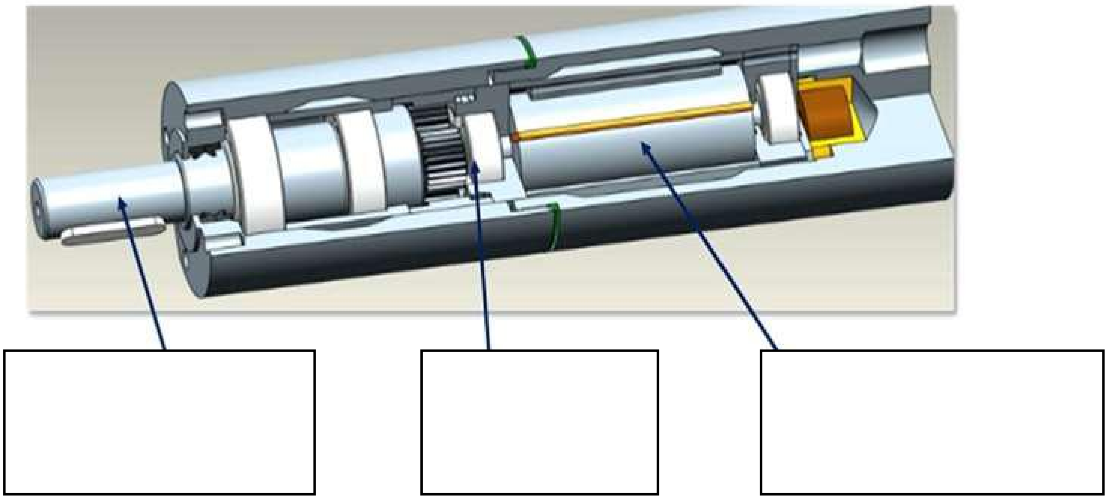


One port acts as the inlet whilst the other remains closed, the air exhausts from the bottom of the cylinder to one side of the centre on the clockwise rotation of the motor (i.e. the lift side).

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.

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.

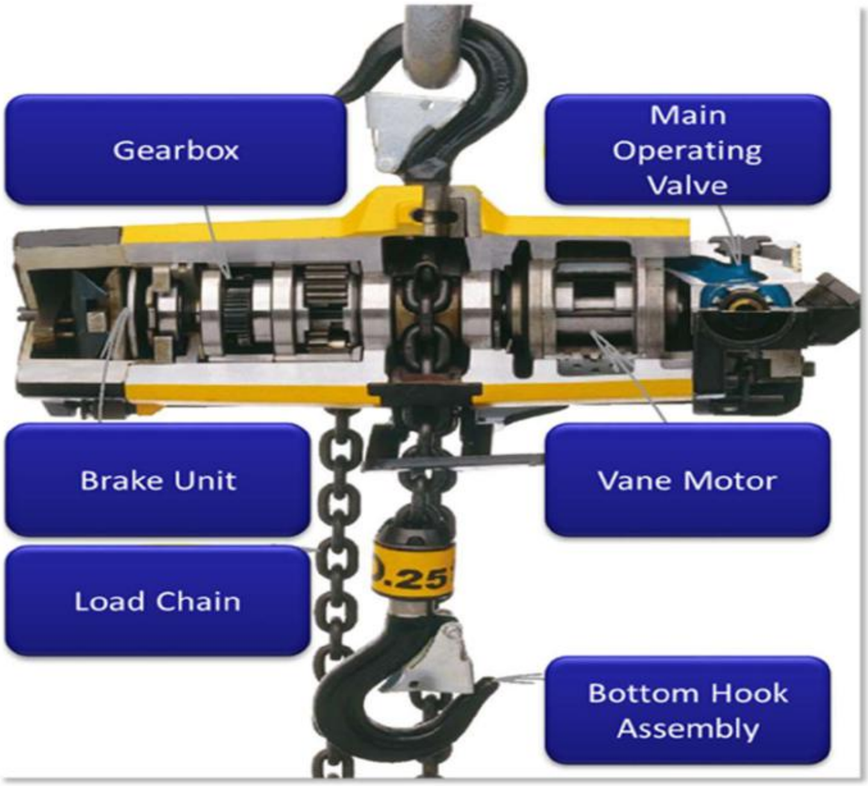
The drive from the motor is transmitted to the gearbox by a transmission shaft.



NOTES:

General Operation

Main Pneumatic Hoist Components

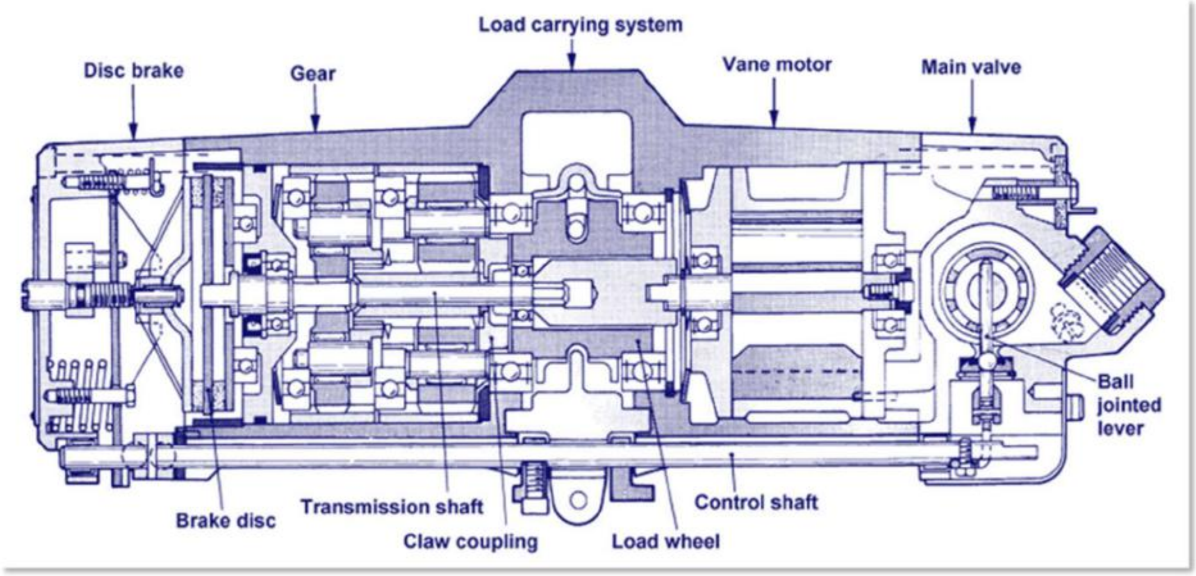


General Arrangement

A typical pneumatic hoist consists of 5 basic sections:

1. Main valve
2. Vane motor
3. Load-carrying system
4. Gearbox
5. Braking system

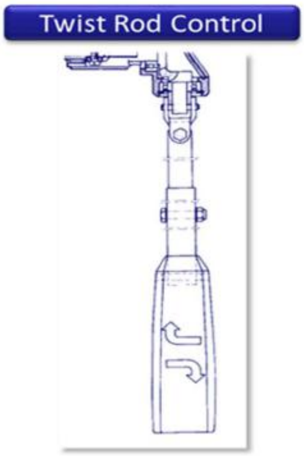
The illustration below shows a typical arrangement of a pneumatic hoist. It consists of 5 basic sections:



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.

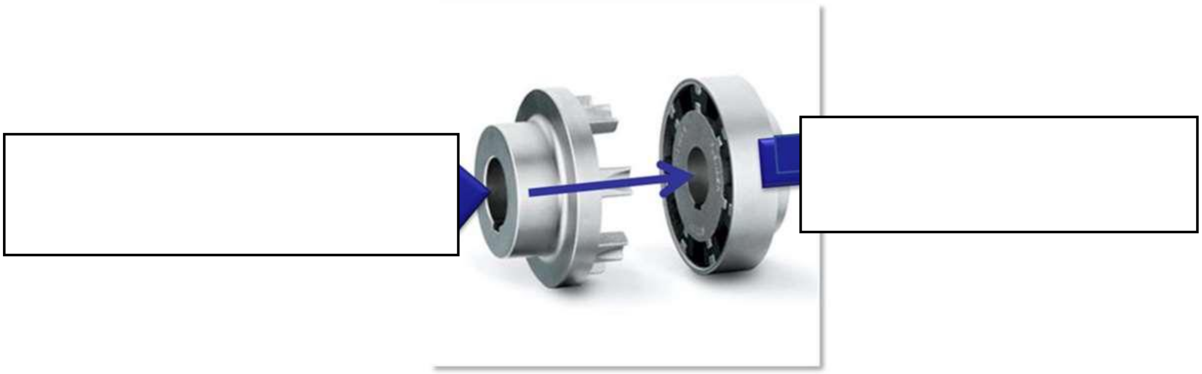
The raising and lowering is controlled by the operator using one of the following methods shown below:



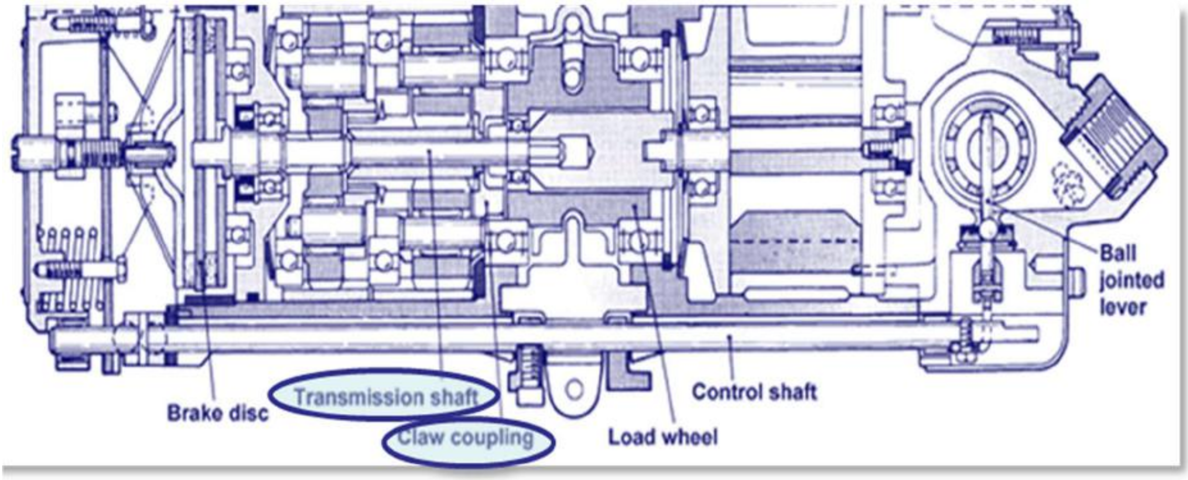
The air exhausts from the bottom of the cylinder to one side of the centre on the clockwise rotation of the motor (i.e. the lift side). The motor is then reversed by changing supply ports so that now the air exhausts before the centre line of the cylinder. This has the advantage of giving air motors 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 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:



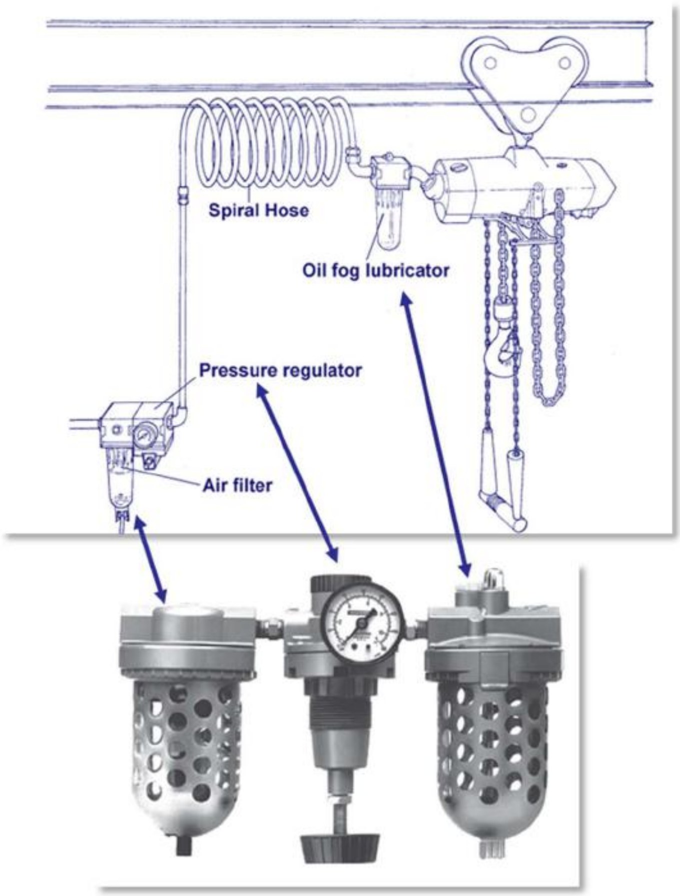
The epicyclic gear arrangement is chosen because it is compact and capable of transmitting high torques.
The load can be stopped and held in any position while raising or lowering by means of a 'fail-safe' brake.



