

Product Safety: Instructions & Warnings on the use of steel wire rope

The following Instructions and Warnings combine to provide guidance on Product Safety and are intended for use by those already having a working knowledge of wire ropes, as well as the new user. They should be read, followed and passed on to others.

Failure to read, understand and follow these instructions could result in harmful and damaging consequences.

A 'Warning' statement indicates a potential hazardous situation which could result in a significant reduction in rope performance and/or put at risk, either directly or indirectly, the safety or health of those persons within the danger zone of the rope and its associated equipment.

Note: As a result of the creation of the single European market and the 'New Approach' Directives which set out 'essential requirements' (e.g. for safety) designers, manufacturers, suppliers, specifiers and users need to keep themselves abreast of any changes to the appropriate Regulations and national standards.

1. Storage

1.1 Unwrap the rope and examine the rope immediately after delivery to check its identification and condition and verify that it is in accordance with the details on the Certificates and/or other relevant documents.

Note: The rope should not be used for lifting purposes without the user having a valid Certificate in his possession.

Check the rope diameter and examine any rope terminations to ensure that they are compatible with the equipment or machinery to which they are to be fitted. (See Fig. 1)



Fig 1

1.2 Select a clean, well ventilated, dry, undercover location. Cover with waterproof material if the delivery site conditions preclude inside storage.

Rotate the reel periodically during long periods of storage, particularly in warm environments, to prevent migration of the lubricant from the rope.

⚠ WARNING

Never store wire rope in areas subject to elevated temperatures as this may seriously affect its future performance. In extreme cases its original as-manufactured strength may be severely reduced rendering it unfit for safe use.

Ensure that the rope does not make any direct contact with the floor and that there is a flow of air under the reel.

⚠ WARNING

Failure to do so may result in the rope becoming contaminated with foreign matter and start the onset of corrosion before the rope is even put to work.

Support the reel on a simple A-frame or cradle, located on ground which is capable of supporting the total mass of rope and reel. (See Fig. 2) Ensure that the rope is stored where it is not likely to be affected by chemical fumes, steam or other corrosive agents.

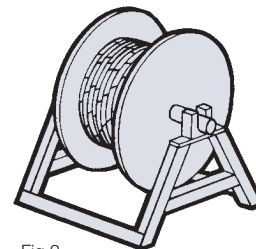


Fig 2

⚠ WARNING

Failure to do so may seriously affect its condition rendering it unfit for safe use.

1.3 Examine ropes in storage periodically and, when necessary, apply a suitable dressing which is compatible with the manufacturing lubricant. Contact the rope supplier, Bridon or original equipment manufacturer's (OEM) manual for guidance on types of dressings available, methods of application and equipment for the various types of ropes and applications.

Re-wrap the rope unless it is obvious that this will be detrimental to rope preservation. (Refer to the relevant Product Data sheets on rope dressings for more detailed information.)

⚠ WARNING

Failure to apply the correct dressing may render the original manufacturing lubricant ineffective and rope performance may be significantly affected.

Ensure that the rope is stored and protected in such a manner that it will not be exposed to any accidental damage either during the storage period or when placing the rope in, or taking it out of storage.

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⚠ WARNING

Failure to carry out or pay attention to any of the above could result in a loss of strength and/or a reduction in performance. In extreme cases the rope may be unfit for safe use.

2. Certification and Marking

Make sure that the relevant Certificate has been obtained before taking the rope into use for a lifting operation. (Refer to statutory requirements)

Check to verify that the marking on the rope or its package matches the relevant Certificate.

Note: The rating of a component part of a machine or lifting accessory is the responsibility of the designer of the machine or accessory. Any re-rating of a lifting accessory must be approved by a competent person.

Retain the Certificate in a safe place for identification of the rope when carrying out subsequent periodic statutory examinations in service. (Refer to statutory requirements)

3. Handling and Installation

- 3.1** Handling and installation of the rope should be carried out in accordance with a detailed plan and should be supervised by a competent person.

⚠ WARNING

Incorrectly supervised handling and installation procedures may result in serious injury to persons in the vicinity of the operation as well as those persons directly involved in the handling and installation.

- 3.2** Wear suitable protective clothing such as overalls, industrial gloves, helmet, eye protectors and safety footwear (and respirator, particularly where the emission of fumes due to heat is likely).

⚠ WARNING

Failure to wear suitable protective clothing and equipment may result in skin problems from over exposure to certain types of rope lubricants and dressings; burns from sparks, rope ends, molten lubricants and metals when cutting ropes or preparing sockets for re-use; respiratory or other internal problems from the inhalation of fumes when cutting ropes or preparing sockets for re-use; eye injuries from sparks when cutting ropes; lacerations to the body from wire and rope ends; bruising of the body and damage to limbs due to rope recoil, backlash and any sudden deviation from the line of path of rope.

- 3.3** Ensure that the correct rope has been supplied by checking to see that the description on the Certificate is in accordance with that specified in the purchaser's order.

- 3.4** Check by measurement that the nominal diameter of the new rope conforms to the nominal size stated on the Certificate.

For verification purposes, measure the diameter by using a suitable rope vernier fitted with jaws broad enough to cover not less than two adjacent strands. Take two sets of measurements spaced at least 1 metre apart, ensuring that they are taken at the largest cross-sectional dimension of the rope. At each point take measurements at right angles to each other.

The average of these four measurements should be within the tolerances specified in the appropriate Standard or Specification.

For a more general assessment of rope diameter use a rope calliper. (See Fig 1)

- 3.5** Examine the rope visually to ensure that no damage or obvious signs of deterioration have taken place during storage or transportation to the installation site.
- 3.6** Check the working area around the equipment for any potential hazards which may affect the safe installation of the rope.
- 3.7** Check the condition of the rope-related equipment in accordance with the OEM's instructions. Include the following -

Sheave and Drum Sizes

Regulations throughout the world quote various minimum D:d ratios for differing rope constructions and these must be considered when selecting a suitable hoist rope. However as guidance the following D:d ratios are recommended.

6 Stranded ropes 80:1

Multi Stranded ropes 80:1

Locked coil ropes 100-120:1 depending upon rope diameter.

(In addition the drum to outer wire ratio should be between 1000 and 1500:1)

Factors such as speed can necessitate an increase in the D:d ratio and in certain circumstances a D:d ratio below the recommended value can be tolerated but some reduction in rope life should be expected.

BRIDON's Mining Division will be pleased to advise on this subject.

Sheave Grooves

Groove diameters should be such that they can accommodate a new rope taking into account the relevant oversize tolerance and the fleet angles involved to provide adequate circumferential support.



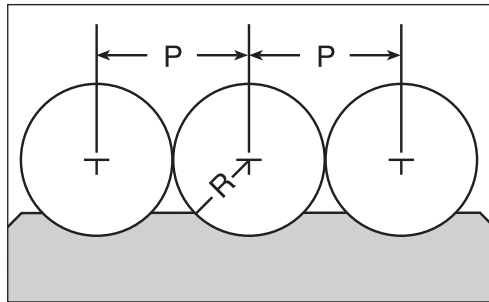
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A groove diameter of 7.5% greater than the nominal rope diameter is normally acceptable. However in certain cases experience has shown that clearances between 10 and 12.5% are required to obtain optimum performance.

Before installing a new rope all sheave grooves should be checked to ensure they provide the recommended clearance.

Drum Grooves

On single layer drum hoists spiral grooving is recommended. Where multilayer coiling is necessary then parallel grooves or one of the patterned coiling systems should be used. In all cases correct pitch, clearance and groove depth are essential to obtain good rope performance.



Dimensions for grooving of drums

General recommendations for stranded ropes

$P = \text{nominal diameter} + 5\%$

$R = \text{nominal radius} + 7.5\%$

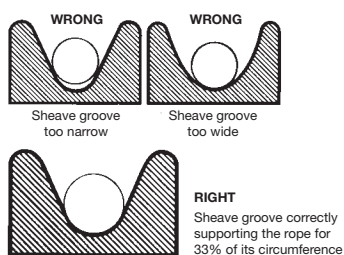
A gap between the last turn on the bottom layer of rope on the drum and the flange can be corrected by fitting a packing (or false cheek) of suitable thickness on the inside of the flange.

WARNING

Failure to carry out any of the above could result in unsatisfactory and unsafe rope performance.

Note: Grooves must have clearance for the rope and provide adequate circumferential support to allow for free movement of the strands and facilitate bending. When grooves become worn and the rope is pinched at the sides, strand and wire movement is restricted and the ability of the rope to bend is reduced. (See Fig. 4)

Fig 4



When a new rope is fitted a variation in size compared with the old worn rope will be apparent. The new rope may not fit correctly into the previously worn groove profile and unnecessary wear and rope distortion is likely to occur. This may be remedied by machining out the grooves before the new rope is installed. Before carrying out such action the sheaves or drum should be examined to ensure that there will be sufficient strength remaining in the underlying material to safely support the rope.

The competent person should be familiar with the requirements of the appropriate application/machinery standard.

Note: General guidance to users is given in ISO 4309 Code of practice for the selection, care and maintenance of steel wire rope.

Transfer the wire rope carefully from the storage area to the installation site.

Coils

Place the coil on the ground and roll it out straight ensuring that it does not become contaminated with dust/grit, moisture or any other harmful material. (See Fig. 5)

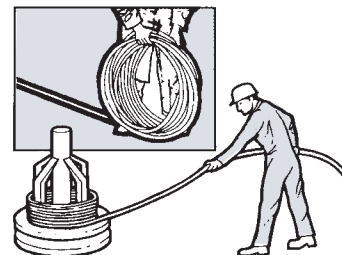


Fig 5

If the coil is too large to physically handle it may be placed on a 'swift' turntable and the outside end of the rope pulled out allowing the coil to rotate. (See Fig. 5)

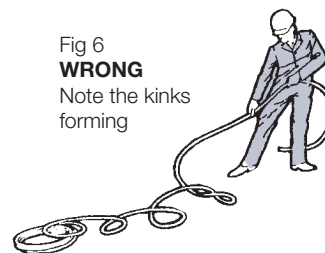
WARNING

Never pull a rope away from a stationary coil as this will induce turn into the rope and kinks will form. These will adversely affect rope performance. (See Fig. 6)

Fig 6

WRONG

Note the kinks forming



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Reels

Pass a shaft through the reel and place the reel in a suitable stand which allows it to rotate and be braked to avoid overrun during installation. Where multi-layer coiling is involved it may be necessary for the reel to be placed in equipment which has the capability of providing a back tension in the rope as it is being transferred from reel to drum. This is to ensure that the underlying (and subsequent) laps are wound tightly on the drum. (See Fig. 7)

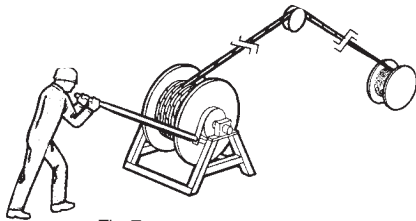


Fig 7

Position the reel and stand such that the fleet angle during installation is limited to 1.5 degrees. (See Fig. 8)

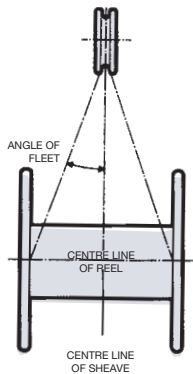


Fig 8

If a loop forms in the rope ensure that it does not tighten to form a kink.

WARNING

A kink can severely affect the strength of a six strand rope and can result in distortion of a rotation-resistant or low rotation rope leading to its immediate discard.

Ensure that the reel stand is mounted so as not to create a reverse bend during reeving (i.e. for a winch drum with an overlap rope, take the rope off the top of the reel). (See Fig. 7)

- 3.9** Ensure that any equipment or machinery to be roped is correctly and safely positioned and isolated from normal usage before installation commences. Refer to the OEM's instruction manual and the relevant 'Code of Practice'.
- 3.10** When releasing the outboard end of the rope from a reel or coil, ensure that this is done in a controlled manner. On release of the bindings and servings used for packaging, the rope will want to straighten itself from its previously bent position. Unless controlled, this could be a violent action. Stand clear.

WARNING

Failure to control could result in injury.