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 below 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.



Notes from video:

Video recap: The preformed spiral PVC hose rests on the wire as shown. It extends and retracts like a spring when the hoist is moved.
The electrical cables occupy more space than cables when the hoist is at the end of the runway.
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.

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.

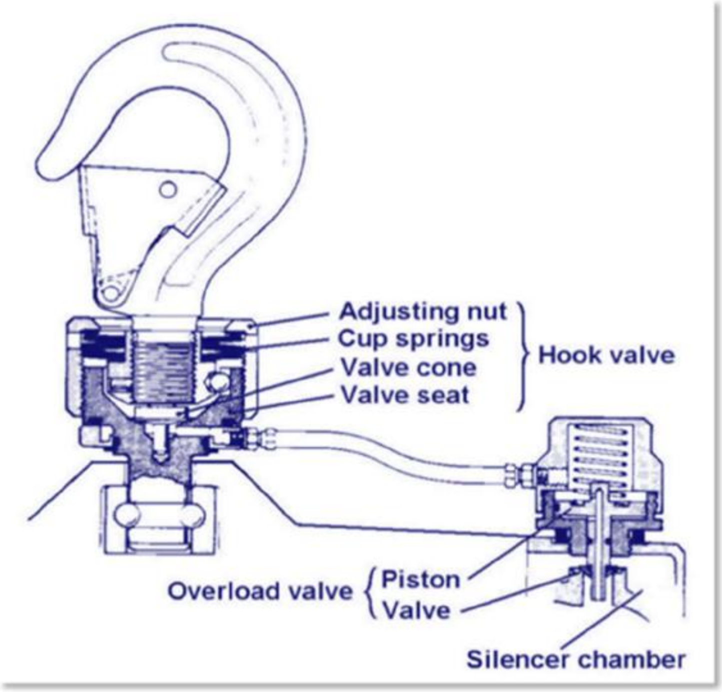
Air feed systems should be inspected on a regular basis and action taken to close leaks and replace damaged or worn hoses. Movement and flexing of hoses at the appliance entry port can cause a breakdown of the hose wall. Oil mist lubricators should be checked on a regular basis and oil levels topped 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.

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 below 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.

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.

The device is normally adjustable between the proof load (i.e. 1.25 x SWL/WLL) and 80% of the SWL/WLL.

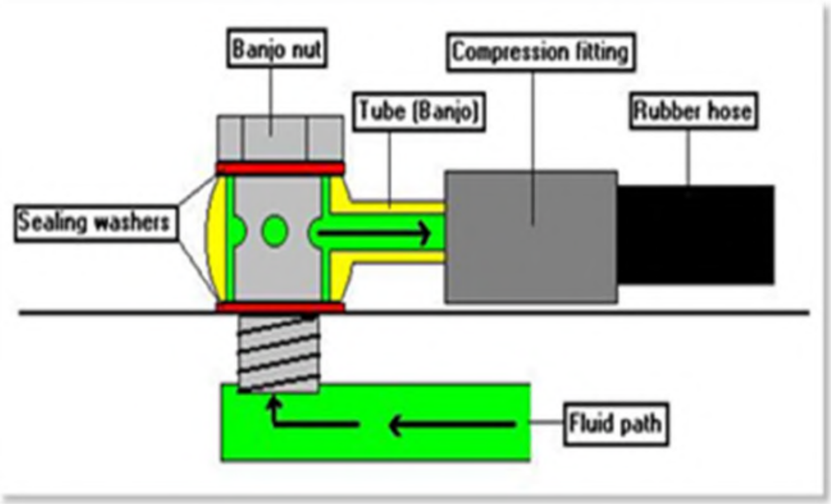
Banjo Fittings

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.


Banjo nut
Compression fitting
Tube (Banjo)
Rubber hose
Sealing washers
Fluid path

Limits and Controls

Requirements of EN 14492

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

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: Direct Acting: 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: '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

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

Defined Scope of Examination
The Thorough Examination

Having completed operational/functional checks, ensure that powered lifting machines are isolated and locked off before attempting to access them for examination work!

- 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 Standards, LEEA technical publications and in the LEEA correspondence courses.

Parts	
Maintenance	

Regularly Inspect

- 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

Note: Although not required by legislation, new powered 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 (where applicable). This document forms an important part of the record of the winch. It should be retained and cross-referenced to the hoists historical records for inspection by the Competent Person or relevant authorities.

Critical Components

- Hooks (suspension and load)
- Hoist structure
- Hoist brake and associated mechanisms (gearbox, couplings, chain wheel etc.)
- Load chain / Roller chain or wire rope and sheaves, where fitted
- Air supply valves, oilers, filters and directional controls plus
- Air supply system
- RCI/RCL and other safety devices
- Marking

Defined Scope of Examination

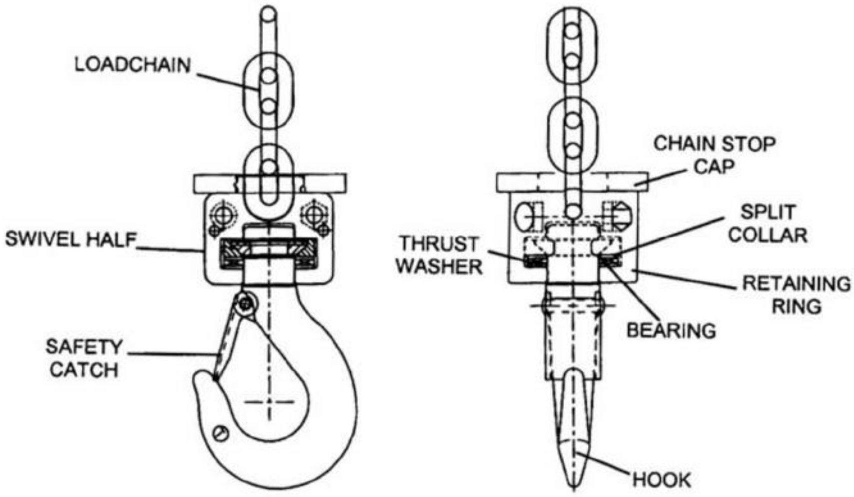
For each of the components checked in the defined scope and relevant supplementary testing the lifting equipment examiner will have a predefined list of acceptance and rejection criteria.

- 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

The following is a non-exhaustive list of such criteria:

Hooks, suspension and load

- Corrosion, cracks, damage, distortion, opening of the throat wear affecting the strength or functionality
- Security of attachment points and sub-structures, fasteners, welds, etc.
- Full or partial seizure of rotating components
- Safety catches are fitted and are effective (if applicable)



Hoist Structure:

- Corrosion, cracks, damage, distortion, wear affecting the strength or functionality
- Security of attachment points and sub-structures, fasteners, welds, etc.

Marking:

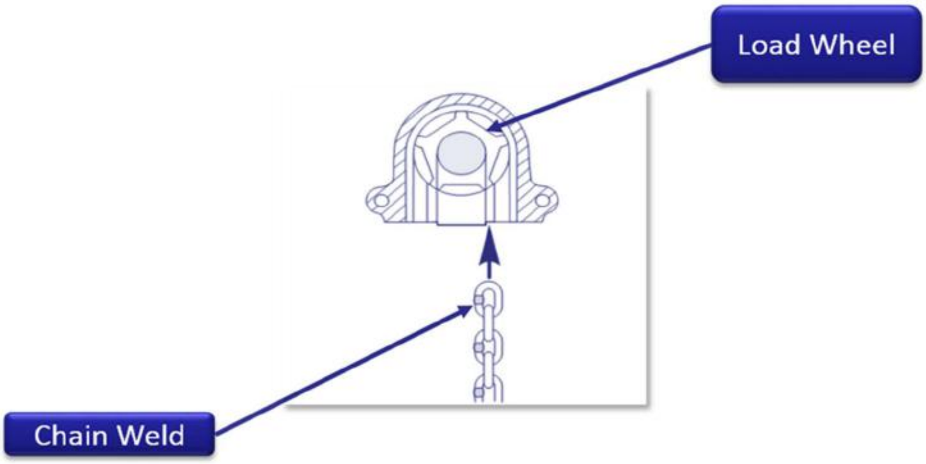
- The presence, accuracy and condition of markings, such as SWL, identification marks, chain grade for example

Hoist Mechanism:

Including motor, brake, couplings, gearbox, chain wheel and bearings
- Alignment within the manufacturers' tolerances
- Corrosion, cracks, damage, distortion, and wear affecting the strength or functionality
- Adequacy of lubrication
- Mode of operation as intended by the manufacturer
- 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
- Full or partial seizure of rotating components
- Chain fitted in correct orientation, as specified by the manufacturer
- Where applicable, check the air supply is cleaned and lubricated in accordance with the manufacturer’s instructions

Chain Orientation:

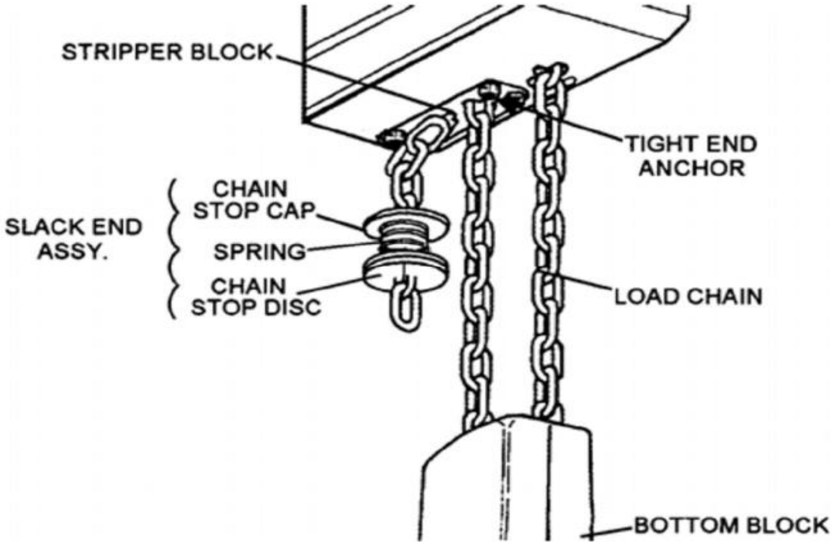
Manufacturers specify which way the load chain should be placed into the load wheel. Generally speaking, most manufacturers specify that the weld on the link of the load chain faces the load wheel, as shown below:



Note: 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.