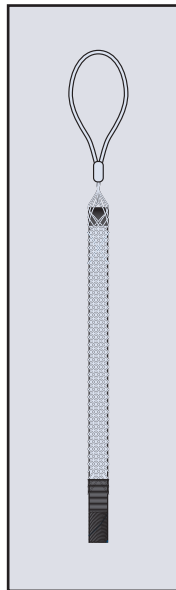
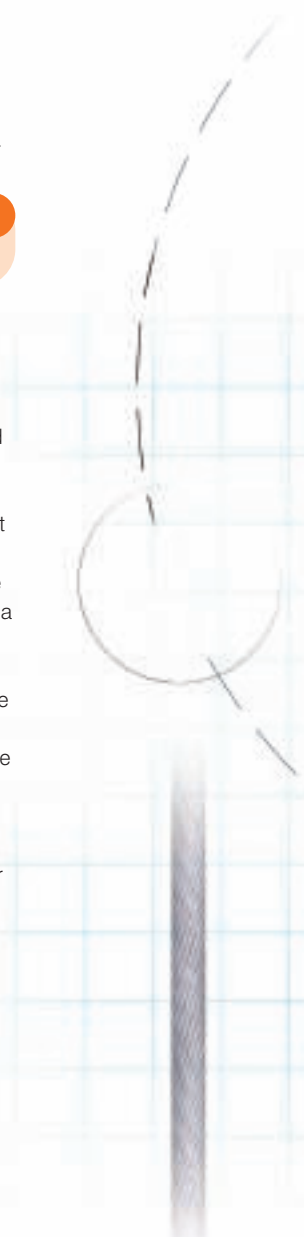


Fig 9

Ensure that the as-manufactured condition of the rope is maintained during installation.

If installing the new rope with the aid of an old one, one method is to fit a wire rope sock (or stocking) to each of the rope ends. Always ensure that the open end of the sock (or stocking) is securely attached to the rope by a serving or alternatively by a clip (See Fig. 9). Connect the two ends via a length of fibre rope of adequate strength in order to avoid turn being transmitted from the old rope into the new rope. Alternatively a length of fibre or steel rope of adequate strength may be reeved into the system for use as a pilot/messenger line. Do not use a swivel during the installation of the rope.



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- 3.11** Monitor the rope carefully as it is being pulled into the system and make sure that it is not obstructed by any part of the structure or mechanism which may cause the rope to come free.

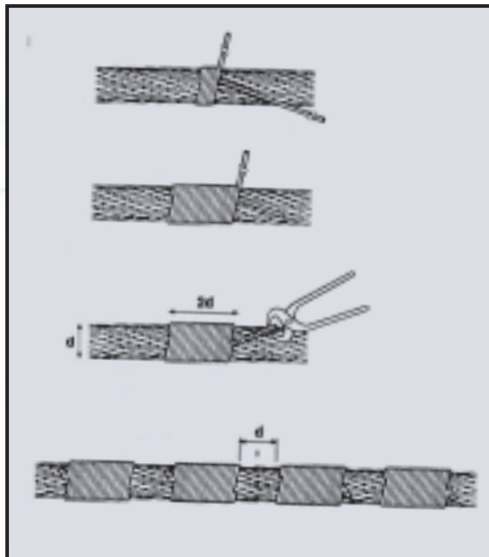


Fig 10

WARNING

Failure to monitor during this operation could result in injury.

This entire operation should be carried out carefully and slowly under the supervision of a competent person.

- 3.12** Take particular care and note the manufacturer's instructions when the rope is required to be cut. Apply secure servings on both sides of the cut mark. (See Fig. 10 for typical method of applying a serving to a multi-layer rope.)
- Ensure that the length of serving is at least equal to two rope diameters. (Note: Special servings are required for spiral ropes, i.e. spiral strand and locked coil.)

Length of serving for locked coil winding ropes and half locked coil guide ropes

The length of rope to be served depends on the object of the serving and on the size and type of the rope. If the serving is to restrain the cut end of a rope it must be longer than one intended to restrain the end of a short sample to be cut from a rope. A rope of the stranded type exerts only a moderate bursting force on a serving but a large locked coil rope exerts a considerable bursting force and, should the serving burst, the rope will unlay itself violently over a long length. Thus, for the cut end of a stranded rope, two servings each of a length at least six times the rope diameter should be used and kept in place until the rope end is otherwise secured. For the cut end of a large locked coil rope a serving or servings each a length of twenty times the rope diameter is advisable, and such servings should be backed up by a minimum of six two-bolt clamps set clear of the served length until the rope end is otherwise secured. Servings should be left permanently on locked coil winding ropes so that there is one about 0.6m (2ft) clear of the capel to allow proper examination of the rope at this point and another between the capel and the nearest pulley or driving sheave in the head frame. This is to localise any unlaying of the rope end, or of broken wires, in the event of some incident.

One serving either side of the cut is normally sufficient for preformed ropes. For non-preformed ropes, multi-layer (i.e. rotation-resistant and low rotation ropes) and parallel closed ropes (i.e. DSC ropes) a minimum of two servings each side of the cut will be necessary (See Fig. 10).

Arrange and position the rope in such a manner that at the completion of the cutting operation the rope ends will remain in position, thus avoiding any backlash or any other undesirable movement.

Cut the rope with a high speed abrasive disc cutter. Other suitable mechanical or hydraulic shearing equipment may be used although not recommended when a rope end is required to be welded or brazed.

For serving instructions for FL and HL ropes refer to Bridon.

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⚠ WARNING

When using a disc cutter be aware of the danger from sparks, disc fragmentation and fumes. (Refer 3.2.)

Ensure adequate ventilation to avoid any build-up of fumes from the rope and its constituent parts including any fibre core (natural or synthetic) any rope lubricant(s) and any synthetic filling and/or covering material.

⚠ WARNING

Some special ropes contain synthetic material which, when heated to a temperature higher than normal production processing temperatures, will decompose and may give off toxic fumes.

⚠ WARNING

Rope produced from carbon steel wires in the form shipped is not considered a health hazard. During subsequent processing (e.g. cutting, welding, grinding, cleaning) dust and fumes may be produced which contain elements which may affect exposed workers.

The products used in the manufacture of steel wire ropes for lubrication and protection present minimal hazard to the user in the form shipped. The user must however, take reasonable care to minimise skin and eye contact and also avoid breathing their vapour and mist.

After cutting, the rope cross-sections of non-preformed ropes, multi-layer ropes and parallel closed ropes must be welded, brazed or fused and tapered such that all wires and strands in the rope are completely secured.

⚠ WARNING

Failure to correctly secure the rope end is likely to lead to slackness, distortions, premature removal from service and a reduction in the breaking force of the rope.

3.13 Ensure that any fittings such as clamps or fixtures are clean and undamaged before securing rope ends.

Make sure that all fittings are secure in accordance with the OEM's instruction manual or manufacturer's instructions and take particular note of any specific safety requirements e.g. torque values (and frequency of any re-application of torque).

When terminating a rope end with a wedge socket, ensure that the rope tail cannot withdraw through the socket by securing a clamp to the tail or by following the manufacturer's instructions.

(See Fig. 11 for two recommended methods of securing the rope tail of a wedge socket termination).

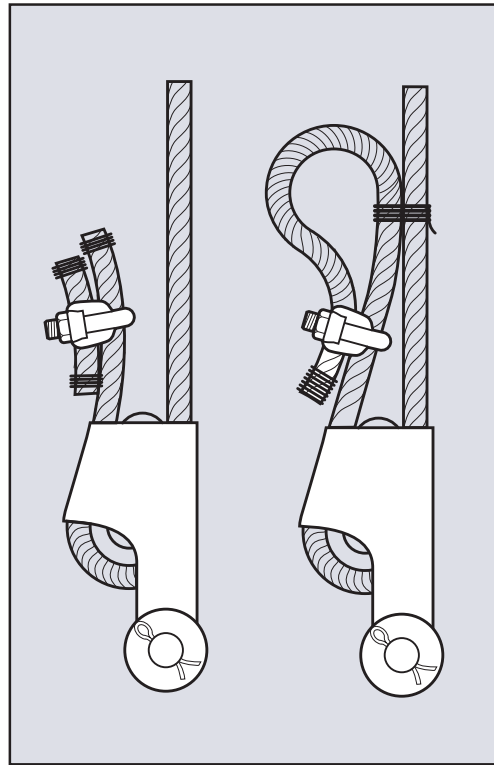


Fig 11

The loop back method uses a rope grip and the loop should be lashed to the live part of rope by a soft wire serving or tape to prevent flexing of the rope in service.

The method of looping back should not be used if there is a possibility of interference of the loop with the mechanism or structure.

⚠ WARNING

Failure to secure in accordance with instructions could lead to loss of the rope and/or injury.

3.14 When coiling a rope on a plain (or smooth) barrel drum ensure that each lap lies tightly against the preceding lap. The application of tension in the rope greatly assists in the coiling of the rope.

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⚠ WARNING

Any looseness or uneven winding will result in excessive wear, crushing and distortion of the rope.

With plain barrel drums it is difficult to achieve satisfactory multi-layer coiling beyond three layers.

The direction of coiling of the rope on the drum is important, particularly when using plain barrel drums, and should be related to the direction of lay of the rope in order to induce close coiling.

(See Fig. 12 for proper method of locating rope anchorage point on a plain drum.)

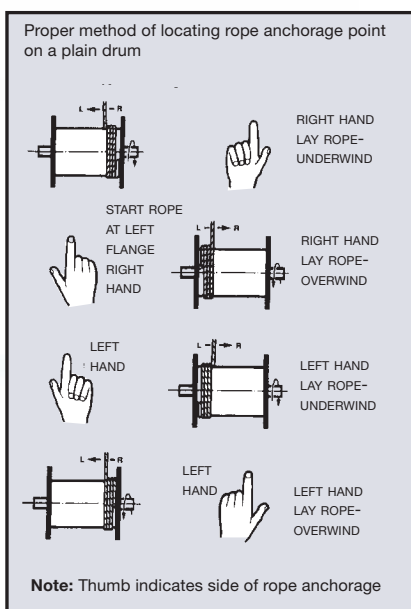


Fig 12

When multi layer coiling has to be used it should be realised that after the first layer is wound on a drum, the rope has to cross the underlying rope in order to advance across the drum in the second layer. The points at which the turns in the upper layer cross those of the lower layer are known as the cross-over points and the rope in these areas is susceptible to increased abrasion and crushing. Care should be taken when installing a rope on a drum and when operating a machine to ensure that the rope is coiled and layered correctly.

- 3.15** Check the state of re-usable rope end terminations for size, strength, defects and cleanliness before use. Non-destructive testing may be required depending on the material and circumstances of use. Ensure that

the termination is fitted in accordance with the OEM's instruction manual or manufacturer's instructions.

When re-using a socket and depending on its type and dimensions, the existing cone should be pressed out. Otherwise, heat may be necessary.

⚠ WARNING

When melting out sockets which have previously been filled with hot metal, the emission of toxic fumes is likely. Note that white metal contains a high proportion of lead.

Correctly locate and secure any connection pins and fittings when assembling end terminations to fixtures. Refer to manufacturer's instructions.

⚠ WARNING

Failure to pay attention to any of the above could result in unsafe operation and potential injury.

- 3.16** Limit switches, if fitted, must be checked and re-adjusted, if necessary, after the rope has been installed.
- 3.17** Record the following details on the Certificate after installation has been completed: type of equipment, location, plant reference number, duty and date of installation and any re-rating information/signature of competent person. Then safely file the Certificate.
- 3.18** 'Run in' the new rope by operating the equipment slowly, preferably with a low load, for several cycles. This permits the new rope to adjust itself gradually to working conditions.

Note: Unless otherwise required by a certifying authority, the rope should be in this condition before any proof test of the equipment or machinery is carried out.

Check that the new rope is spooling correctly on the drum and that no slack or cross laps develop.

If necessary, apply as much tension as possible to ensure tight and even coiling, especially on the first layer.

Where multi-layer coiling is unavoidable, succeeding layers should coil evenly on the preceding layers of rope.

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⚠ WARNING

Irregular coiling usually results in severe surface wear and rope malformation, which in turn is likely to cause premature rope failure.

- 3.19** Ensure that the as-manufactured condition of the rope is maintained throughout the whole of the handling and installation operation.
- 3.20** If samples are required to be taken from the rope for subsequent testing and/or evaluation, it is essential that the condition of the rope is not disturbed. Refer to the instructions given in 3.12 and, depending on the rope type and construction, any other special manufacturer's instructions.

4. In Service

- 4.1** Inspect the rope and related equipment at the beginning of every work period and particularly following any incident which could have damaged the rope or installation.

The entire length of rope should be inspected and particular attention paid to those sections that experience has proven to be the main areas of deterioration. Excessive wear, broken wires, distortion and corrosion are the usual signs of deterioration. For a more detailed examination special tools are necessary (see Fig. 13) which will also facilitate internal inspection (see Fig. 14.)

Fig 13

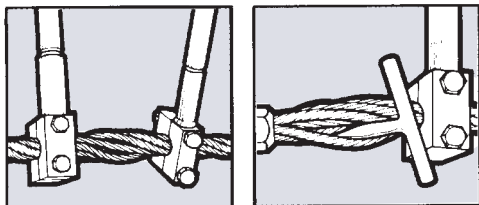
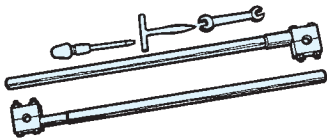


Fig 14

In the case of ropes working over drums or sheaves it is particularly necessary to examine those areas entering or leaving the grooves when maximum loads (i.e. shock loads) are experienced, or those areas which remain for long periods in exposed places such as over a head gear pulleys.