Chain, terminations and anchorages, guides, pins, bearings, bottom block and hook(s)

- Corrosion, cracks, damage, distortion, wear, kinks, broken wires, etc. affecting the strength or functionality
- Adequacy of lubrication
- Full or partial seizure of rotating components
- Safety latches fitted and functioning correctly
- Security of attachment points and sub-structures, fasteners, welds, anchorages, etc.



- Chain; Corrosion, cracks, damage, distortion, elongation, wear and deposits that cannot be removed affecting the strength or functionality
- Chain; Links articulate freely
- Chain; Increase in gauge length which exceeds that manufacturer's recommendations. In the absence of manufacturer's recommendations, the chain should be replaced if the gauge length measured over any 5, 7, 9 or 11 links exceeds that of the unused chain by 2%. (reference ISO 7592)
- Chain; Interlink wear leaves a rough surface (maximum 8% - LEEA recommendation)
- Wire ropes and sheaves (for pneumatic wire rope hoists) follow examination guidance from earlier section for wire rope hoists

Traveling Trolleys
Types of Powered Trolleys

Notes from video:

This section of your training course 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.
This subject will be covered in the LEEA Overhead Travelling Cranes Advanced Programme.
For this section of the course, we will concentrate on the suspended (underslung) options, these are:

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

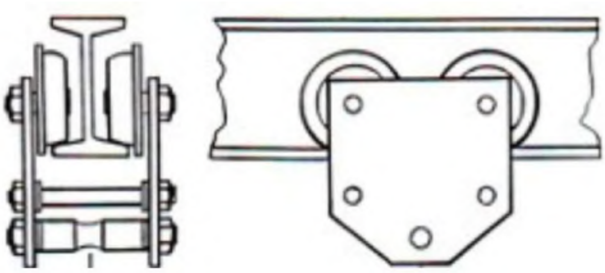
Hook/Eye Suspension

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

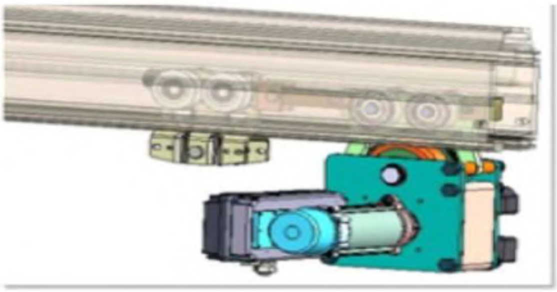
Manual Push-Travel Trolley



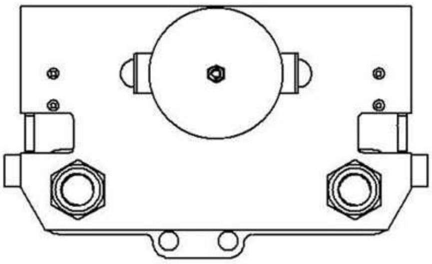
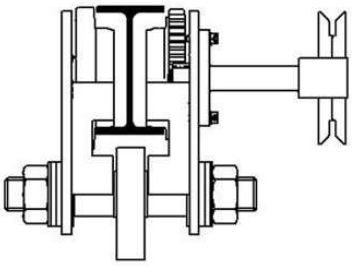
A simple, easy to install trolley option.

Hoist suspension directly to the trolley load bar.

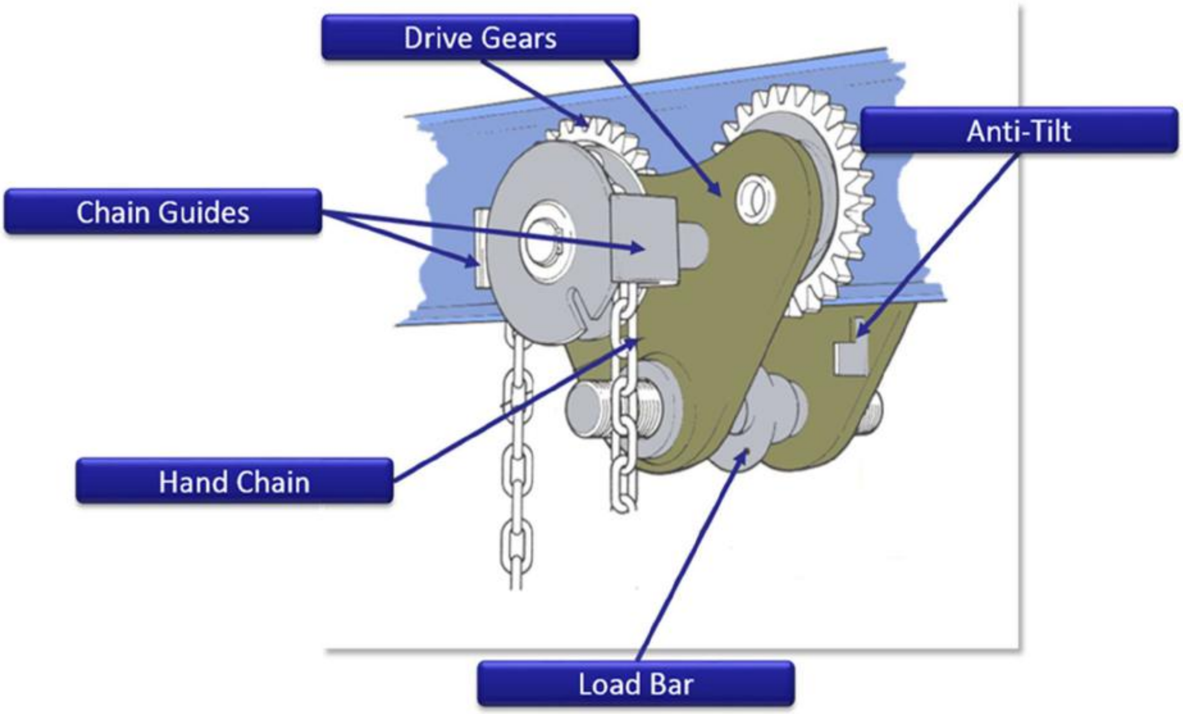

Light Crane System Trolleys



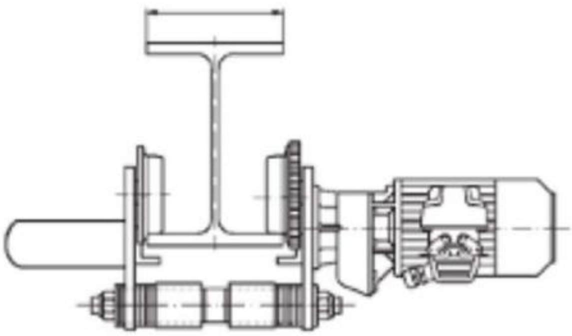

Hand Geared Trolley

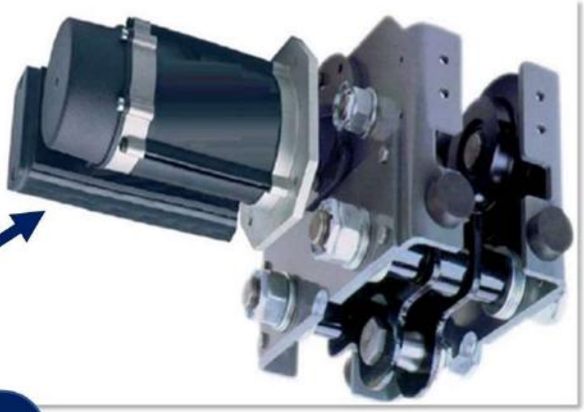



This is a manual trolley with a hand chain, allowing the operator to manually traverse the trolley into position. The hand chain wheel drives two geared runner wheels on the drive side of the trolley via a drive pinion gear.



Powered Trolleys





The trolley is fitted with an electric/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.

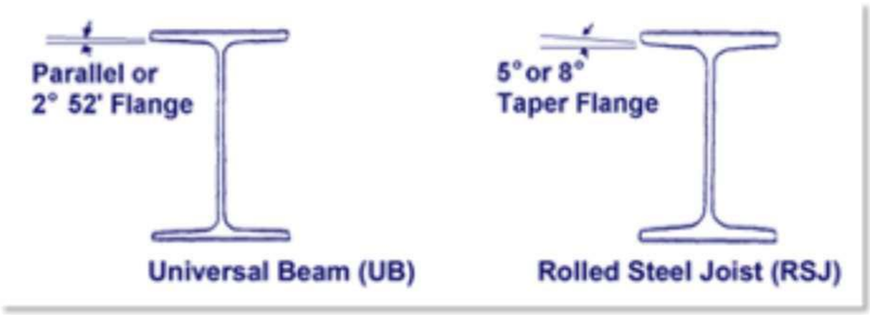
NOTES:

General Principles of Selection and Operation
Runway Beams and Traveling Trolleys

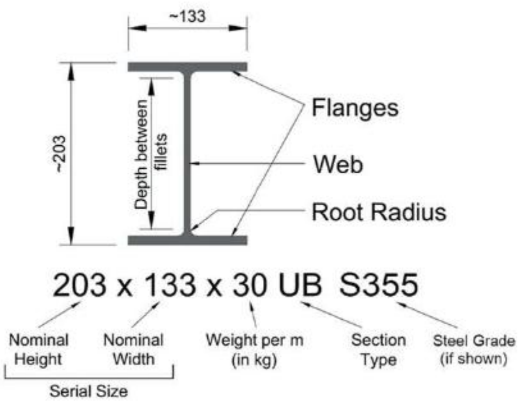
Runway beams are usually constructed in accordance with relevant national standards. Most modern runway systems utilise the universal beam section (UB). On older installations the runway may be of the old rolled steel joist section (RSJ).

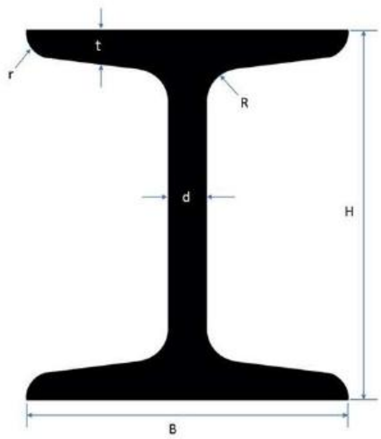
- RSJ stands for Rolled Steel Joist and is a layman's term used by builders and tradespeople who work with steel. It's actually a long beam made from hot or cold-rolled steel.
- UB stands for Universal beam, commonly known as I beams, are probably the most commonly-used steel product throughout the construction industry.
    - The design and shape of steel I beams make them capable of withstanding a variety of different heavy loads.

The standard steel beam is, typically, a long structure consisting of two horizontal plates (known as flanges), connected by a vertical component (known as the web). The shape of these steel flanges and web create an "I" cross-section, hence their common industry name.