On some running ropes, but particularly relevant to standing ropes (e.g. guide ropes) the areas adjacent to terminations should be given special attention (see Fig. 14).

Note: Shortening the rope re-positions the areas of maximum deterioration in the system. Where conditions permit, begin operating with a rope which has a slightly longer length than necessary in order to allow for periodic shortening.

When a non-preformed rope, multi-layer rope or parallel closed rope is used with a wedge socket and is required to be shortened, it is essential that the end of the rope is secured by welding or brazing before the rope is pulled through the main body of the socket to its new position. Slacken the wedge in the socket. Pass the rope through the socket by an amount equivalent to the crop length or sample required. Note that the original bent portion of the rope must not be retained within the wedge socket. Replace the wedge and pull up the socket. Prepare and cut in accordance with section 3.12. Ensure that the rope tail cannot withdraw through the socket, see section 3.13.

⚠ WARNING

Failure to observe this instruction will result in a significant deterioration in the performance of the rope and could render the rope completely unfit for further service.

In cases where severe rope wear takes place at one end of a wire rope, the life of the rope may be extended by changing round the drum end with the load end, i.e. turning the rope 'end for end' before deterioration becomes excessive.

- 4.2** Remove broken wires as they occur by bending backwards and forwards using a pair of pliers until they break deep in the valley between two outer strands (see Fig. 15). Wear protective clothing such as overalls, industrial gloves, helmet, eye protectors and safety footwear during this operation.

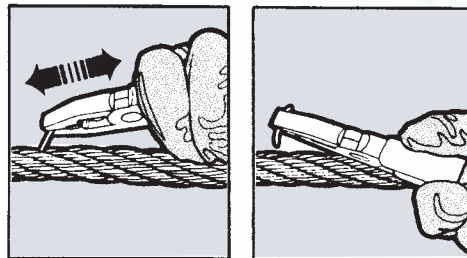


Fig 15

⚠ WARNING

Do not shear off the ends of broken wires with pliers as this will leave an exposed jagged edge which is likely to damage other wires in the rope and lead to premature removal of the rope from service. Failure to wear adequate protective clothing could result in injury.

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Note: Broken wires are a normal feature of service, more so towards the end of the rope's life, resulting from bending fatigue and wear. The local break up of wires may indicate some mechanical fault in the equipment.

Record the number and position in the rope of any removed broken wires.

- 4.3 Do not operate an appliance if for any reason (e.g. rope diameter, certified breaking force, rope construction, length or strength and type of rope termination) the wire rope and its termination is considered unsuitable for the required duty.
- 4.4 Do not operate an appliance if the wire rope fitted has become distorted, been damaged or has deteriorated to a level such that discard criteria has been reached or is likely to be reached prior to normal expected life based on historical performance data.

⚠ WARNING

Rope distortion is usually a result of mechanical damage and can significantly reduce rope strength.

- 4.5 An authorised competent person must examine the rope in accordance with the appropriate Regulations.
- 4.6 Do not carry out any inspection, examination, dressing/lubrication, adjustment or any other maintenance of the rope whilst it is suspending a load, unless otherwise stated in the OEM's instruction manual or other relevant documents.

Do not carry out any inspection or maintenance of the rope if the appliance controls are unattended unless the surrounding area has been isolated or sufficient warning signs have been posted within the immediate vicinity.

If the appliance controls are attended, the authorised person must be able to communicate effectively with the driver or controller of the appliance during the inspection process.
- 4.7 Never clean the wire rope without recognising the potential hazards associated with working on a moving rope.

⚠ WARNING

Failure to pay attention or take adequate precaution could result in injury.

If cleaning by cloth/waste, the material can be snagged on damaged surfaces and/or broken wires. If cleaning by brush, eye protectors must be worn. If using fluids it should be recognised that some products are highly inflammable. A respirator should be worn if cleaning by a pressurised spray system.

⚠ WARNING

Failure to take adequate precaution could result in injury or damage to health.

Only use compatible cleaning fluids which will not impair the original rope lubricant nor affect the rope associated equipment.

⚠ WARNING

The use of cleaning fluids (particularly solvent based) is likely to 'cut back' the existing rope lubricant leading to a greater quantity of lubricant accumulating on the surface of the rope. This may create a hazard in appliances and machinery which rely on friction between the rope and the drive sheave (e.g. lifts, friction winders and cableways).

- 4.8 Lubricants selected for in-service dressing must be compatible with the rope manufacturing lubricant and should be referenced in the OEM's instruction manual or other documents approved by the owner of the appliance.

If in doubt contact the rope supplier or Bridon.
- 4.9 Take particular care when applying any in-service lubricant/dressing. Application systems which involve pressure should only be operated by trained and authorised persons and the operation carried out strictly in accordance with the manufacturer's instructions.

Most wire ropes should be lubricated as soon as they are put into service and at regular intervals thereafter (including cleaning) in order to extend safe performance.

⚠ WARNING

A 'dry' rope unaffected by corrosion but subject to bend fatigue, is likely to achieve only 30% of that normally attained by a 'lubricated' rope.

Do not dress/lubricate the rope if the application required it to remain dry. (Refer OEM's instruction manual.)

Reduce the period between examinations when ropes are not subjected to any in-service dressing and when they must remain dry.

Note: The authorised person carrying out a rope inspection must be capable of recognising the potential loss of safe performance of such a rope in comparison with lubricated rope.

Clean the rope before applying a fresh dressing/lubricant if it is heavily loaded with foreign matter e.g. sand, dust.

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4.10 The authorised person responsible for carrying out wire rope maintenance must ensure that the ends of the rope are secure. At the drum end this will involve checking the integrity of the anchorage and ensuring that there are at least two and a half dead laps tightly coiled. At the outboard end the integrity of the termination must be checked to ensure that it is in accordance with the OEM's manual or other documents approved by the owner of the appliance.

Adjust the lengths of ropes in multi-rope systems in order that equal forces (within approved limits) are evident.

If a wire rope needs cutting refer to 3.12.

When securing rope ends refer to 3.13.

When re-usable end terminations are used refer to 3.15.

When re-connecting any end terminations to fixtures refer to 3.15.

4.11

⚠ WARNING

Damage to, or removal of component parts (mechanical or structural) caused by abnormal contact with wire rope can be hazardous to the safety of the appliance and/or the performance of the rope (e.g. damage to the drum grooving, such that coiling is erratic and/or the rope is 'pulled down' into underlying layers, which might cause a dangerous condition or, alternatively, cause localised rope damage at 'cross-over' positions, which might then radically affect performance; loss/removal of wear plates protecting the structure leading to major structural damage by cutting and/or failure of the wire rope due to mechanical severance).

4.12 Following any periodic statutory examination or routine or special inspection where any corrective action is taken the Certificate should be updated and a record made of the defects found, the extent of the changes and the condition of the rope.

4.13 Apply the following procedures for the selection and preparation of samples, from new and used lengths of rope, for the purpose of examination and testing to destruction.

Check that the rope end, from which the sample will be taken, is secured by welding or brazing. If not, select the sample length further away from the rope end and prepare new servings (see 3.12).

Handle the rope in accordance with the instructions given in section 3. Serve the rope, using the buried wire technique (see Fig. 10) and apply a rope clamp or grip as close to the cut mark as practically possible. Do not use solder to secure the servings.

Ensure that the sample is kept straight throughout the whole procedure and ensure that the minimum sample length is 3 metres for ropes up to and including 40mm diameter and 12 metres for larger diameter ropes.

The rope should be cut with a high speed abrasive disc cutter or an oxyacetylene torch. Weld the rope ends of the sample as described in section 3.12, after which the clamp or grip can be removed.

The identification of the rope must be established and the sample suitably marked and packed. It is recommended that the 3 metre sample is retained straight and secured to a wood batten for transportation. For a 12 metre sample, coil to a diameter as large as practically possible and never less than 2 metres.

Note: Samples taken for destruction testing are required to be terminated in accordance with a recognised resin socketing standard (e.g. BS EN 13411-4 or ISO 7596).

⚠ WARNING

Failure to comply with these procedures will result in measured breaking force values which are not truly representative of the actual strength of the rope.

5. Wire Rope Discard

5.1 Discard the wire rope in accordance with current Regulations and in accordance with the OEM's instruction manual.

5.2 If a wire rope is removed from service at a level of performance substantially different to historically established performance data and without any obvious reason(s), contact Bridon or Bridon's distributor for further guidance.

5.3 Only qualified and experienced personnel, taking the appropriate safety precautions and wearing the appropriate protective clothing, should be responsible for removing the wire rope.

⚠ WARNING

Take particular care when removing ropes with mechanical damage as they may fail abruptly during the change-out procedure.

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Take the utmost care when removing 'exhausted/failed' ropes from drums and sheaves as they may be grossly distorted, lively and tightly coiled.

⚠ WARNING

Failure to take adequate precautions could result in injury.

- 5.4 Store discarded rope in a safe and secure location or compound and ensure that it is suitably marked to identify it as rope which has been removed from service and not to be used again.

⚠ WARNING

Discarded rope can be a danger (e.g. protruding broken wires, excessive grease/lubricant and rope mass) to personnel and equipment if not handled correctly and safely during disposal.

- 5.5 Record the date and reason for discard on the Certificate before filing for future reference.
- 5.6 Pay attention to any Regulations affecting the safe disposal of steel wire rope.

6. Rope Selection Criteria

Ensure that the correct type of wire rope is selected for the equipment by referring to the OEM's instruction manual or other relevant documents. If in doubt contact Bridon or Bridon's distributor for guidance.

6.1 Rope Strength

If necessary, refer to the appropriate Regulations and/or application standards and calculate the maximum force to which the rope will be subjected.

The calculation may take into account the mass to be lifted or moved, any shock loading, effects of high speed, acceleration, any sudden starts or stops, frequency of operation and sheave bearing friction.

By applying the relevant coefficient of utilisation (safety factor) and, where applicable, the efficiency of the rope termination, the required minimum breaking load or force of the rope will be determined, the values of which are available from the relevant National, European or International standards or from specific Product Data literature.

If in doubt ask for advice from Bridon or Bridon's distributor.

6.2 Bending fatigue

The size and number of sheaves in the system will influence the performance of the rope.

⚠ WARNING

Wire rope which bends around sheaves, rollers or drums will deteriorate through 'bending fatigue'. Reverse bending and high speed will accelerate the process. Therefore, under such conditions select a rope with high bending fatigue resistance. Refer to Product Data Information, and if in doubt ask for advice.

6.3 Abrasion

Wire rope which is subject to abrasion will become progressively weaker as a result of:

Externally - dragging it through overburden, sand or other abrasive materials and passing around a sheave, roller or drum.

Internally - being loaded or bent.

⚠ WARNING

Abrasion weakens the rope by removing metal from both the inner and outer wires. Therefore, a rope with large outer wires should normally be selected.

6.4 Vibration

Vibration in wire rope will cause deterioration. This may become apparent in the form of wire fractures where the vibration is absorbed.

⚠ WARNING

These fractures may be internal only and will not be visually identified.

6.5 Distortion

Wire rope can be distorted due to high pressure against a sheave, improperly sized grooves or as a result of multi-layer coiling on a drum.

Rope with a steel core is more resistant to crushing and distortion.

6.6 Corrosion

Rope with a large number of small wires is more susceptible to corrosion than rope with a small number of large wires. Therefore, if corrosion is expected to have a significant effect on rope performance select a galvanised rope with as large an outer wire size as possible bearing in mind the other conditions (e.g. bending and abrasion) under which the rope will be operating.

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6.7 Connecting Ropes

In the event that it is necessary to connect one rope to another (in series) it is essential that they have the required strength, are of the same type and both have the same lay direction (i.e. connect 'right' lay to 'right' lay).

⚠ WARNING

Failure to heed this warning could result in catastrophic failure particularly at a termination which is capable of being pulled apart (i.e. splice) due to unlaying.

6.8 Rope Length

Rope length and /or difference in length between two or more ropes used in a set may be a critical factor and must be considered along with rope selection.

⚠ WARNING

Wire rope will elongate under load. Other factors such as temperature, rope rotation and internal wear will also have an effect. These factors should also be considered during rope selection.

6.9 Preformed and Non-preformed Ropes

Single layer round strand rope is normally supplied preformed. However, if a non-preformed rope is selected then personnel responsible for its installation and/or maintenance need to take particular care when handling such rope, especially when cutting. For the purposes of this instruction, multi-layer, parallel closed and spiral ropes should be regarded as non-preformed ropes.

6.10 Operating Temperatures

Wire rope with a steel core should be selected if there is any evidence to suggest that a fibre core will not provide adequate support to the outer strands and/or if the temperature of the working environment may be expected to exceed 100°C.

For operating temperatures above 100°C de-rating of the minimum breaking force of the rope is necessary (e.g. between 100°C and 200°C reduce by 10%; between 200°C and 300°C reduce by 25%; between 300°C and 400°C reduce by 35%).

Do not use ropes with high carbon wires above 400°C.

⚠ WARNING

Failure to observe this general guidance could result in failure of the ropes to support the load.

For temperatures over 400°C, other materials such as stainless steel or other special alloys should be considered.

⚠ WARNING

Rope lubricants and any synthetic filling and/or covering materials may become ineffective at certain low or high operating temperature levels.

Certain types of rope end terminations also have limiting operating temperatures and the manufacturer or Bridon should be consulted where there is any doubt. Ropes with aluminium ferrules must not be used at temperatures in excess of 150°C.

Product Safety: Instructions & Warnings on the use of steel wire rope

WARNING

CAUTIONARY NOTICE – RESTRICTIONS ON THE USE OF LARGE DIAMETER MULTISTRAND ROPES.

All wire ropes are prone to damage if they are not properly supported when used at high loads. Larger Multistrand ropes are particularly susceptible to this form of abuse, due to their rigid construction and the relatively fine wire sizes involved in their manufacture/construction. Instances have been recorded of ropes being heavily worked over plain drums and failing "prematurely", despite the nominal tension being

being in the region of half the breaking strength of the rope.

The best way of preventing difficulties of this sort is to avoid conditions that are likely to generate damagingly high contact stresses. A simple method of assessing the severity of the contact conditions is to firstly calculate the tread pressure based on the projected nominal area and then apply a factor (of say 10*) to allow for the highly localised and intermittent nature of the actual wire contacts, as indicated below :-

Type of contact	Close-fitting U-groove	Oversize U-groove	Plain drum
Level of support	Good	Fair	Poor
Tread path width	100% of rope dia.	50% of rope dia.	20% of rope dia.
Tread pressure =	2T/Dd	4T/Dd	10T/Dd
Contact stress =	20T/Dd	40T/Dd	100T/Dd

Note: Contact stresses which exceed 10% of the wire UTS should be considered a cause for concern, especially if the rope is operating at a low factor of safety.

[This is because the true contact area is very much less than the projected nominal area.]*

Worked example:

Consider case of a 50mm Multistrand rope (MBL=2100kN) operating at a 3:1 factor of safety. Then, for the Contact stress < 200 Mpa say, the following minimum bending diameters are indicated:

Close-fitting groove – 1400mm
 Oversize U-groove - 2800mm
 Un-grooved drum - 7000mm

Material Safety Data

Introduction

Steel wire rope is a composite material and dependent upon its type may contain a number of discrete materials. The following provides full details of all the individual materials which may form part of the finished wire rope.

The description and/or designation of the wire rope stated on the delivery note and/or invoice (or certificate, when applicable) will enable identification of the component parts.

The main component of a steel wire rope is the wire, which may be carbon steel, coated (zinc or Zn95/A15) steel or stainless steel.

The other three components are (i) the core, which may be of steel of the same type as used in the main strands or alternatively fibre (either natural or synthetic), (ii) the rope lubricant and, where applicable, (iii) any internal filling or

external covering. No Occupational Exposure Limits (OEL's) exist for steel wire rope and the values provided in this publication relate to component elements and compounds. The actual figures quoted in relation to the component parts are taken from the latest edition of EH40.

Rope produced from carbon, coated or stainless steel wires in the as-supplied condition is not considered a health hazard. However during any subsequent processing such as cutting, welding, grinding and cleaning, dust and fumes may be produced which contain elements that may affect exposed workers.

The following indicates the order in which specific information is provided:-

Carbon steel wire, Coated steel wire, Stainless steel wire, Manufacturing rope lubricants, Fibre cores, Filling and covering materials, General information

Carbon Steel Wire - Hazardous Ingredients

Component	% Weight (Max)	Long term exposure limit (8-hour TWA reference period) mg/m ³	Short term exposure limit (10-minute reference period) mg/m ³
BASE METAL			
Aluminium	0.3	10	20
Carbon	1.0	None Listed	
Chromium	0.4	0.5	
Cobalt	0.3	0.1	
Copper	0.5	0.2	
Iron	Balance	5	10
Manganese	1.0	5	5
Molybdenum	0.1	5	10
Nickel	0.5	1	
Phosphorus	0.1	0.1	0.3
Silicon	0.5	10	
Sulphur	0.5	None Listed	
Vanadium	0.25	0.5	
Boron	0.1	10	20
Titanium	0.1	10	
Nitrogen	0.01	5	9
Lead	0.1	0.15	
Arsenic	0.01	0.2	
Zirconium	0.05	5	10
COATED			
Sodium	0.5	None Listed	
Calcium	0.5	2	
Boron	1.0	10	20
Phosphorus	1.0	0.1	0.3
Iron	1.0	5	10
Zinc	1.0	5	10
Oil may be applied	5.0	5	10

Physical Data

Specific Gravity:	7.5 - 8.5	Vapour Pressure:	N/A
Melting Point:	1350 - 1500 °C	Vapour Density:	N/A
Appearance & Odour:	Solid, Odourless Metal	Evaporation:	N/A
Solubility in water:	Insoluble	% Volatiles:	N/A
Flash Point:	None	Boiling Point:	> 2800 °C

Material Safety Data

Coated (Zinc and ZN95/A 15) Steel Wire - Hazardous Ingredients

Component	% Weight (Max)	Long term exposure limit (8-hour TWA reference period) mg/m ³	Short term exposure limit (10-minute reference period) mg/m ³
BASE METAL			
Aluminium	0.3	10	20
Carbon	1.0	None Listed	
Chromium	0.4	0.5	
Cobalt	0.3	0.1	
Copper	0.5	0.2	
Iron	Balance	5	10
Manganese	1.0	5	5
Molybdenum	0.1	5	10
Nickel	0.5	1	
Phosphorus	0.1	0.1	0.3
Silicon	0.5	10	
Sulphur	0.5	None Listed	
Vanadium	0.25	0.5	
Boron	0.1	10	20
Titanium	0.1	10	
Nitrogen	0.01	5	9
Lead	0.1	0.15	
Arsenic	0.01	0.2	
Zirconium	0.05	5	10
COATED			
Zinc	10.0	5	10
Aluminium	1.5	10	20
Iron	5.0	5	10
Sodium	0.5	None Listed	
Calcium	0.5	2	
Boron	1.0	100	20
Phosphorus	1.0	0.1	0.3
Sulphur	0.5	None Listed	
Oil may be applied	5.0	5	10
Wax may be applied	5.0	2	6

Physical Data

Specific Gravity:	7.5 - 8.5	Vapour Pressure:	N/A
Melting Point:	1350 - 1500 °C	Vapour Density:	N/A
Appearance & Odour:	Solid. Odourless Metal	Evaporation:	N/A
Solubility in water:	Insoluble	% Volatiles:	N/A
Flash Point:	None	Boiling Point:	> 2800 °C

Material Safety Data

Manufacturing Rope Lubricants

The products used in the manufacture of steel wire ropes for lubrication and protection present minimal hazard to the user in the as-supplied condition. The user must, however, take reasonable care to minimise skin and eye contact and also avoid breathing their vapours and mists.

A wide range of compounds is used as lubricants in the manufacture of steel wire rope. These products, in the main, consist of mixtures of oils, waxes, bitumens, resins, gelling agents and fillers with minor concentrations of corrosion inhibitors, oxidation stabilizers and tackiness additives.

Most of them are solid at ambient temperatures and provided skin contact with the fluid types is avoided, none present a hazard in normal rope usage.

However, to assist in the assessment of the hazard caused by these products, the following table contains all the components which may be incorporated into a wire rope lubricant and which may be considered hazardous to health.

Hazardous Ingredients:

Component	Long term exposure limit (8-hour TWA reference period) mg/m ³	Short term exposure limit (10-minute reference period) mg/m ³
Oil mist	5	10
Paraffin wax fume	2	6
Bitumen	5	10
Silica, fused		
Total inhalable dust	0.3	
Respirable dust	0.1	
Aluminium flake	10	20
Zinc oxide, fume	5	10
Butane	1430	1780

There are no other known constituents of any wire rope lubricant used that are classified as hazardous in the current edition of EH40.

General advice on handling ropes with lubricants

To avoid the possibility of skin disorders, repeated or prolonged contact with mineral or synthetic hydrocarbons must be avoided and it is essential that all persons who come into contact with such products maintain high standards of personal hygiene.

The worker should:

- 1) use oil impermeable gloves, or if not available, suitable oil repellent type barrier creams,
- 2) avoid unnecessary contact with oil using protective clothing,
- 3) obtain first aid treatment for any injury, however slight,
- 4) wash hands thoroughly before meals, before using the toilet and after work,
- 5) use conditioning creams after washing, where provided.

The worker should not:

- 1) put oily rags or tools into pockets, especially trousers,
- 2) use dirty or spoiled rags for wiping oil from the skin,
- 3) wear oil soaked clothing,
- 4) use solvents such as paraffin, petrol etc., to remove oil from the skin.

Concentrations of oil mists, fumes and vapours in the working atmosphere must be kept as low as is reasonably practicable. Levels quoted in the current edition of HSE Guidance Note EH40 'Occupational Exposure Limits' must not be exceeded.

Health Hazards

Inhalation of oil mists or fumes from **heated** rope lubricants in high concentrations may result in dizziness, headache, respiratory irritation or unconsciousness. Eye contact may produce mild transient irritation to some users.

Fumes from **heated** rope lubricants in high concentrations may cause eye irritation.

If **heated** rope lubricants contacts skin, severe burns may result.

Prolonged or repeated skin contact may cause irritation, dermatitis or more serious skin disorders.

Fibre Cores

Being in the centre of a steel wire rope, the materials (natural or synthetic) from which fibre cores are produced do not present a health hazard during normal rope handling. Even when the outer core strands are removed (for example when the rope is required to be socketed) the core materials present virtually no hazard to the users, except, maybe, in the case of a used rope where, in the absence of any service dressing or as a result of heavy working causing internal abrasive wear of the core, the core may have decomposed into a fibre dust which might be inhaled, although this is considered extremely unlikely.

The principal area of hazard is through the inhalation of fumes generated by **heat**, for example when the rope is being cut by a disc cutter.

Material Safety Data

Under these conditions, natural fibres are likely to yield carbon dioxide, water and ash, whereas synthetic materials are likely to yield toxic fumes.

The treatment of natural fibres, such as rotproofing, may also produce toxic fumes on burning.

The concentrations of toxic fumes from the cores, however, will be almost negligible compared with the products generated by heating from the other primary materials, e.g. wire and manufacturing lubricant in the rope.

The most common synthetic core material is polypropylene, although other polymers such as polyethylene and nylon may occasionally be used.

Filling and Covering Materials

Filling and covering materials do not present a health hazard during handling of the rope in its as-supplied condition.

The principal area of hazard is by the inhalation of fumes generated by heat, for example when the rope is being cut by a disc cutter.

Under these conditions, fillings and coverings, which are generally polypropylene, polyethylene and polyamid (but in some cases may be of natural fibre) are likely to produce toxic fumes.

General Information

Occupational protective measures

- 1) Respiratory protection** - Use general and local exhaust ventilation to keep airborne dust or fumes below established occupational exposure standards (OES's). Operators should wear approved dust and fume respirators if OES's are exceeded. (The OES for total dust is 10mg/m³ and for respirable dust is 5mg/m³).
- 2) Protective equipment** - Protective equipment should be worn during operations creating eye hazards. A welding hood should be worn when welding or burning. Use gloves and other protective equipment when required.
- 3) Other** - Principles of good personal hygiene should be followed prior to changing into street clothing or eating. Food should not be consumed in the working environment.

Emergency medical procedures

- 1) Inhalation** - Remove to fresh air; get medical attention.
- 2) Skin** - Wash areas well with soap and water.
- 3) Eyes** - Flush well with running water to remove particulate; get medical attention.
- 4) Ingestion** - In the unlikely event that quantities of rope or any of its components are ingested, get medical attention.

Safety Information

- 1) Fire and explosion** - In the solid state, steel components of the rope present no fire or explosion hazard. The organic elements present, i.e. lubricants, natural and synthetic fibres and other natural or synthetic filling and covering materials are capable of supporting fire.
- 2) Reactivity** - Stable under normal conditions.

Spill or leak procedures

- 1) Spill or leak** - Not applicable to steel in the solid form.
- 2) Disposal** - Dispose of in accordance with local Regulations.

Rope Terminology

Wires

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

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

Core wires: All wires of the core of a stranded rope.

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

Layer of wires: An assembly of wires having one pitch circle diameter. The exception is Warrington layer comprising alternately laid large and small wires where the smaller wires are positioned on a larger pitch circle diameter than the larger wires. The first layer is that which is laid immediately over the strand centre.

Note: Filler wires do not constitute a separate layer.

Tensile strength grade of wires: A level of requirement of tensile strength of a wire and its corresponding tensile strength range. It is designated by the value according to the lower limit of tensile strength and is used when specifying wire and when determining the calculated minimum breaking force or calculated minimum aggregate breaking force of a rope.

Wire finish: The condition of the surface finish of a wire, e.g. bright, zinc coated.