The illustrations below shows a typical Universal Beam with its technical details, and an RSJ showing key dimensions:



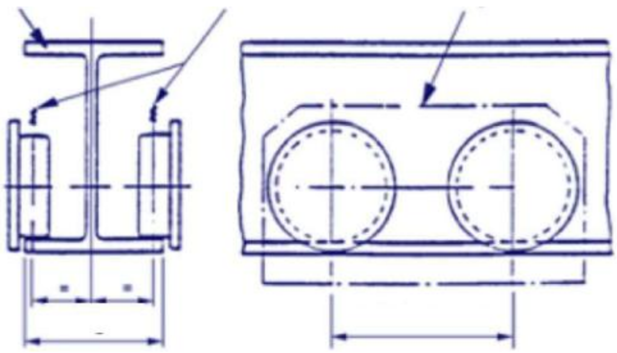


What is the main difference?

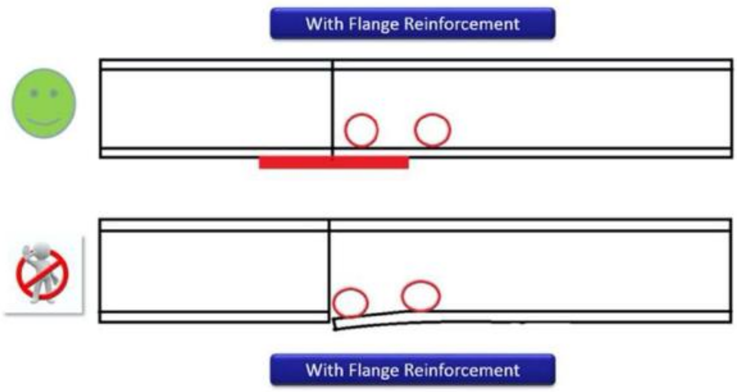
Runway Beam Flange Bending

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

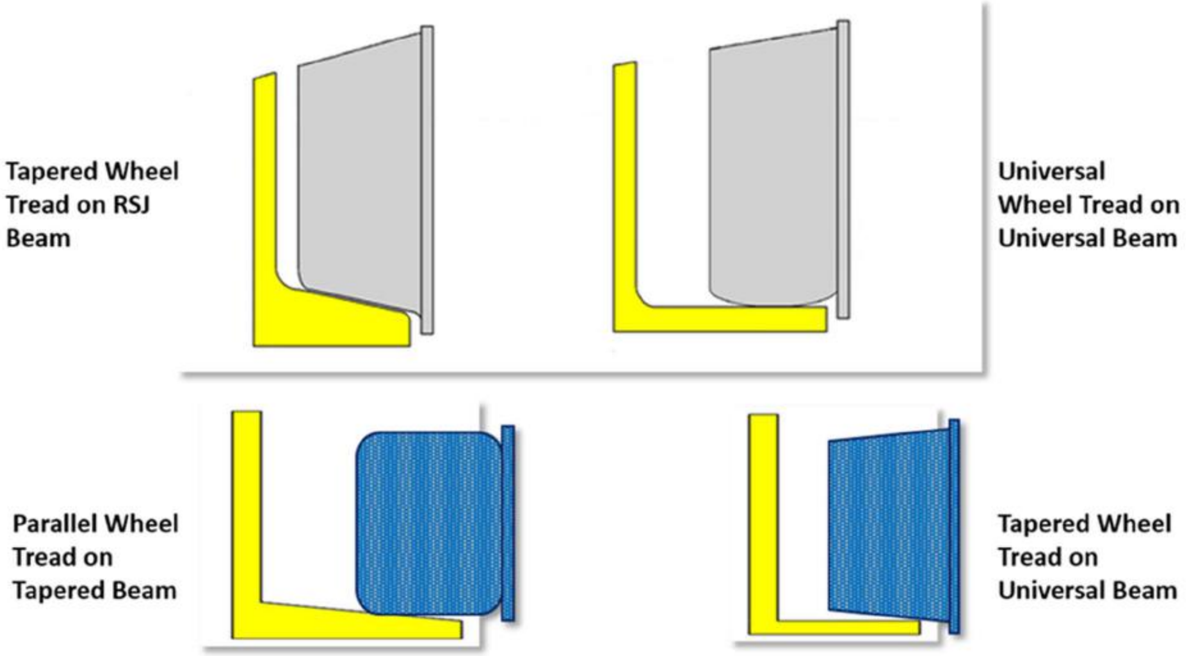


Note: If a runway is joined and has no reinforcing of the lower flange at the join then the flange is considerably weakened and could cause local permanent set at the joint.

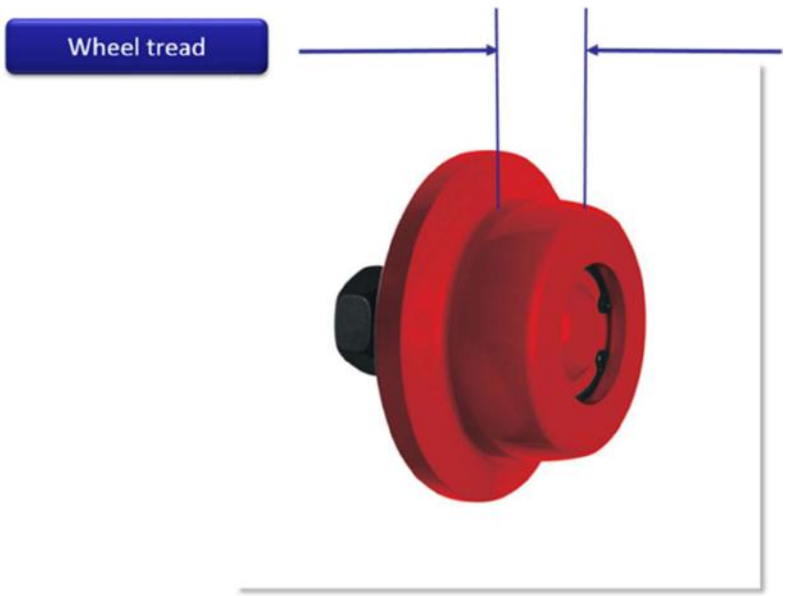


Trolley Wheel Profiles

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.



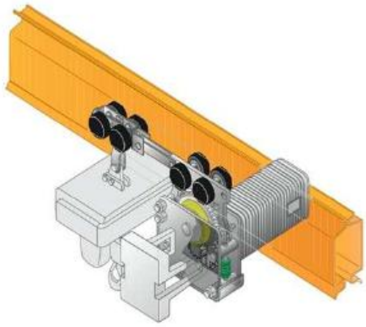
The modern trolley runner has a radius end profile (wheel tread), although small, allowing it to sit correctly on either type of flange:



Light Duty Crane Trolleys

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.

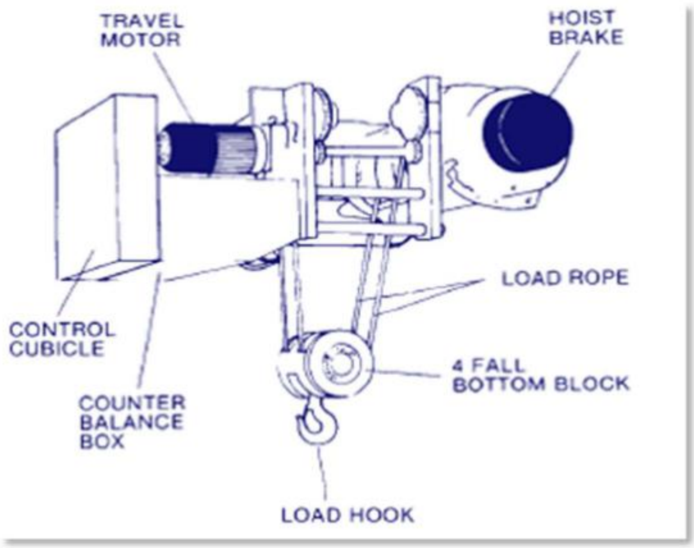


Traveling Trolley Fleet Angles

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 limited, 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.

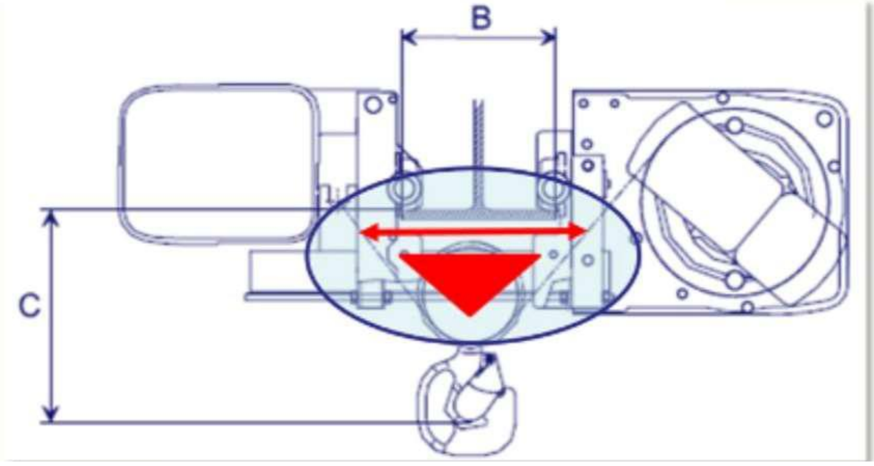


Rope Fleet Angles

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

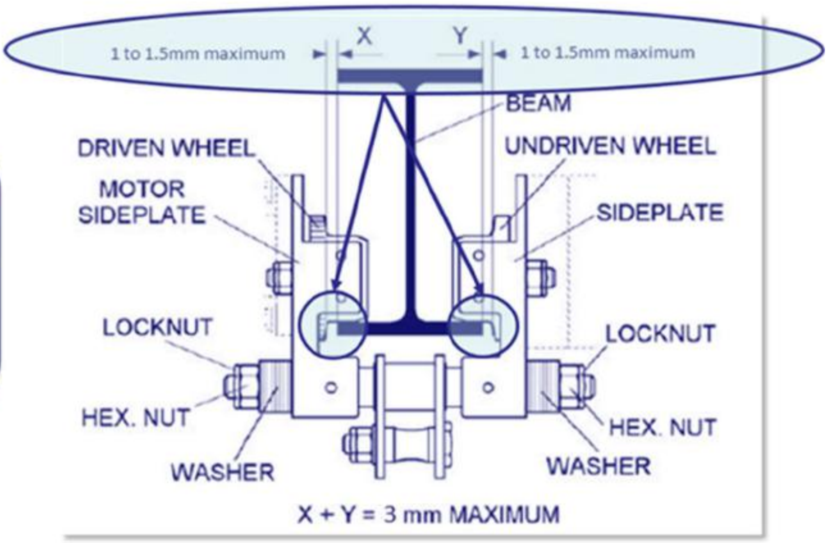
There are several different methods of adjusting the trolley to suit the width of girder flange on which they are to run and some are made to a fixed width.

- 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

Typical trolley adjustment

X + Y = 2-3mm maximum

Always follow manufacturers recommendations



Another, increasingly popular, method of adjustment is the use of a load bar which is threaded left and right hand into the side plates. The arrangement shown below utilises an adjustment handle which opens and closes the trolley to suit the width of the runway beam flange:

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.

Defined Scope of Examination
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.

In-Service Inspection (Interim)
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 marking

The Thorough Examination
Having completed operational/functional checks, ensure that powered lifting machines are isolated and locked off before attempting to access them for examination work!

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 (where applicable). 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 authorities.

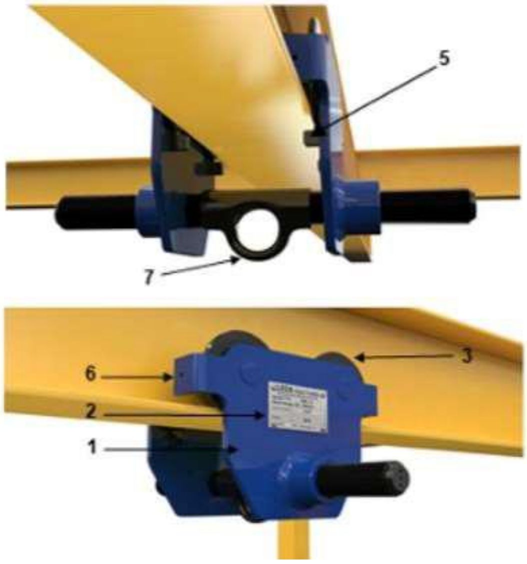
Adequate lighting	
Clean machinery	
Competent Person	
Standard procedures of examination	
Parts	

Note: The operation of mating parts must be checked and observed and other vital mechanisms must be checked for safe and correct operation

Critical Components

1. Trolley structure
2. Marking
3. Travel drive, wheels, gears, axels, bearings and brakes, where applicable
4. Hand chain, where applicable
5. Safety devices, e.g. anti-tip
6. Buffers
7. Load suspension point

Travelling Girder Trolleys



Geared Trolley

Supplementary testing

Supplementary testing of manual trolleys will largely depend upon the nature of the examination.

Common examples of testing that the lifting equipment examiner may use to support the thorough examination of a trolley are as follows:

- Operational testing
- Proof load testing

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.

Defined Scope of Examination

Trolley Structure

- Corrosion, cracks, damage, distortion, wear, affecting the strength or functionality.
- Security of attachment points and sub-structures, fasteners, welds, etc.

Marking

- The presence, accuracy and condition of markings, such as SWL, identification marks, chain grade for example.

Travel drive wheels, gears, axels, bearings and brakes, where applicable

- Alignment within the manufacturers tolerances or in accordance with a recognised standard, for example, EN 13157
- Corrosion, cracks, damage, distortion, wear affecting the strength or functionality
- Adequacy of lubrication
- Mode of operation as intended by the manufacturer
- Full or partial seizure of rotating components
- 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
- Check bearing/wheel stub axles for wear and deformation

Hand Chain, where applicable

- Corrosion, cracks, damage, distortion, elongation, wear and deposits that cannot be removed affecting the strength or functionality
- Links articulate freely

Safety Devices, e.g. anti-tilt

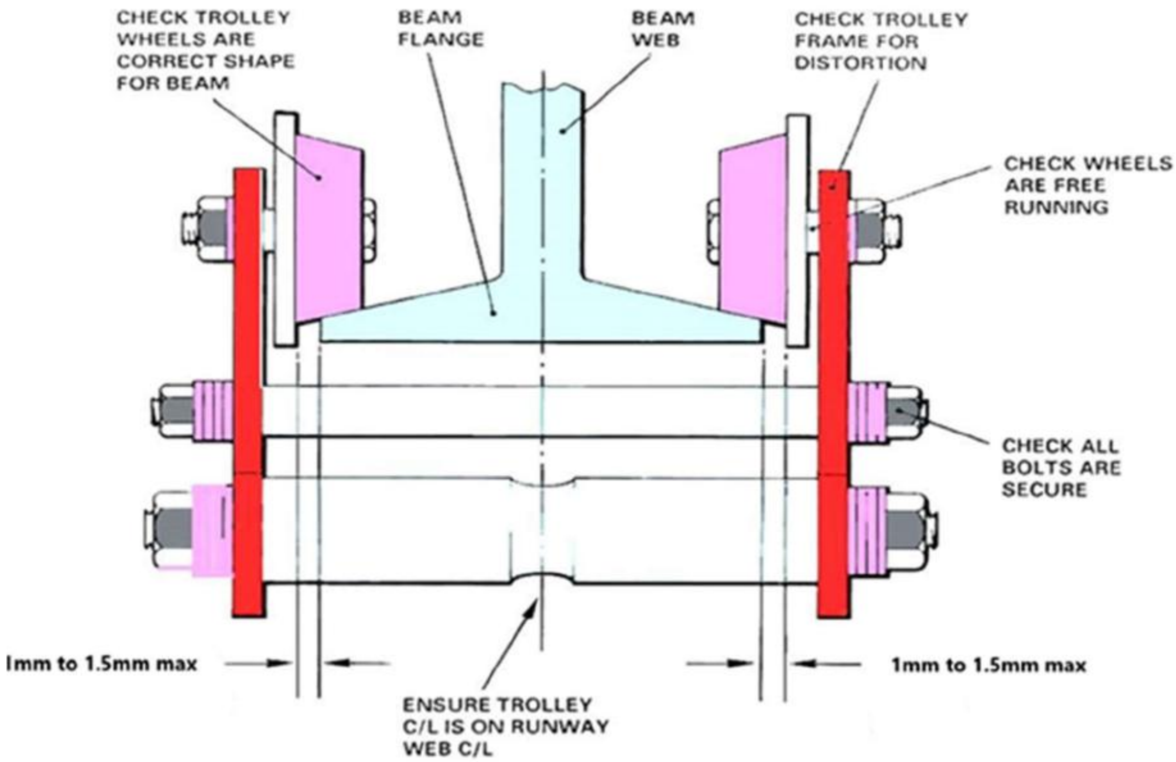
- Operation as intended by the manufacturer (anti-tip/tilt prevents the trolley from disengaging from the runway flanges
- Corrosion, cracks, damage, distortion, wear affecting the strength or functionality
- Security of attachment points and sub-structures, fasteners, welds, etc.

Buffers

- Corrosion, cracks, damage, distortion, wear affecting the strength or functionality
- Security of attachment points and sub-structures, fasteners, welds, etc.

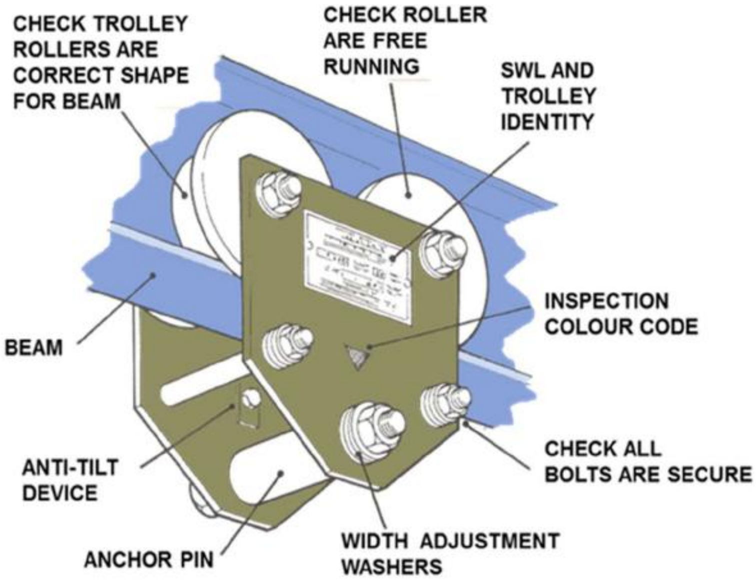
Load suspension point

- Corrosion, cracks, damage, distortion, opening of the throat wear affecting the strength or functionality
- Security of attachment points and sub-structures, fasteners, welds, etc.
- Full or partial seizure of rotating components



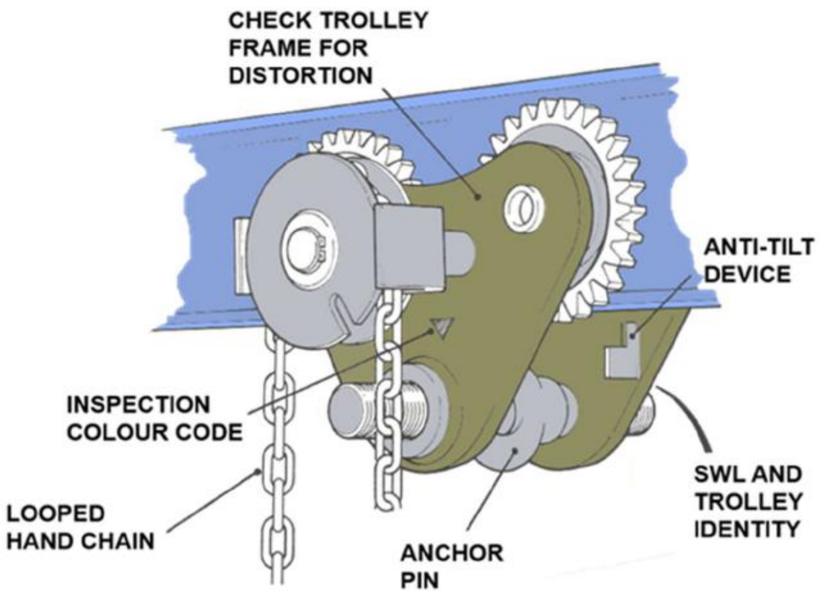
When examining a hoist with trolley mounted on a runway the runway must also form a part of the examination:

- 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
- Check the markings on the trolley (i.e. SWL/WLL, distinguishing number, manufacturer's name) against the test certificate



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:

- ____
  ____
- ____
  ____
- ____
  ____
- ____
  ____
  ____
- ____
  ____

In addition, for trolleys fitted to the runway beam, 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

NOTES:

Power Feed Systems
Types of 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.

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	
2	
3	
4	
5	

In the past, bare copper conductors were used to provide a power supply for overhead travelling cranes.

Bare Copper Conductors

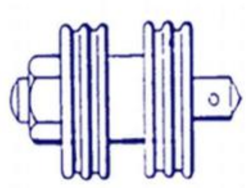
Although this system is considered unsuitable for new installations nowadays, it was widely used in the past on all types of installations. Many of these old installations may still be found in service.

The general advice is to review the installation;

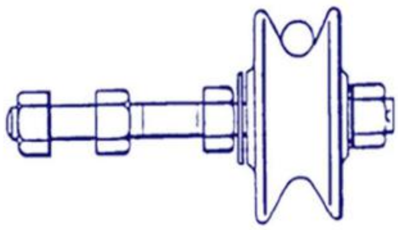
- It may be that the bare wires present a possible danger to people working in the area
  - In this case the advice must be given to change this for a more suitable supply system
- On the other hand, it may be considered that the system is safe by virtue of its position
  - In this case it may be left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

Note: that the owner of the equipment has a duty of care to ensure that a safe system of work is always provided. This must be taken into account when making assessment as to whether or not any existing bare copper conductors are safe to continue in service

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.
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.



Insulating Conductor Bracket

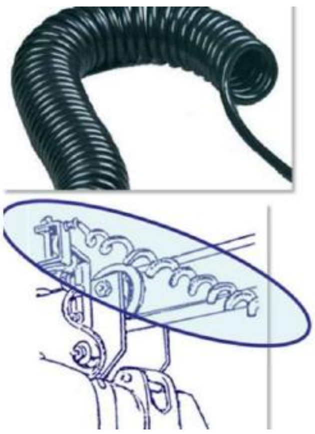


Wheel Type Collector

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 payed 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.

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

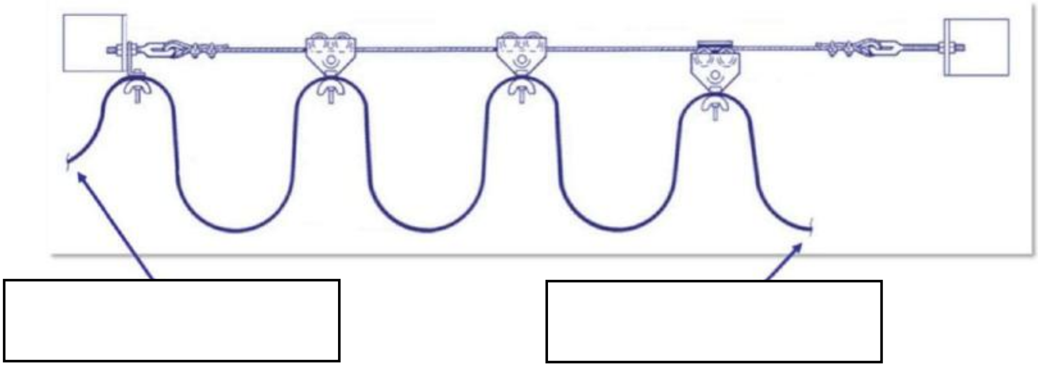
Reeling Configurations: Rated cable capacities should be further de-rated according to the configuration of the reel to be chosen.

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

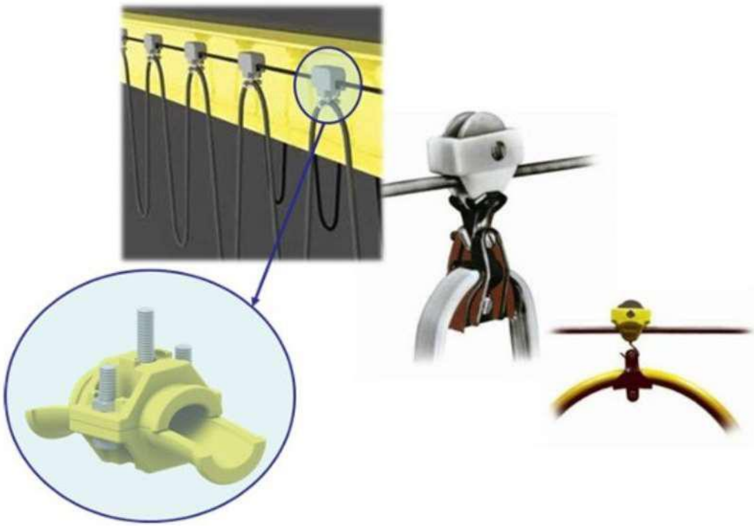
Note: Although not expected to design electrical power supply systems the Tester and Examiner would be expected to understand the fundamental requirements of a system to enable him for example to identify the reason for a performance deficiency of a hoist under test.

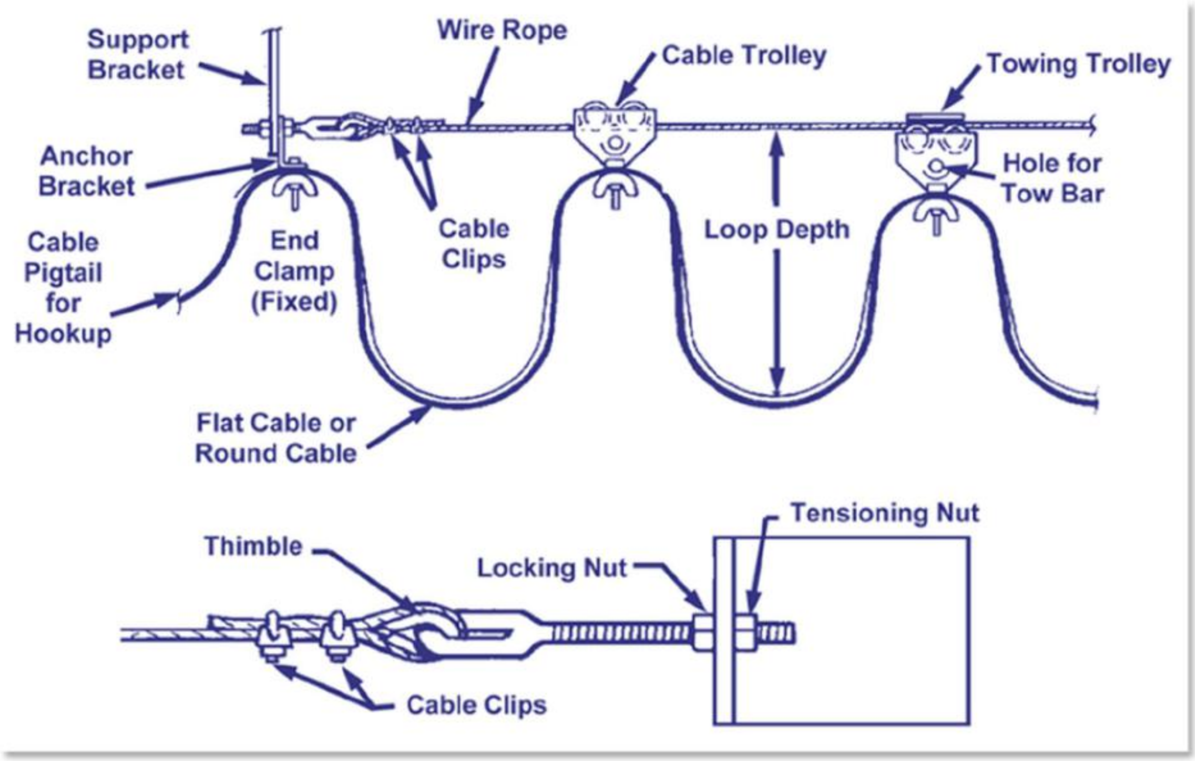
Taut Wire

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.



Festoon Trolleys





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.

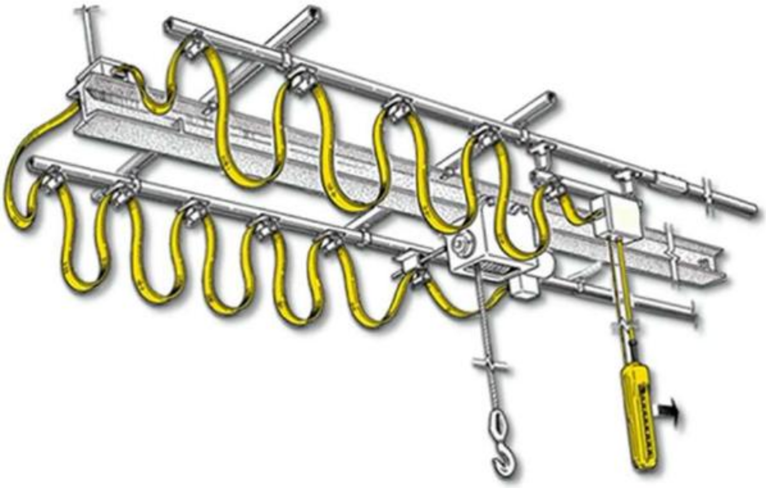
The manufacturers of these systems offer a range of profile sections for most loading conditions from light to heavy duty.

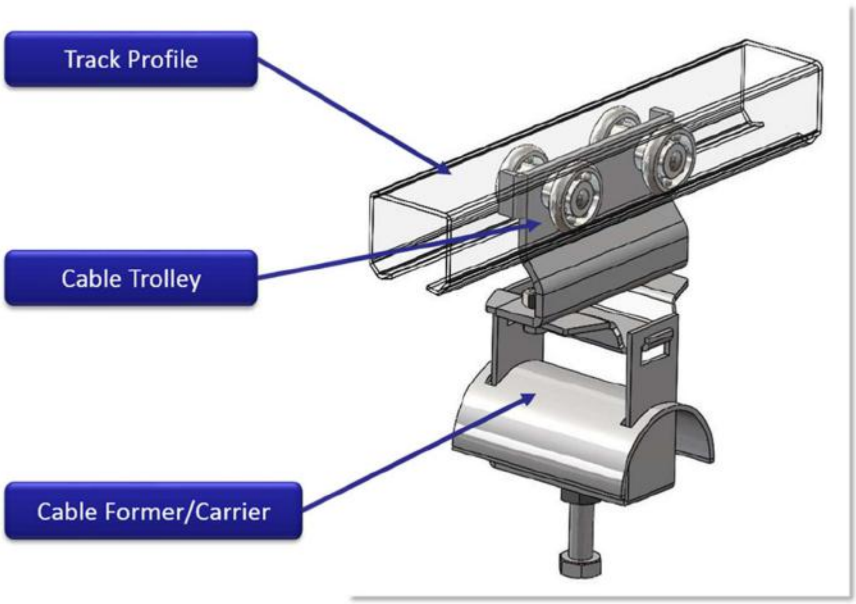
The tracked festoon systems are very safe with perfect insulation hence no loss of energy or voltage drop where current has to pass from conductor to collector. Also on long track installations the size of cables would need to be increased to limit voltage drop hence requiring a heavier track system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

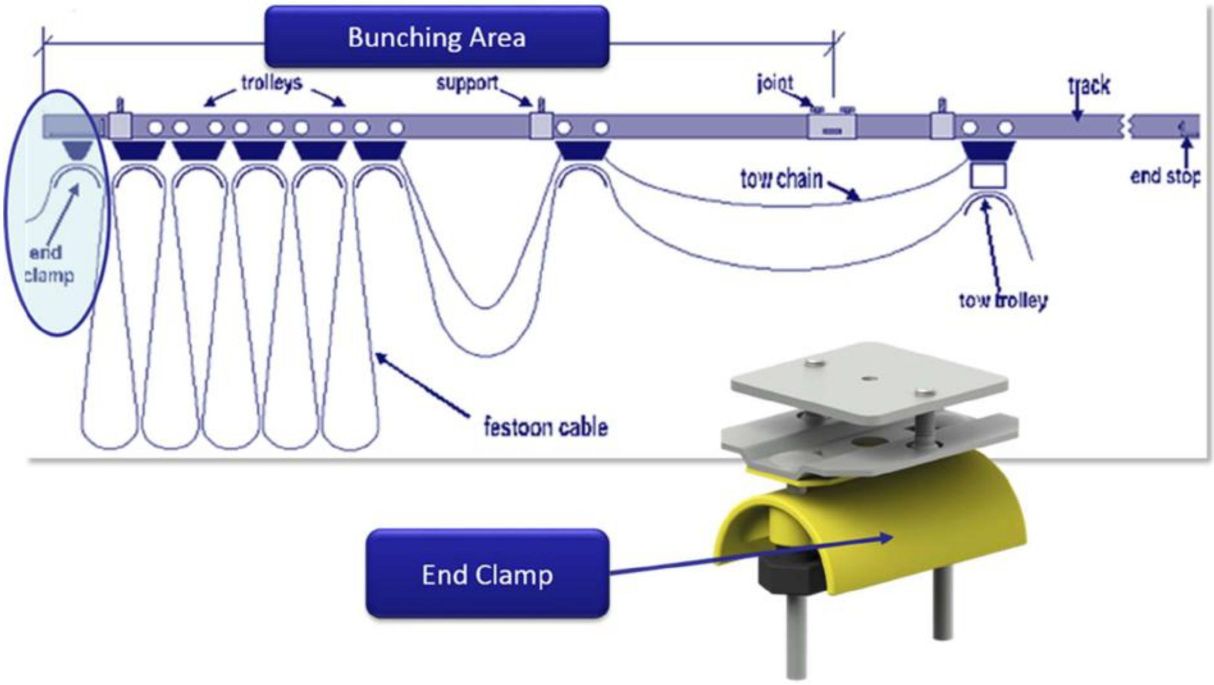
The image below provides an example of an underslung single-girder crane which incorporates a taut wire conductor system supplying power to the hoist across the span of the crane bridge, and for the power supply along the supporting gantry beams we can see that a tracked cable system has been used to incorporate the longer length, hence weight of the cables it is supporting.

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.

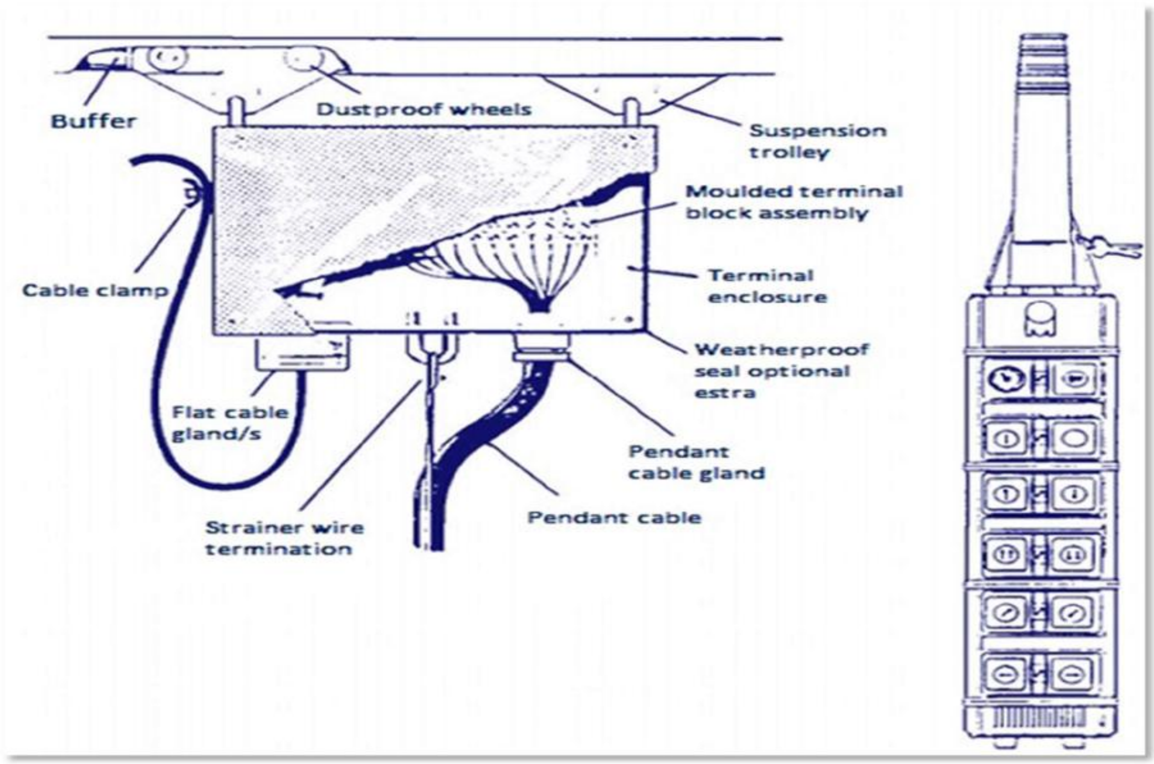




A limiting factor of the festoon system could be loss of travel of the hoist unit due to bunching of the trolleys especially on long track applications.



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

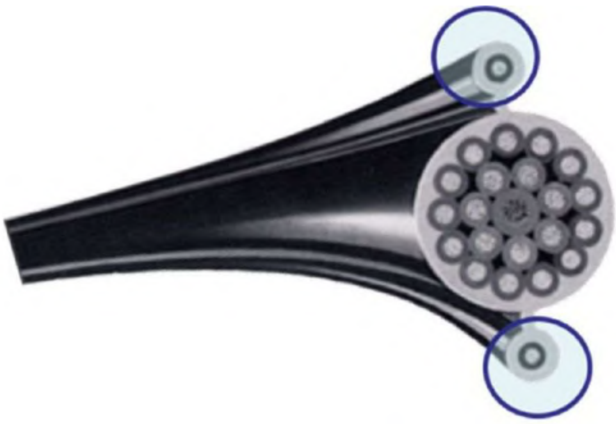


Hoist Control

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.

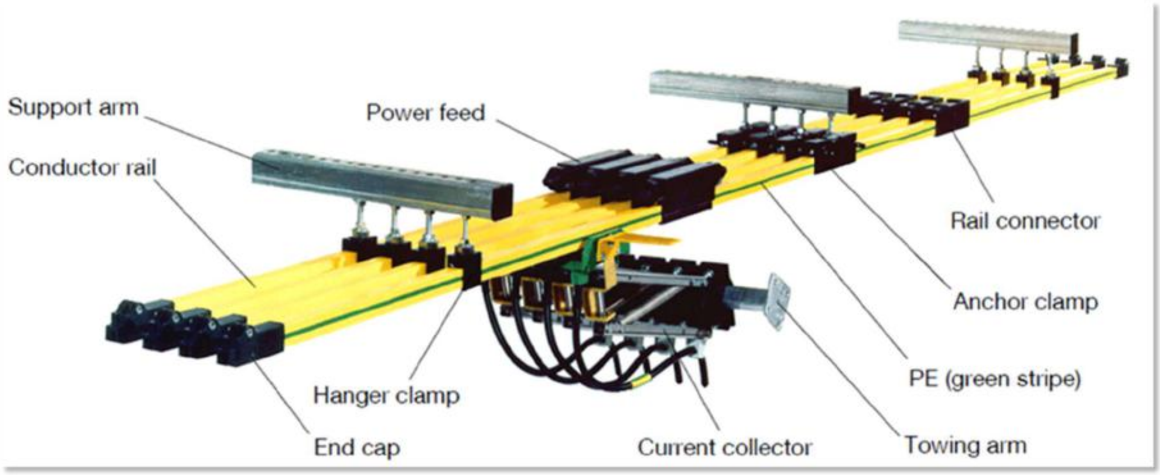
Pendant Cables

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.

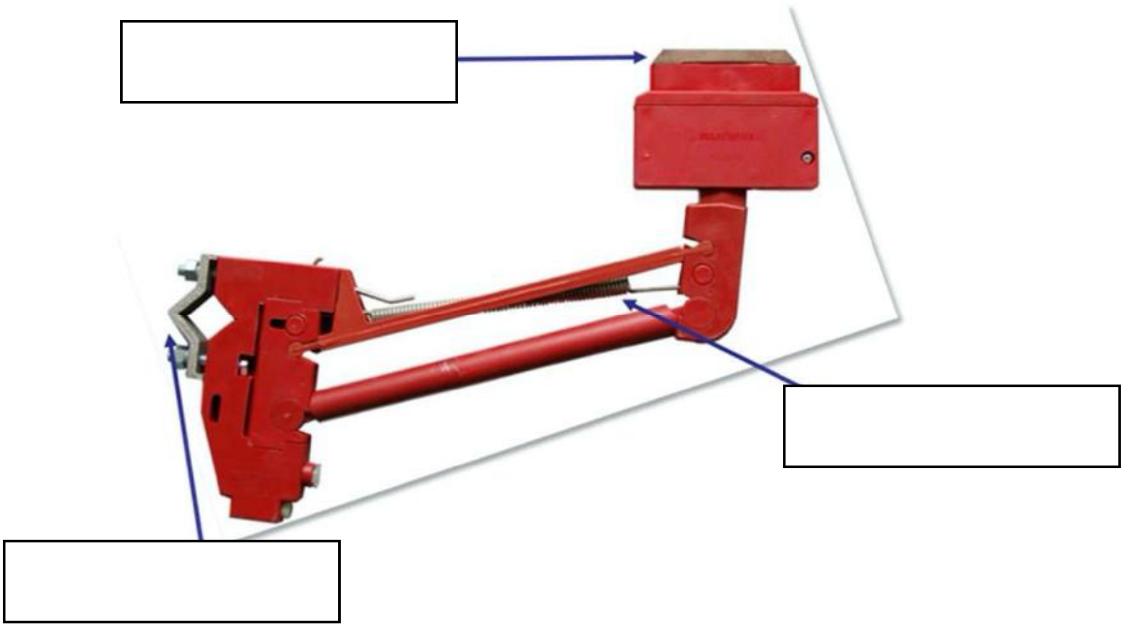


Insulated Conductors

Shrouded conductor systems 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.

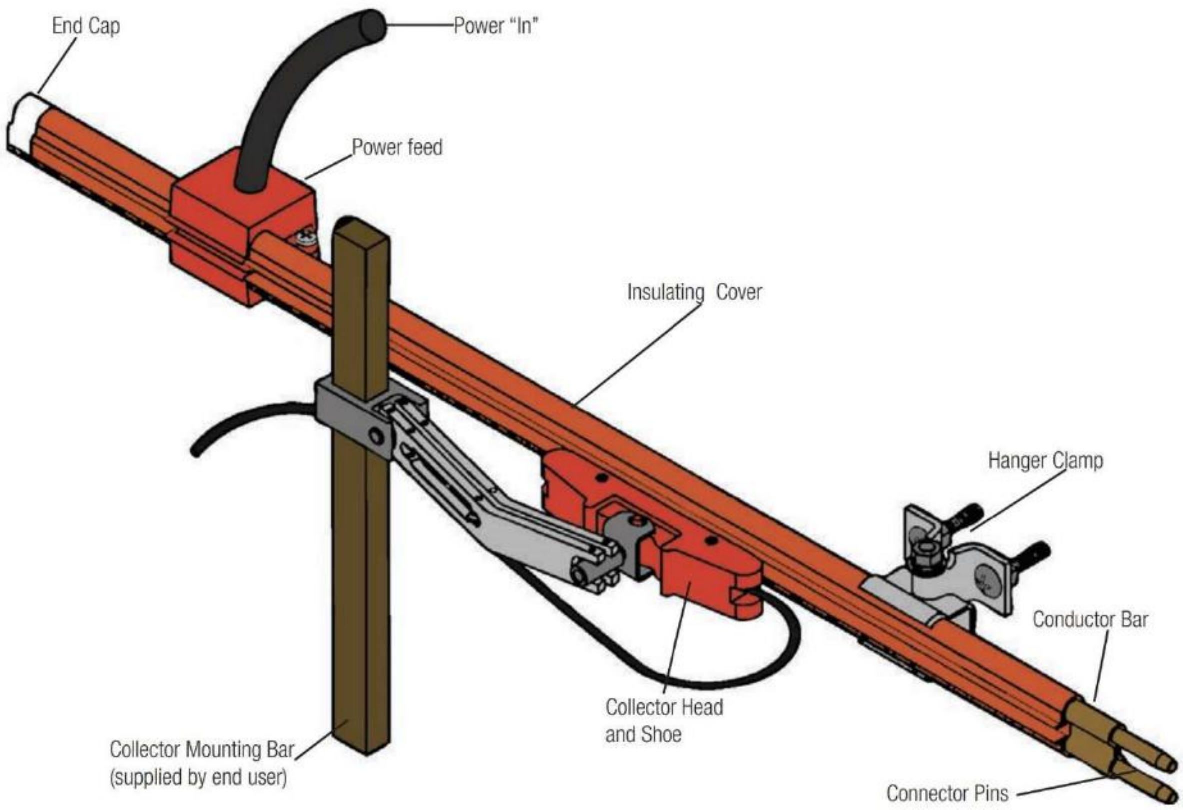


The collection assembly is spring loaded to ensure good contact with the conductor bar and articulated to enable the contact shoe to follow the track without binding.



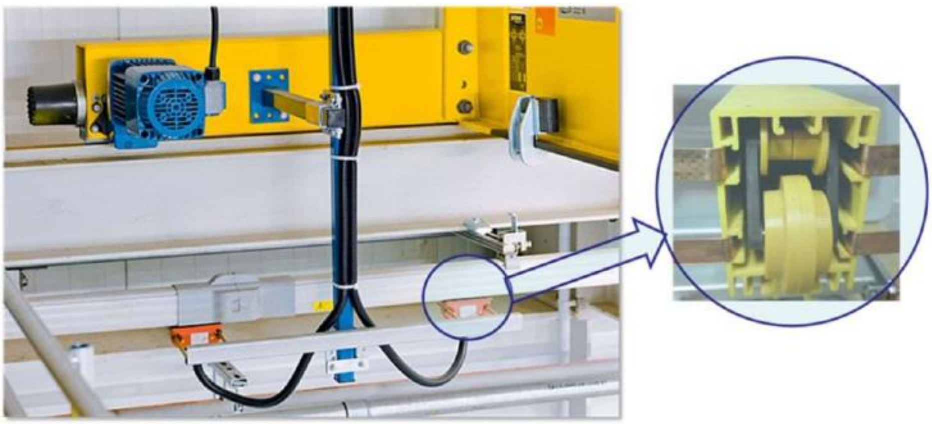
When mounted in position, note that the earth conductor is always mounted external from the gantry beam/runway so that a live conductor is not exposed externally. This mitigates risk from accidental contact with an exposed conductor.

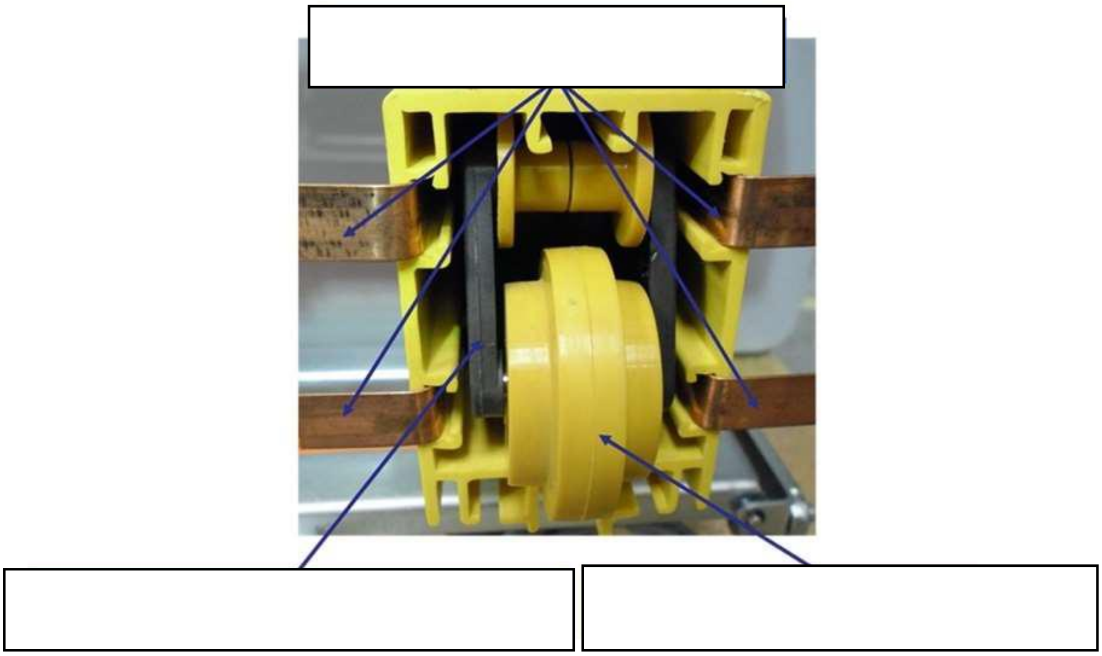
Multi-bar conductor systems may be mounted vertically, as shown above, or horizontally, as shown below:



Totally Enclosed Conductor Systems

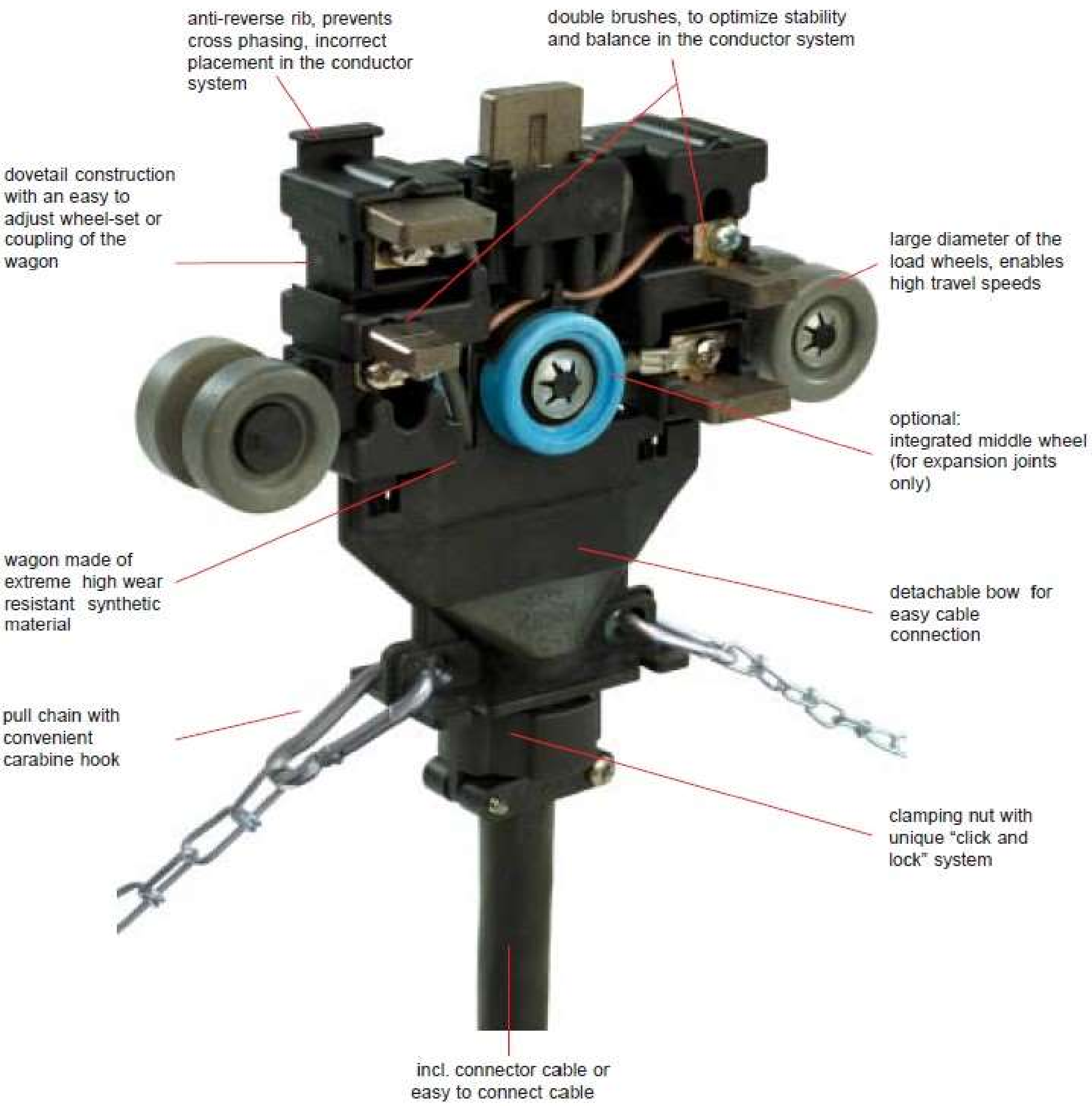
A totally enclosed conductor system is used where multiple conductors are required in one housing. It is a rigid and compact system. They are commonly used in overhead crane applications but also for traveling hoists.

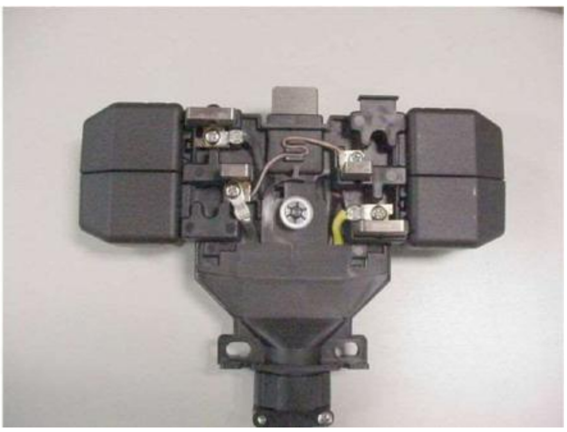




These systems have the advantage of needing very little maintenance and can be provided with a flexible seal to prevent ingress of dust and moisture. They provide a compact, reliable and safe power supply for cranes and hoisting equipment:

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


anti-reverse rib, prevents cross phasing, incorrect placement in the conductor system
double brushes, to optimize stability and balance in the conductor system
dovetail construction with an easy to adjust wheel-set or coupling of the wagon
large diameter of the load wheels, enables high travel speeds
optional: integrated middle wheel (for expansion joints only)
wagon made of extreme high wear resistant synthetic material
detachable bow for easy cable connection
pull chain with convenient carabine hook
clamping nut with unique "click and lock" system
incl. connector cable or easy to connect cable



The additional 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 conductor 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.
The picture below shows a typical power supply arrangement which feeds the conductors from one end of the conductor track. Note the isolator is lockable for safe access to carry out thorough examination of the supply system.

The picture below shows a typical power supply arrangement which feeds the conductors from one end of the conductor track. Note the isolator is lockable for safe access to carry out thorough examination of the supply system.

Energy Chain Systems

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

Explosion Proof Hoist marking

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.

Note: 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.

Defined Scope of Examination

Thorough Examination

It is essential that a 'lock-out/tag-out' isolation procedure is followed and controlled by the person conducting the examination work. Where more than one worker is exposed to the system, a multi-lock padlock hasp must be used and each worker places their padlock in the hasp. This ensures that the power supply cannot be reconnected until all workers are no longer exposed and have removed their own isolation.

Note: Please be warned, that if you do not adhere to carefully controlled isolation of power supplies prior to access for examination work, the consequences can be fatal!

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.

Notes from video:

The Lifting Equipment Engineers Association (LEEA) is established across the world as the leading trade association for all those involved in the lifting industry.

We make no apology for repeating this extremely important safety information!

Think back to the very early stages of this course and our vision statement.
What does the vision statement commit to? Well, you should remember that we are proud to promote our vision and commitment to lifting and height safety industries which have eliminated accidents, injuries and fatalities.

You are therefore reminded that 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.
Thank you for your attention.

Summary

On completion of this training course, you will sit your end-point assessment (exam) for the qualification of Powered Lifting Machines (Global) Diploma. On successful completion, you will receive a LEEA Diploma and TEAM Card. Existing TEAM Card holders will have this qualification added to their profile. Further Resources

LEEA COPSULE (Code of Practice for the Safe Use of Lifting Equipment) Edition 9 -November 2019 ISBN 978-0-9930124-0-2

LIFTING EQUIPMENT – A USER'S POCKET GUIDE (5th Edition) – A6 Pocket Guide published by LEEA – www.leeaint.com

LEEA Lifting Equipment Examiner's Handbook

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We would be grateful for your feedback regarding this Workbook, after completing this training course. Please make your comments known to your LEEA Facilitator – 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 for in advance for your participation.

Andrew Wright LEEA Deputy CEO

Notes: