Lineworker Rigging

CLICK TO CONTENTS

CONTENTS

PREFACE

The instructions in this manual have been developed for use by persons employed in the Victorian Electricity Supply Industry (VESI).

It is the responsibility of all persons to ensure that safe systems of work are employed and that statutory requirements are met. Powerline works involving a rigging activity should only be performed by individuals who are appropriately licensed in accordance with the Victorian OHS regulations, or trained in accordance with a related exemption published by WorkSafe Victoria.

This manual is not intended, nor should it in any way be relied upon as a substitute for such training, however this manual can serve the purpose of a course book for related lineworker training

In the event that any user of this manual considers that any of its provisions is uncertain, ambiguous or otherwise in need of interpretation, the user should seek clarification from a network operator, HSE or Work Practices representative.

SCOPE

These instructions apply to all VESI employees concerned with the use of loadshifting equipment and associated gear. The instructions set out minimum standards which shall be maintained at all times. Proper adherence is necessary for the safety of employees and the public and the safe operation of plant and equipment.

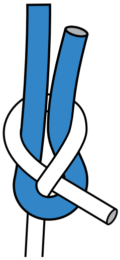
DEFINITIONS

Approved

Having a department's endorsement for a specified function.

Authorised

Has the permission of an appropriate departmental officer, or has the authority to act on behalf of a department, for the duty concerned.



Bend

A bend is used to:

a) join two ends of a rope to form a loop

b) join two ropes together

c) join sheeting or tarp to a rope

Examples include the Double Fisherman's bend, Reef knot (Reef bend), Sheet bend and Tape knot (overhand bend tied with tape).

Bight

A bight is a part of a rope between each end in which a knot can be formed (the line does not cross itself otherwise it would be a loop). Note: A bight of rope does not have to be close to an end (as pictured) it may be positioned at any point along the length of the rope.

Breaking Force

Maximum force reached during the static tensile test of the component, at which the component fails to retain the load.

Chain Grade T (8, 80 or 800)

The grade of chain used for slings with a specified nominal breaking force of 800 MPa.

Chain Grade V (10, 100 or 1000)

The grade of chain used for slings with a specified nominal breaking force of 1000 MPa.

Grade V(100) chain can be produced by using materials that are suitable for a 200°C or 380°C operating range. Each temperature range has specific minimum alloying elements requirements. V200 refers to Grade V(100) chain that has a maximum operating temperature of 200°C, V400 refers to Grade V(100) chain that has a maximum operating temperature of 380°C.

Circumference of Rope

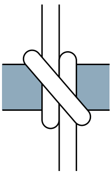
The length of the smallest enclosing circle around a cross-section of the rope.

Diameter

The measurement of a straight line passing from side to side through the centre of an object or circle.

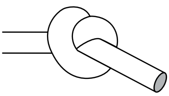
Dogging

The application of slinging techniques, including the selection or inspection of lifting gear, or the directing of a crane or hoist operator in the movement of a load when the load is out of the operator's view.



Hitch

A knot tied around an object that when the object is removed the knot falls apart. Examples include the clove hitch, rolling hitch and truckies hitch.



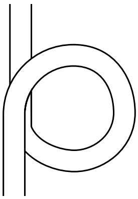
Knot

A knot when tied in a rope will maintain its own form. Examples include the overhand knot and the figure of eight knot.

Lifting Tackle

Any equipment that is placed in the line of pull, whether used separately, associated with a crane or hoist, and is used to assist lifting of a load. All equipment whether used for lifting, pulling or moving loads should, wherever possible, be subject to the same safety standards.

Note: For the purpose of these instructions, 'lifting tackle' includes fibre and wire ropes, fibre and wire rope slings, chain and rope blocks, jacks, chains, chain slings, shackles, hooks, eyebolts, guy ropes and associated components, all manually operated gear, power operated chain blocks and hoists up to and including five tonne capacity and power operated winches up to and including five tonne capacity.



Loop

A closed curve or circle of rope.

Minimum Breaking Force (MBF)

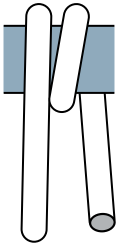
MBF is the minimum load or force guaranteed by the manufacturer after which a product will break.

Rated Capacity

The maximum gross load which may be applied to the crane or hoist or lifting attachment while in a particular working configuration and under a particular condition of use.

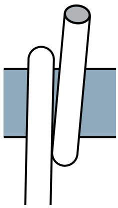
Round Turn

Two wraps of rope around an object. It is called a “round turn” because it is one complete encirclement of the object.



Safety Factor

The ratio of the ultimate strength of the material to the permissible stress.



Turn

Same as a loop but around an object.

Working Load Limit (WLL)

The WLL is the maximum load that equipment can carry on a particular service. The WLL should be based on the minimum breaking force, not the actual breaking force, which can vary depending on construction, size and the applicable design factor.

Part 1

EQUIPMENT – SELECTION, CARE AND USE

CONTENTS

1 GENERAL SAFETY

1.1 Safe Work Method Statement (SWMS)

The Victorian OHS Regulations state that an employer must not perform high risk construction work if there is a risk to the health or safety of any person arising from the work, unless a SWMS is prepared before the work commences.

A SWMS is defined as a document that:

a. identifies work that is high risk construction work; and

b. states the hazards and risks to health or safety of that work; and

c. sufficiently describes measures to control those risks; and

d. describes the manner in which the risk control measures are to be implemented.

Most activities performed by VESI workers fall within the definitions of high risk work, e.g. working at heights and work on electrical networks. This means that the use of SWMSs is a mandatory requirement for all VESI workers.

1.2 Job Safety Analysis

Whilst a SWMS can be considered a formal, sequential risk assessment of a high risk activity, any additional site hazards not identified within the SWMS shall be controlled using a JSA procedure.

Also known as Job Hazard Analysis or Site Risk Assessment, JSAs are the most effective administrative control for controlling hazards specific to the site.

These additional hazards should be controlled so that the residual risk is eliminated or reduced to a level that is as low as reasonably practicable and allows the work to be performed by the work party.

All members of the work party including contractors and visitors must sign onto the JSA. By signing on the individual acknowledges they understand the potential hazards and the controls put in place.

An essential part of the JSA is the assignment of responsibility for each of the control measures. In many cases it will be the members of the work group, however there may be some controls that are allocated to others, e.g. Traffic Control.

Monitoring of the controls for their appropriateness and effectiveness should be periodically undertaken during the course of the works or when the work environment changes. Where a control does not appear to be meeting the requirements, then the control should be revised with the agreement of all members of the work party or those directly affected by the change. Any changes must be recorded on the JSA form and all work party members advised of the change.

1.3 Personal Protective Equipment (PPE)

PPE requirements may include:

- Safety headwear, safety footwear and ankle to wrist natural fibre or arc flash resistant clothing in accordance with Clause 1.1.10 of the Green Book, plus
- Fall prevention
- Eye and ear protection
- Hand protection

1.4 Fall Arrest

As lineworkers, you will be already trained in working at heights. However, it is important to remember that fall arrest equipment must be inspected before use. Common defects to look for include:

- Webbing
- Stitching
- Snap hooks
- Buckles and adjusters
- Rescue kit contents
- EWP escape kits
- Inertia reels

2 EQUIPMENT, SELECTION, CARE AND USE

2.1 General

The importance of using only equipment that is fit for purpose and in good order cannot be overstated. Faulty and/or incorrectly rated equipment is a common cause of serious industrial incidents.

Plant and equipment commonly associated with overhead powerline works includes:

- Cable trailers and recovery units
- Winch [truck mounted, capstan]
- Rope
- Sheaves and blocks
- Rope tackle
- Cable rollers
- Slings [fibre, wire]
- Chains
- Chain hoist
- Lugall
- Strap hoist
- Tirfor
- Shackles
- Comealong clamps
- Cable grips
- Helical terminations

3 ROPE

Fibre rope is the tool most commonly used for work which may generally be described as rigging. Rope has many applications in daily hoisting and rigging operations and is readily available in a wide variety of synthetic and natural fibre materials.

These ropes may be used as:

- handlines for lifting light loads
- tying down loads on trailers
- raising conductors and cables
- taglines for helping to guide and control loads.

There are countless situations where power workers will be required to tie a safe and reliable knot or hitch in a fibre rope as part of the rigging operation, such as securing loads, making eyes for slings, and tying on a tagline.

3.1 Natural Fibre Ropes

First grade rope is made with manila fibre, second grade with a blend of manila/sisal and third grade with sisal only.

A sisal rope is whiter and does not have the gloss and smoothness of a manila rope as sisal fibres are stiffer and tend to split.

Manila and sisal each have approximately the same mass for equal lengths of rope.

The most common type of natural fibre rope consists of three strands twisted together and this construction is known as plain or hawser laid.

Manila Rope

3.2 Natural Fibre Rope Care

While there are too many variables in work conditions to predict everything that can go wrong, proper rope care and use can minimise the risk of damaging rope. Proper care and use includes:

- Storing ropes in a well ventilated dry atmosphere away from heat, strong sunlight and corrosive substances.
- Avoiding abrasive conditions such as exposure to sharp edges, rough surfaces, and improperly sized pulleys.
- Avoiding the build-up of excessive turns. Kinks cause permanent damage and loss of strength. Never load a rope to remove kinks.
- Except for a bowline, avoid knotting a rope for the purpose of forming an eye. Splice the rope in the normal manner. Knots can reduce a rope's strength by up to 50%.

3.3 Synthetic Ropes

Most ropes used in the electricity industry are now made from synthetic fibres. Synthetic ropes generally have greater strength, flexibility and resistance to abrasion.

They handle better when wet and have a much higher resistance to mildew, rot and chemical attack.

Their main disadvantage is a smoother surface which decreases the reliability of knots and splices. Where possible extra turns should be taken when making knots in synthetic ropes.

When splicing synthetic rope, use at least two extra tucks per strand when compared to the same size natural fibre rope.

Polypropylene Rope

3.4 Fibre and Synthetic Rope Inspection

Inspect fibre rope regularly and before each use. Any estimate of its capacity should be based on the portion of rope showing the most deterioration.

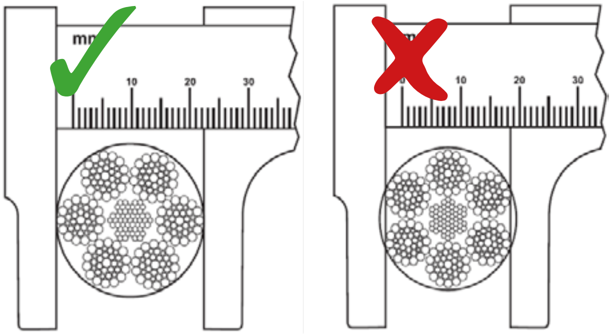
Check first for external wear and cuts, variations in the size and shape of strands, discolouration, and the elasticity or “life” remaining in the rope.

Untwist the strands without kinking or distorting them. The inside of the rope should be as bright and clean as when it was new. Check for broken yarns, excessively loose strands and yarns, or an accumulation of powdery dust, which indicates excessive internal wear between strands as the rope is flexed back and forth in use.

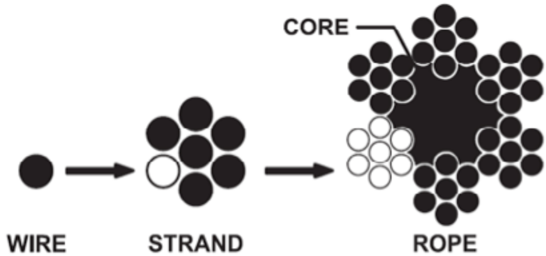
If the inside of the rope is dirty, if strands have started to unlay, or if the rope has lost life and elasticity, do not use it for hoisting.

STEEL WIRE ROPE

The properties of a wire rope are derived from its size, construction, quality lay and type of core. Ropes are referred to by a diameter size. The correct way to measure wire rope is shown below



The main components of a wire rope are shown below



The size and number of wires in each strand, as well as the size and number of strands in the rope greatly affect the characteristics of the rope.

A large number of small-size wires and strands produce a flexible rope with good resistance to bending fatigue. Ideal for running or moving ropes such as winches, hoists and luffing type applications.

Conversely a wire rope with a small number of larger wires produces a non-flexible rope with good durability and low stretch properties.

4.1 Rope Core

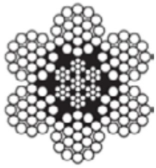
A number of core types are available and each has specific properties:

Wire Strand Core (WSC)

These cores are used chiefly for standing ropes (guys or rigging), and offer high tensile strength and, owing to the larger wires in the core, greater resistance to corrosion.

Fibre Core (FC)

Fibre cores are used for ropes that are not subjected to heavy loading and where flexibility in handling is required.



Not preferred where wire rope is subjected to heavy loading, prolonged outdoor exposure and crushing on small drums and sheaves.

Wire Rope Core (RWC)

Preferred for operating ropes in applications of high tensile stress, high compression loads on small drums and sheaves (such as on earth moving equipment) and high operating temperatures (such as cranes handling large quantities of molten metal). A rope with a WRC is approximately 11% heavier and 7.5% stronger than fibre cored rope of the same size.

RIGHT HAND ORDINARY LAY

LEFT HAND ORDINARY LAY

RIGHT HAND LANGS LAY

LEFT HAND LANGS LAY

4.2 Rope Lay

Rope lay refers to the way the wires in the strands, and the strands in the rope are formed into the completed rope. The wire strands are essentially laid up in a planetary motion with controlled twist being imparted to produce a tightly formed rope.

Ordinary lay means the wires in a strand are laid in a direction opposite to the direction in which the strands are laid in the final rope.

Langs lay means the wires in the strand are laid in the same direction in which the strands are laid in the final rope.

These ropes have superior resistance to wear, abrasion, fatigue and scuffing.

4.3 Steel Wire Rope Inspection

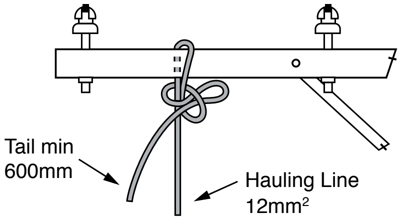
Check for broken, damaged or kinked wires and strands.

Check for excessive abrasion or scuffing.

Check for corrosion or lack of flexibility.

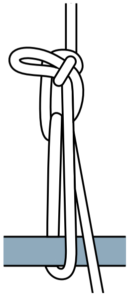
Ensure that all rope terminations are serviceable and that the wire rope is secure within the end termination (where fitted).

KNOTS AND HITCHES



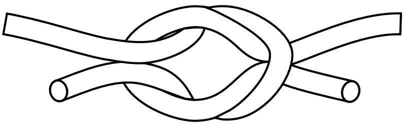
Quick Release knot

Used on a safety handline in case of an emergency in pole top rescue (PTR).



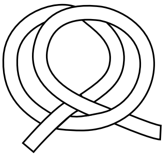
Half Sheepshank knot

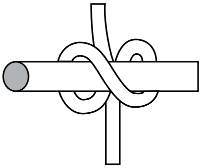
Also known as the truckies hitch, commonly used for securing loads on trailers and vehicles.



Reef knot

Used for tying lashing to a crossarm being erected and for tying the lashing around the handline or tackle being used to raise a crossarm. Used for tying bandages.



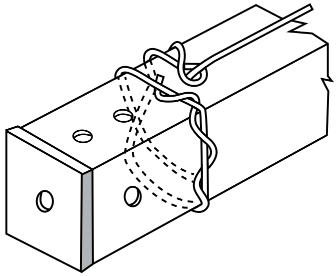


Clove hitch

Used to commence rope lashings. For all other purposes it must be secured with half hitches.

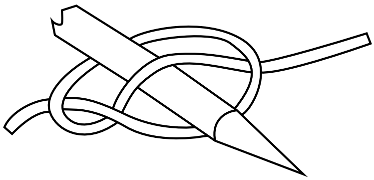
Round Turn and Timber hitch

Used when raising and lowering crossarms.



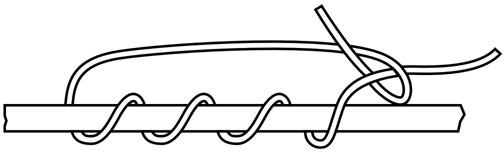
Lever hitch

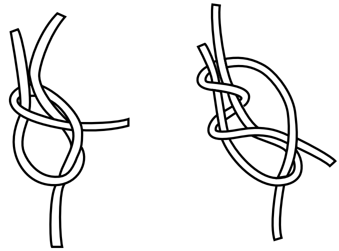
Used to raise and lower mats, preformed tubing, tools and equipment. The greater the weight, the tighter it grips (provided it is not tied upside down).



Service Hauling knot

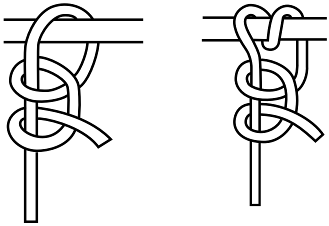
Used to raise, lower and strain cable.





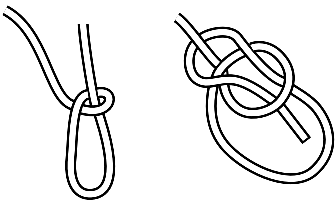
Sheet bend

Used to join rope together, and for making endless handlines. It is safer when the double sheet bend is used, particularly when rope sizes differ.



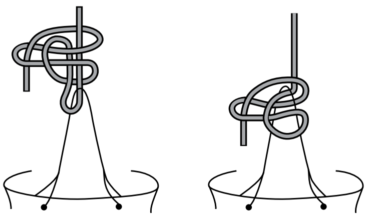
Two Half hitches

Used in PTR to secure the dead end of the hauling line to an anchor point, after having passed it through the waist section of the harness.



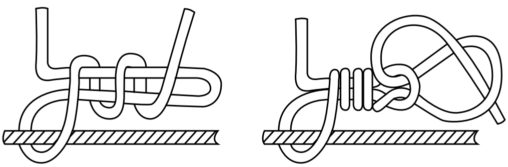
Bowline knot

Used to make a loop in a rope, to enable tackles and other lifting or straining devices to be attached. Used extensively during pole erection and live line.



Pole Bag Quick Release knot

Used to secure a pole bag when it is being raised or lowered from pole or crossarm (both methods shown below are acceptable).



Cable Stringing knot

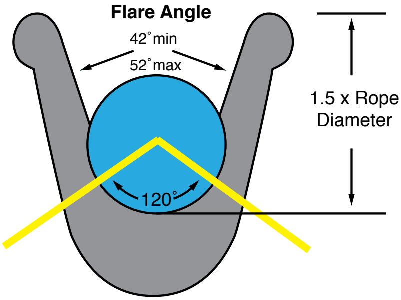
Used to secure a conductor when it is being raised or lowered from a crossarm.

6 SHEAVES

Sheaves lead the rope over the head of cranes and hoists and are used in pulley or tackle systems to gain a mechanical advantage.

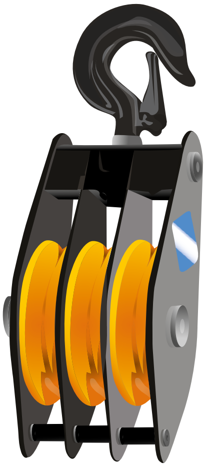
The groove depth of a sheave should not be less than 1.5 times the rope diameter, and 1/3 of the rope circumference should sit within the groove of the sheave.

The sheave groove sides should have a flare angle of a minimum of 42° and a maximum of 52°.



Correct Groove

7 SHEAVE BLOCKS

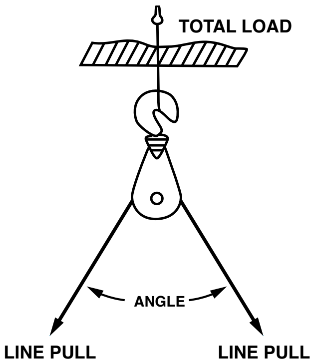


A type of block in which the side plates are fixed and the rope cannot be placed into the block at any point along its length. Sheave blocks can only be reeved by feeding the end of the rope through the block. This type of block is most commonly used with wire rope in crane fall blocks. Sheave blocks and crane fall blocks often have numerous sheaves depending on the crane configuration.

Sheave blocks manufactured to AS 2089 are used in a variety of applications such as crane hoists, luffing systems, ship-loaders, concrete 'tilt slab' arrangements, diversion blocks and winch and lift blocks to provide mechanical advantage.

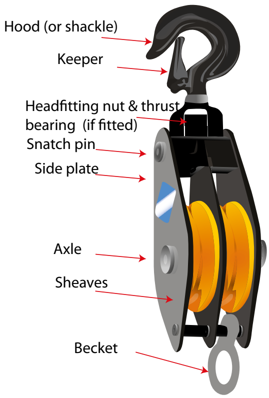
A single sheave block used to change load line direction can be subjected to a total load in excess of the weight being lifted or pulled. The total load value varies with the angle between the incoming and departing lines to and from the sheave block.

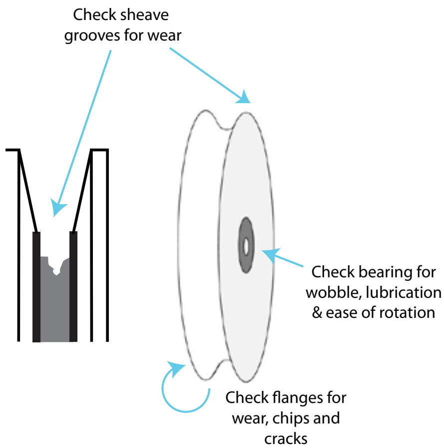
The following chart indicates the factor to be multiplied by the line pull to obtain the total load on the block.



ANGLE	FACTOR	ANGLE	FACTOR
0	2.00	100	1.29
10	1.99	110	1.15
20	1.97	120	1.00
30	1.93	130	0.84
40	1.80	135	0.76
45	1.84	140	0.68
50	1.81	150	0.52
60	1.73	160	0.35
70	1.64	170	0.17
80	1.53	180	0.00
90	1.41		

7.1 Sheave Block Inspection





The head fitting nut must be checked to ensure it is properly engaged to the full depth, the thread is locked and the R clip is fitted correctly.

Look for wear on pins, axles, rope grooves, side plates, bushes, bearings and fittings. 10% wear is the maximum permissible.

Look for deformation and distortion in side plates, pins, axles and attachment points.

Any deformation is cause for further inspection and will most likely require that the block be removed from service.

Look for wobble or misalignment in sheaves. These symptoms may mean that bearings require replacement or axles are damaged and are cause for further inspection. Also look and listen for grinding when the sheave is rotated.

Check if the sheave axle does not turn. This may mean the axle bearing has seized or been damaged and/or the keeping method is damaged or loose.

Check the hook and latch for any sign of deformation. Deformed hooks are a sign of overloading which may weaken the hook. Replacement latches are available.

Sheave blocks manufactured to AS 2089 should be marked with the following information:

- Manufacturer's identification.
- Nominal size of rope.
- Rope material: fibre (natural or synthetic) or steel wire rope.
- The material grade.
- Construction of the wire rope if other than 1770 grade.
- WLL.
- Serial number correlating to test certificate.

8 SNATCH BLOCKS

A snatch block usually only has one sheave and is used more as a lifting accessory or as a means of increasing line pull as opposed to an integral part of a crane as is often the case with sheave blocks.

The main feature common to snatch blocks is that the side plates open to allow the block to be placed on a rope at any point, or to allow wire rope slings to be placed into the block. This is because in most circumstances it is impractical to feed a wire rope sling through a sheave block.

Because one of the side plates can be folded back, snatch blocks are not as inherently strong as other pulley blocks.

9 PURCHASES

Purchases are a series of sheaves reeved up to form a mechanical advantage in flexible steel wire rope.

Fibre rope can be safely used in a wire rope purchase block.

The minimum groove depth for a wire rope purchase is 1.5 times the rope diameter.

They can be used with cranes, winches and hoist assemblies.

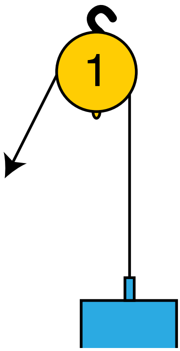
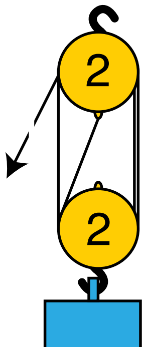
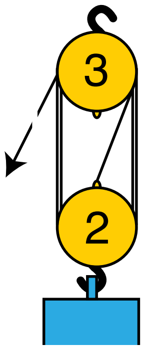
10 ROPE TACKLES

Rope tackles have fibre rope reeved through sheaves to form a mechanical advantage.

Wire ropes cannot be used in a fibre rope tackle.

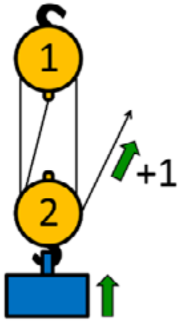
The minimum groove depth for a tackle is ½ the fibre rope diameter. The minimum diameter fibre rope that can be used for lifting a load in a tackle block is 12mm (mechanically) or 16mm (by hand).

10.1 Rope Tackle Types

Gantline	Gun Tackle	Handy Billy
		
A fibre rope reeved through a single sheave block.	A fibre rope tackle, which uses an upper block with two sheaves and a lower block with two sheaves.	A fibre rope tackle where one block has two sheaves and the other block has three sheaves.

CONTENTS

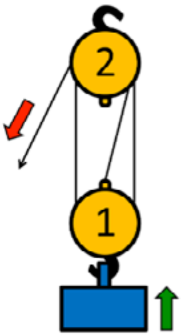
The way that the rope is reeved through the sheaves can also affect the mechanical advantage. Rope can be reeved to ‘advantage’ or ‘disadvantage’ as shown in the 2 examples below:



Reeved to Advantage

We can see that 3 parts of line are supporting the load and that the rope is being pulled in the same direction of the lifted load.

This creates a mechanical advantage, increasing the ratio from 3 to 4.



Reeved to Disadvantage

The same 3 parts of line are being used to hoist the load, however the rope is being pulled in the opposite direction to the lifted load (the direction of the pulling force is reversed). This configuration is reeved to disadvantage and therefore the mechanical advantage remains at 3.

This is the arrangement typically used in the VESI because it is operated by a person at ground level who is pulling down on the lead rope.

10.2 Mechanical Advantage and Loads on Rope Tackles

It is important to have an understanding of the mechanical advantage gained by a rope tackle so that its limitations and the effort required to gain the advantage are understood.

Always be aware that the mass of the load being lifted and its resultant action in the rope on the surface of each sheave causes friction.

Whenever performing calculations for tackle, a reduction for this friction, (known as the friction allowance), needs to be included in the calculations to properly determine the load that can be lifted.

Friction allowance formula

The standard allowance for friction is 5% per sheave. This can be calculated for any relevant number by either:

dividing by 20, or

multiplying by 0.05.

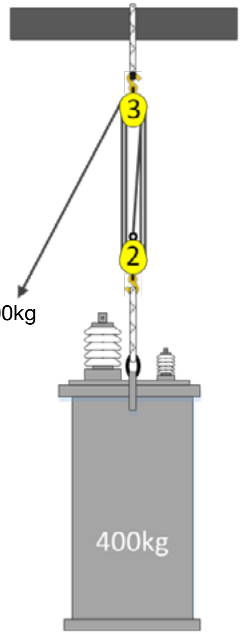
Becket Load

To work out the load in the running gear you need to firstly figure out the 'Becket Load'. The Becket Load is the total load on the lower block divided by the number of parts in the purchase (sheaves).

In this example shown at right:

1. There is a 400kg load rigged to the lower block; and
2. There are 3 sheaves in the support block and 2 in the lower block.

This means the Becket load is 400kg ÷ 5 = 80kg



Lead Load

Lead load is the force or effort applied to the lead rope (or hauling line) of a tackle to raise the load, remembering to allow for friction in the pulley, (refer Friction Allowance Formula bottom of previous page). The load in the lead rope (or Lead Load) can be calculated using the formula:

Lead Load = BL + (BL x Number of Sheaves ÷ Friction Allowance)

Therefore in our example:

Lead Load = 80 + (80 x 5 ÷ 20)

Lead Load = 80 + (20)

Lead Load = 100kg

Purchase Head Load

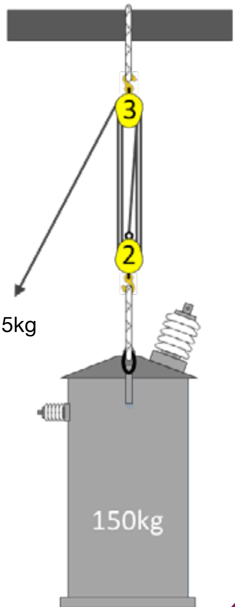
In order to safely lift this load, the structure and supporting tackle will need to be able to support the purchase head load.

The purchase head load is the sum of the lead load and the total weight on the purchase.

Therefore in our example:

Purchase Head Load = 400 + 100

Purchase Head Load = 500kg



Sample Calculation

Using the information provided, calculate the:

Becket load = 150 ÷ 5 = 30kg

Lead Load = 30 + (30 x 5 ÷ 20)

Lead Load = 30 + (7.5)

Lead Load = 37.5kg

Purchase Head Load = 150 + 37.5

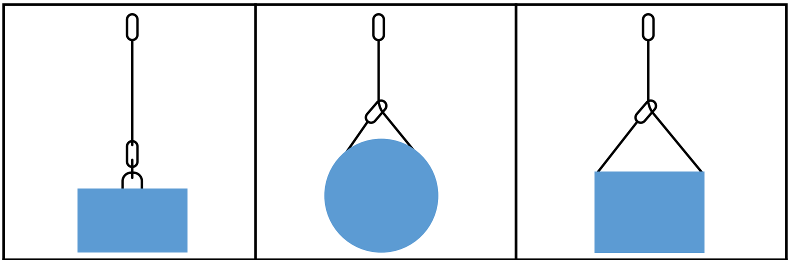
Purchase Head Load = 187.5kg

11 SLINGS - LOAD FACTORS

The lifting capacity of a sling for a straight lift is the WLL. Once the WLL has been altered due to a particular slinging method such as an increase in the angle between two legs or a reeve it is then referred to as the safe working load (SWL).

The different methods of reeving that alter the lifting capacity are known as the reeve factor.

For example, a reeved sling around a square load will halve the lifting capacity of a sling. This gives a load factor of 0.5.



Load factor = 1 | Load factor = 0.75 | Load factor = 0.5

12 CHAIN

Lifting chain is proof-tested, short link chain. The barrel of short link chain:

- Requires a greater force to bend.
- Provides greater strength.
- Reduces the tendency to twist.
- Provides better reeving performance.

Chain slings should be made up to AS 3775 Chain slings–Grade T or the manufacturer's recommendations.

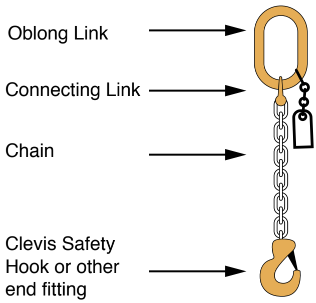
A Working Load Limit (WLL) tag must be fixed on all chain assemblies. If a tag is missing the chain should be taken out of service. The WLL tags shall be marked:

- WLL
- Conditions of use
- Serial number or identification mark matching the relevant test certificate
- Manufacturer's identification
- Grade of steel
- Specific applications
- Date of test

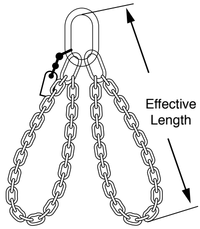
Benefits of alloy chain slings:

- Easy to use
- Completely adjustable when shortening hooks are fitted
- Easy to inspect
- Quick to assemble and test
- Very high chemical resistance
- Long lasting compared to wire rope & synthetic slings
- Grades 80, 100 and 120 & stainless steel grade 50 available
- Able to work in hotter environments than wire rope & synthetic slings
- Many types of fittings available
- All chain slings shall be individually proof load tested in compliance with the relevant Australian Standard

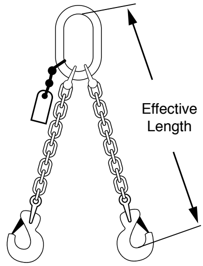
12.1 Types and Configurations of Chain Slings



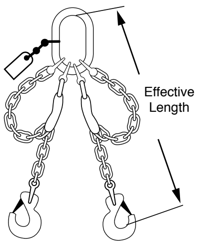
2 Leg Basket Sling



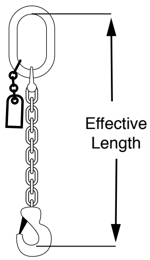
2 Leg Sling



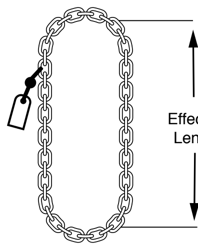
Adjustable 2 Leg Sling



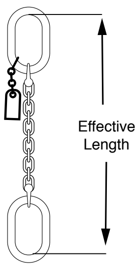
Single Leg Sling



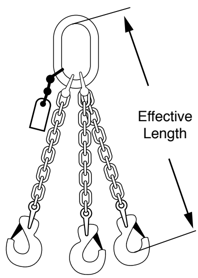
Endless Sling



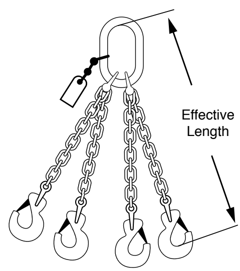
Single Leg Reevable Sling



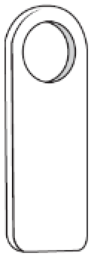
3 Leg Sling

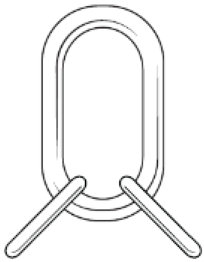


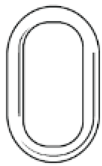
4 Leg Sling

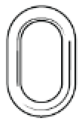


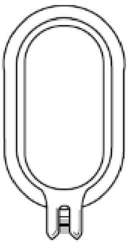
12.2 Chain Components

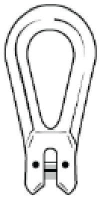

SWL Tag

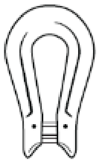

Large Multi

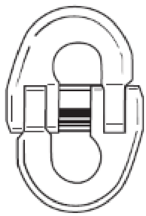

Large Series


Regular Series


Clevis Oblong Link


Clevis Pear Link


Kupler


Hammerlock


Sling Hook


Cradle Grab Hook


Foundry Hook


Choker Hook


Latchlok Hook


Swivel Latchlok


Clevis Latchlok


Clevis Foundry Hook

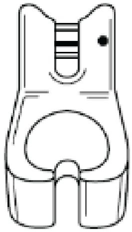
Clevis Safety Hook

Clevis Sling Hook

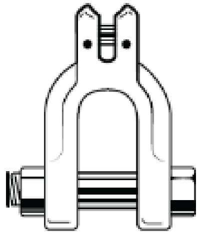
Clevis Grab Hook

Drum Hook

Clevis Grade Grab Hook



Clevis Shortner



Clevis Shackle

Each lifting component shall be legibly and indelibly marked in a place where the marking will not be removed by use and in a manner that will not impair the mechanical properties.

The marking shall include at least the following information:

a) The manufacturer's identification.

b) Quality grade: T, 8, 80, 800, or V, 10, 100, 1000 or 12, 120.

c) Nominal size.

d) The traceability code.

12.3 CHAIN – Australian Standards

In December 2014 Standards Australia released the new Standards for Chain Slings:

AS3775.1:2014 Chain Slings for Lifting Purposes - Grade T (80) and V (100). Part 1: Product Specification. AS3775.2:2014 Chain Slings for Lifting Purposes - Grade T (80) and V (100). Part 2: Care and Use.

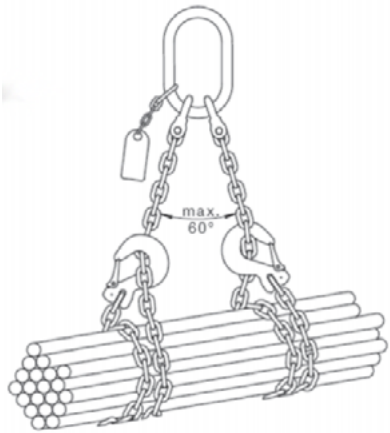
Key points include:

1. 'Competent Person' definitions – clearly defined.
2. Periodic Inspection Guide – now included.
3. Grade V (100) WLL's – up to 32mm now included.
4. Proof Testing – each sling shall be proof tested after manufacture, when damaged & when missing tags.
5. New Deration Guide – for corner loading.
6. Reeving Angle – maximum angle is now 60 degrees.

12.4 CHAIN – Reeving angles

A reeve (sometimes known as a nip) is a method of slinging where the sling passes back through itself. This in turn reduces the safe working load of the chain.

The 2014 Australian Standard mandates a maximum reeving angle of 60 for lifting. This maximum angle will apply when a chain is reeved through the end oblong link (as when lifting a pole), or back on itself via a hook.



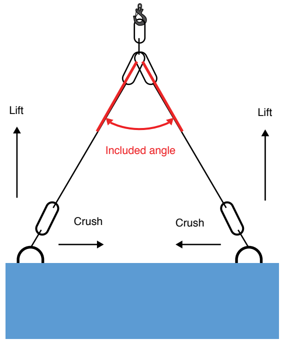
12.5 CHAIN – Load factors

A multi-leg sling is a permanent joining of two or more chain legs. The angle between the legs is critical and is known as the included angle.

As the included angle increases, so does the tension on each chain leg as the more horizontal the lifting chain becomes. This in turn increases the inward crushing pressure.

The recommended maximum included angle shouldn not exceed 90 and the best rule of thumb is to make sure the horizontal distance between the points of attachment of the load does not exceed the length of the slings.

This will ensure the angle between the two slings legs does not exceed 60.



Load Factors on Multi Leg Slings

This image shows the angle factor for 2 leg slings when measuring the included angle.

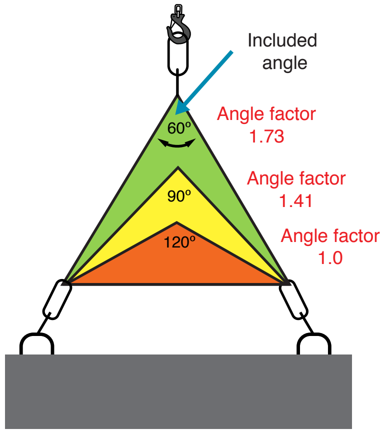
By using the shown factor of angle, the total SWL of this two leg sling can be determined, e.g:

If each leg of this chain sling has a WLL of 500kg, and the included angle is 60°, multiply the WLL by the angle factor of 1.73

SWL = WLL x angle factor

SWL = 500 x 1.73

SWL = 865kg



Alternatively, the same angle factor can be used to determine the load in each leg.

If the load is 2000kg and the included angle is 60°, divide the load by the safety factor of 1.70:

Load per leg = Load ÷ angle factor

Load per leg = 2000 ÷ 1.73

Load per leg = 1156kg

Note: in these examples, the slings are connected directly to rated lifting points and no further reduction (due to reeving factor) is needed

12.6 CHAIN – Rating

The rated capacity of chain is determined by the grade (G). Do not use a chain to lift if it does not have a manufacturer's tag that gives details of the rated capacity.

To calculate the rated capacity of 80 grade lifting chain in kilograms, square the diameter (D) in millimetres (mm) and multiply by 32.

For example:

Chain diameter (D)	= 10mm
Rated Capacity (kgs)	= D^2 (mm) x 32
	= D (mm) x D (mm) x 32
	= 10 x 10 x 32
	= 3200 kg; or
Rated Capacity (t)	= 3.2 tonnes

The previous equation can be reversed to calculate the diameter (D) in millimetres of chain needed to lift a given load.

To do this, divide the load (L) in kilograms by 32 and find the square root of the result.

For example:

Chain Load	= 3200kg
Diameter of Chain	= √ (Load (kg) ÷ (32))
	= √ (3200kg ÷ 32)
	= √ 100
	= 10mm

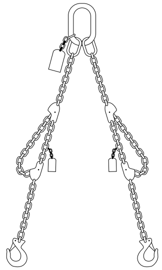
Therefore a Grade 80 chain, 10mm in diameter is needed to lift a 3200 kg load in a straight lift.

12.7 CHAIN – De-rating

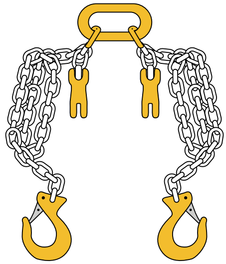
Chain de-rating is a reduction in the capacity of a chain, component or sling with a consequent revision of its working load limit (WWL), due to factors including how it is used, what it is used for, its surface finish and the work environment.

Some shortening devices, such as grab hooks, may de-rate the WLL for the sling by 25%.

Other shortening devices such as shortening hooks and grab hooks with cradle configuration, may not de-rate the WLL for the sling.



Chain sling with shortening hooks



Chain sling with shortening clutches

The latest Australian Standard states that inline shortening assemblies can now be used under the following conditions:

1. As long as the sling assembly is tested and tagged.
2. Up to 16mm - locking shorteners are to be used as an integral part of the assembly - see Figures (a), (b) and (c).
3. Over 16mm - A Risk Assessment is required and additional measures taken ensuring the device does not become detached.
4. Slings without locking mechanisms – must be accompanied by a Warning Advice.

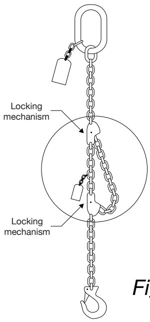


Fig. (a)

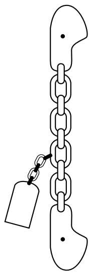


Fig. (b)

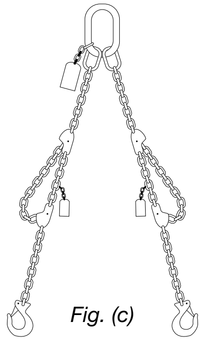
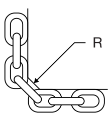
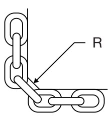
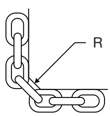


Fig. (c)

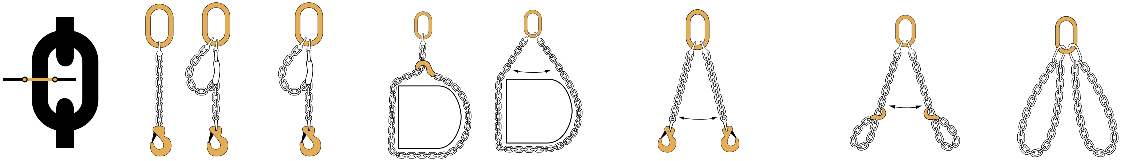
It is very rare for powerline workers to sling chain around any load other than poles. Items other than poles are typically fitted with rated lifting points and lifted with multi-leg chain slings.

Notwithstanding this, it is important to understand how slinging a chain around square objects is another avenue towards de-rating the chain.

The following deration applies for using chain slings when lifting objects with sharp corners of metal or hard material.

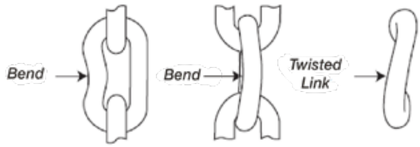
	R = larger than 2 x d	R = larger than d	R = smaller than d
Edge load *			
Load factor	1	0.7	0.5

12.8 Working Load Limits (Tonnes) for Grade T(80) Chain Slings



Loading Factors	1.00	0.75	0.75	1.30	1.73	1.41	1.00	1.30	2.25
Chain Size (mm)	Straight sling or adjustable sling with no deration	Adjustable sling with deration (Note 1)	Reeved sling	Basket sling Max 60°	Straight sling (Note 2)			Reeved sling (Notes 2 and 3)	Basket Sling (Note 2, 3 and 4)
					60°	90°	120°	Max angle 60°	Max angle 60°
6	1.1	0.8	0.8	1.5	1.9	1.6	1.1	1.5	2.5
7	1.5	1.1	1.1	2	2.6	2.1	1.5	2	3.4
8	2	1.5	1.5	2.6	3.5	2.8	2	2.6	4.5
10	3.2	2.4	2.4	4.1	5.5	4.5	3.2	4.1	7.2
13	5.3	4.0	4.0	6.9	9.2	7.5	5.3	6.9	11.9
16	8	6.0	6.0	10.4	13.8	11.3	8	10.4	18.0
19	11.2	8.4	8.4	14.6	19.4	15.8	11.2	14.6	25.2
20	12.5	9.4	9.4	16.3	21.6	17.6	12.5	16.3	28.1
22	15	11.3	11.3	19.5	26.0	21.2	15	19.5	33.8
26	21.2	15.9	15.9	27.6	36.7	29.9	21.2	27.6	47.7
32	31.5	23.6	2.6	41	54.4	44.4	31.5	41	70.9

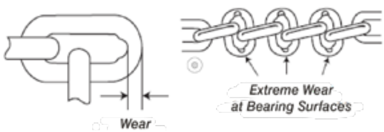
12.9 CHAIN – Inspection



Clean the chain thoroughly. Lay the chain out on a clean surface or hang it up in a well-lit area.

Check for working load limit tag with correct markings.

Every chain link should be individually inspected for any signs of wear, twisting, stretching, nicks or gouging and any worn link measured to determine degree of wear using vernier calipers.



Master links and hooks should be inspected for any signs of wear at their bearing points and for any signs of distortion, such as widening of the hook throat opening. Maximum allowable wear is 10%.

Chain links or fittings having any defects should be clearly marked to indicate rejection and the sling withdrawn from service until properly repaired. Chain repairs shall only be carried out by qualified professionals.

12.10 CHAIN – Care In Use

The operator should establish the weight of the load to be lifted as accurately as possible and ensure that the crane or other lifting equipment and the lifting points are adequate to lift the load.

Prepare the site where the load is to be landed in advance. Ensure that the chain is not trapped by the load in such a way that removal of the chain cannot be made by hand.

Check compatibility of the chain sling to the crane hook and the lifting points on the load.

Ensure the chain is free from twists and is protected from any sharp corners on the load.

Ensure the load is evenly distributed on all sling legs. This can be facilitated through the use of shortening hooks.

When using a choke hitch, the bite should be allowed to assume its own position.

Commence the lift slowly, taking up the slack gradually.

Care must be taken to ensure that the load remains stable throughout the lift.

A trial lift should be made prior to the full lift operation. If the load is not balanced it should be lowered and the slings re-positioned.

Sling hooks of a multi-leg sling should be positioned so that they face outward from the load.

13 HOOKS

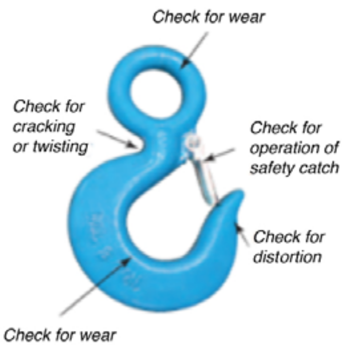
There are numerous hook designs and configurations to suit many different applications. It is important to select the right hook for the job.

All hooks designed and tested in accordance with Australian Standards shall be marked with:

- Manufacturer's identification.
- Quality grade.
- SWL or WLL.
- Identification marking or batch number to trace the hook to the manufacturer's test certificate.

13.1 Hook Inspection

The pre-use check of hooks should cover the following:



- The WLL should be clearly marked.
- The safety catch should be in place and functioning correctly.
- Check for any distortion, cracking and excessive wear or corrosion.
- Moving parts should be checked for free movement.
- Check any ball bearing swivels are swivelling freely and not making any unusual noises. This may be a sign of bearing failure.
- If the hook has a threaded machined shank ensure that the thread is in good order and that the nut is turning freely on the thread.

13.2 Hook Care and Use

Never use a hook if its throat opening has been increased, or its tip has been bent more than 10 degrees out of plane from the hook body, or is in any other way distorted or bent.

Never use a hook that is worn beyond a recommended maximum of 8%.

Remove from service any hook with a crack, nick or gouge.

Never repair, alter, rework or reshape a hook by welding, heating, burning or bending.

Never side load, back load or tip load a hook.

The WLL of a hook applies only when the load is correctly positioned on the load line of the hook. If the hook is eccentrically loaded, or the load is applied other than on the load line, the WLL is greatly reduced.

Use a swivel hook if the load has a tendency to rotate when lifted.

Always check that the hook safety catch has closed correctly before allowing the load to be lifted.

14 SLINGS

14.1 Synthetic Slings

Round sling with a protected tag

Round sling with the cover pulled back to inspect tag details

Flat webbing and round synthetic slings are used for lifting where it is necessary to protect the load from damage and for protection from electrical hazards.

It is important to ensure that synthetic webbing slings are not twisted when being used to support or lift loads.

Each sling shall be fitted with a tag displaying:

- The rated capacity
- Angle factors
- Reeve factors
- Manufacturer
- Grade applications
- Conditions of use

Synthetic slings are most commonly made from 100% polyester, but the internal fibres can be made with other materials for specific applications.

The colour of the working load limit tag shall identify the type of fibre used for the sling as follows:

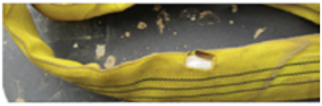
Polyester	Blue
Nylon	Green
Polypropylene	Brown
Aramid Polymide	Yellow

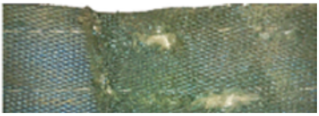
The actual colour of the sling is a code that indicates its lifting capacity or rating, (see table on page 46). This can always be confirmed by an inspection of the WLL tag.

The benefits of synthetic slings include:

- Approximately 5 x lighter than wire rope at the same capacity
- Easy to use
- Do not rust
- No de-rating of WLL when wet
- Good choking and reeving capabilities
- Easily inspected
- High chemical resistance
- Free of static electricity (non-conductive)
- Cheaper than chain or wire rope slings

14.2 Synthetic Sling Inspection





Synthetic slings shall be inspected before use for the following:

- WLL tag is intact, legible and the sling is correct for the application
- External wear on the cover
- Inspect for any cuts to load bearing fibres
- Holes in the cover
- Local abrasion
- Internal wear
- Damage to protective coating or sleeve
- Damage from high temperatures or UV damage
- Chemical attack
- Deterioration of stitching
- Internal thickening of a round sling

14.3 Synthetic Sling Care and Use

Avoid contact with hot surfaces (blow lamps or welding torches) and exposure to damaging conditions such as prolonged exposure to sunlight, dust or chemicals.

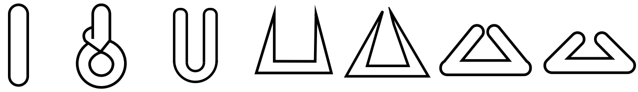
Immediately wash a synthetic sling that has come into contact with acids or alkalis with water. Refer to manufacturer's instructions when cleaning synthetic slings.

Wet slings should be hung and allowed to dry naturally. Slings shall never be force dried or dried near a source of heat.

Store off the ground in a dry, ventilated area that is clean and free from dirt & grit.

NOTE: Always refer to manufacturer's instructions for cleaning synthetic slings or if the sling has been used in the presence of or come into contact with chemicals.

14.4 Working Load Limits for Synthetic Slings



Direct Load	Material Colour	Vertical WLL kg	Choke WLL kg	Basket WLL kg	30° WLL kg	60° WLL kg	90° WLL kg	120° WLL kg
1000	Violet	1000	800	2000	1900	1700	1400	1000
2000	Green	2000	1600	4000	3800	3400	2800	2000
3000	Yellow	3000	2400	6000	5700	5100	4200	3000
4000	Grey	4000	3200	8000	7600	6800	5600	4000
5000	Red	5000	4000	10000	9500	8500	7000	5000
6000	Brown	6000	4800	12000	11400	10200	8400	6000
8000	Blue	8000	6400	16000	15200	13600	11200	8000
10000	Orange	10000	8000	20000	19000	17000	14000	10000

14.5 Wire Rope Slings

Wire rope slings are manufactured in accordance with AS 1666 and can be made to various configurations. They are manufactured from wire rope conforming to AS 3569 or applicable International Standard.

Variations can include the number of legs, the length of legs and the fittings attached to the wire.

Benefits of wire rope slings include:

- Wire rope slings are used for lifting and are generally substantially cheaper than chain slings.
- They can be supplied in longer lengths and higher capacities than alloy lifting chain.
- Wire rope slings can be used to run through sheave blocks where alloy chain cannot, e.g. concrete tilt up slabs.
- All wire rope slings are individually load proof tested in compliance with the Australian Standard.

A Thimble eye secured with a ferrule

A Flemish eye secured with a ferrule

All wire rope slings or assemblies shall be legibly marked or tagged with the following:

- Manufacturer's identification.
- WLL for the single leg or multiple leg assemblies.
- Serial number, identification mark or test number matching the relevant test certificate.

Note: Date of test is not mandatory for wire rope sling WLL tags or sling markings.

Wire rope slings are typically finished in one of two styles, as illustrated on left.

14.6 Wire Rope Sling Inspection

Check for the following:

- the identification stamp or tag is present and ensure the WLL of the sling is clearly legible.
- any load-bearing points for excessive wear, kinking, broken wires, bird caging, crushing or flattening and corrosion.
- each strand along its length, opening the rope as much as practicable to enable examination of the surfaces of the strands towards the inside of the rope.
- end fittings and attachments for any signs of deformation, excessive wear or corrosion.
- heat damage which is usually obvious through the discolouration of the wires.

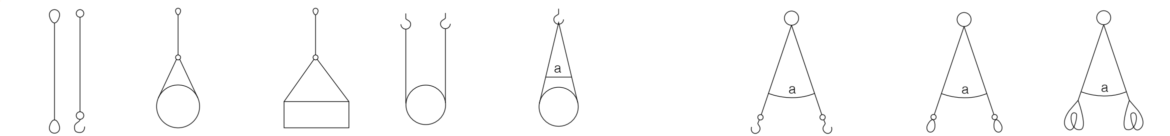
14.7

Working Load Limits for Wire Rope Slings

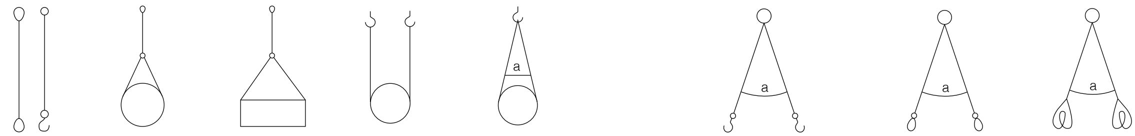
1570 Grade Fibre Core

Wire Rope Slings - Single, Two, Three & Four Leg with Ferrule Secured Eyes, using Galvanised or Black Wire Rope in accordance with AS 1666.1 – 1570 Grade Fibre Core

Method of Loading Sling		Direct Loaded	Choke Hitch		Basket Hitch				Direct Loaded			Choke Hitch Round Load	
			Round Load	Rectangular Load	Round Load							Single Wrap	Double Wrap
Including Angle		-	-	-	0°	60°	90°	120°	0°-60°	90°	120°	0-°45°	0-°60°
Nom. Dia. (mm)	MBF												
8	28.2	0.55	0.41	0.27	1.11	0.96	0.78	0.55	0.96	0.78	0.55	0.72	
9	35.6	0.70	0.52	0.35	1.40	1.21	0.99	0.70	1.21	0.99	0.70	0.91	
10	44.0	0.86	0.65	0.43	1.73	1.50	1.22	0.86	1.50	1.22	1.86	1.13	
11	53.2	1.05	0.78	0.52	2.10	1.81	1.48	1.05	1.81	1.48	1.05	1.36	
12	63.3	1.23	0.92	0.61	2.47	2.14	1.74	1.23	2.14	1.74	1.23	1.61	



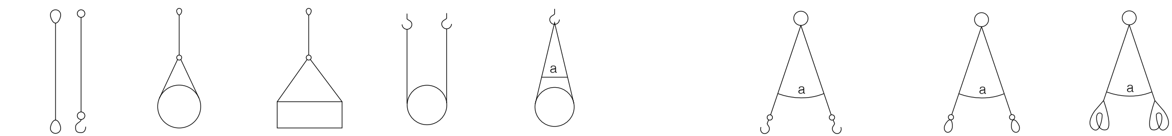
1570 Grade Fibre Core

Method of Loading Sling		Direct Loaded	Choke Hitch		Basket Hitch				Direct Loaded			Choke Hitch Round Load	
			Round Load	Rectangular Load	Round Load							Single Wrap	Double Wrap
Including Angle		-	-	-	0°	60°	90°	120°	0°-60°	90°	120°	0-°45°	0-°60°
Nom. Dia. (mm)	MBF												
13	74.3	1.47	1.10	0.73	2.94	2.54	2.07	1.47	2.54	2.07	1.47	1.91	
14	86.2	1.70	1.27	0.85	3.40	2.94	2.40	1.70	2.94	2.40	1.70	2.21	
16	113	2.22	0.67	1.11	4.45	3.85	3.14	2.22	3.85	3.14	2.22	2.89	
18	53.2	2.80	2.10	1.40	5.61	4.85	3.95	2.80	4.85	3.95	2.80	3.65	
20	176	3.48	2.61	0.74	6.97	6.03	4.91	3.48	6.03	4.91	3.48	4.53	
22	213	4.20	3.15	2.10	8.40	7.27	5.92	4.20	7.27	5.92	4.20	5.46	
24	253	5.01	3.76	2.50	10.03	8.67	7.07	5.01	8.67	7.07	5.01	6.52	
26	297	5.88	4.41	2.94	11.77	10.18	8.30	5.88	10.18	8.30	5.88	7.65	
28	345	6.81	5.11	3.40	13.63	11.67	9.61	6.81	11.79	9.61	6.81	8.86	
32	450	8.90	6.68	4.45	17.81	15.41	12.56	8.90	15.41	12.56	8.90	11.58	

CONTENTS

1770 Grade Wire Rope Core

Wire Rope Slings - Single, Two, Three & Four Leg with Ferrule Secured Eyes, using Galvanised or Black Wire Rope in accordance with AS 1666.1 - 1770 Grade Wire Rope Core

Method of Loading Sling		Direct Loaded	Choke Hitch		Basket Hitch				Direct Loaded			Choke Hitch Round Load	
			Round Load	Rectangular Load	Round Load							Single Wrap	Double Wrap
Including Angle		-	-	-	0°	60°	90°	120°	0°-60°	90°	120°	0-°45°	0-°60°
Nom. Dia. (mm)	MBF												
8	40.20	0.78	0.58	0.39	1.56	1.35	1.10	0.78	1.35	1.10	0.78	1.01	
9	51.1	0.99	0.74	0.49	1.98	1.71	1.40	0.99	1.71	1.40	0.99	1.29	
10	63.1	1.22	0.92	0.61	2.40	2.10	1.72	1.22	2.10	1.72	1.22	1.59	
11	76.3	1.48	1.11	0.74	3.00	2.60	2.10	1.48	2.60	2.10	1.48	1.92	
1.92	90.8	1.76	1.32	0.88	3.50	3.00	2.50	1.76	3.00	2.50	1.76	2.30	

1770 Grade Wire Rope Core

Method of Loading Sling		Direct Loaded	Choke Hitch		Basket Hitch				Direct Loaded			Choke Hitch Round Load	
			Round Load	Rectangular Load	Round Load							Single Wrap	Double Wrap
Including Angle		-	-	-	0°	60°	90°	120°	0°-60°	90°	120°	0-°45°	0-°60°
Nom. Dia. (mm)	MBF												
13	107	2.10	1.55	1.04	4.10	3.60	2.90	2.10	3.60	2.90	2.10	2.70	
14	124	2.40	1.80	1.20	4.80	4.20	3.40	2.40	4.20	3.40	2.40	3.10	
16	161	3.10	2.30	1.56	6.20	5.40	4.40	3.10	5.40	4.40	3.10	4.10	
18	204	4.00	3.00	1.98	7.90	6.80	5.60	4.00	6.80	5.60	4.00	5.10	
20	252	4.90	3.70	2.40	9.80	8.40	6.90	4.90	8.40	6.90	4.90	6.30	
22	305	5.90	4.40	3.00	11.80	10.20	8.30	5.90	10.20	8.30	5.90	7.70	
24	363	7.0	5.30	3.50	14.10	12.20	9.90	7.00	12.20	9.90	7.00	9.10	
26	426	8.30	6.20	4.10	16.50	14.30	11.60	8.30	14.30	11.60	8.30	10.70	
28	494	9.60	7.20	4.80	19.10	16.60	13.50	9.60	16.60	13.50	9.60	12.40	
32	646	12.50	9.40	6.30	25.00	22.00	17.60	12.50	22.00	17.60	12.50	16.30	
36	817	15.80	11.90	7.90	32.00	27.00	22.00	15.80	27.00	22.00	15.80	21.00	
40	1010	19.60	14.70	9.80	39.00	34.00	28.00	19.60	24.00	28.00	19.60	25.00	
44	1220	24.00	17.70	11.80	47.00	41.00	33.00	24.00	41.00	33.00	24.00	31.00	
48	1450	28.00	21.00	14.00	56.00	49.00	40.00	28.00	49.00	40.00	28.00	37.00	
52	1760	33.00	25.00	16.60	66.00	57.00	47.00	33.00	57.00	47.00	33.00	43.00	
56	1980	38.00	29.00	19.20	77.00	66.00	54.00	38.00	66.00	54.00	38.00	50.00	
60	2270	44.00	33.00	22.00	88.00	76.00	62.00	44.00	76.00	62.00	44.00	57.00	

CONTENTS

15 SHACKLES

Dee Shackle

Bow Shackle

A shackle is a portable link used for joining various pieces of lifting equipment. The two main shapes for load lifting are the 'dee' and 'bow' shackles.

If you are using a shackle to support multiple slings ensure that you use a bow shackle.

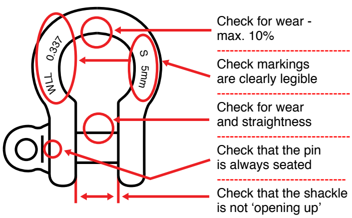
In accordance with AS 2741 shackles shall be marked with:

- Manufacturer's identification.
- Quality Grade, as M or 4, or S or 6.
- WLL.
- Identification marking to correlate the shackle to the test certificate.

Grade M shackles comply with AS 2741 and are typically known as large D or large bow shackles. They generally have larger internal dimensions but will have a lower WLL than grade S.

Grade S shackles comply with AS 2741 and have approximately twice the working load limit of grade M shackles. These are most commonly used for lifting, rigging, lashing and mooring systems and are available in screw pin and safety pin configuration.

15.1 Shackle Inspection



- Missing or illegible rated capacity
- Stretched, defective or incorrect pin
- Pin wont screw in or seat properly
- Bent or warped
- Cracked or chipped
- Over 10% wear

NOTE 1: All lifting shackles conforming to AS 2741 are recognisable by markings and will have a larger pin diameter than the body of the shackle.

NOTE 2: The colour of the pin is supplier related not Standard related.

15.2 Shackle Care and Use

Commercial grade shackles are not to be used for lifting purposes.

For screw pin shackles the collar of the pin should be fully seated on the shackle eye.

When securing the screw pin into a shackle, tension the pin finger tight and then back the pin off by a ¼ turn. Never use a shifter or similar device to tension the pin into position.

Ensure that the pin is the correct length so that it penetrates the full depth of the screwed eye and allows the collar of the pin to bed evenly on the surface of the shackle eye.

If the shackle pin does not seat correctly this indicates that the pin may be bent or the thread is not correct.

If a shackle is to be left in a loaded position for a period of time, or has the potential for the pin to become dislodged, mouse the pin of the shackle into place.

16 LEVER BLOCKS

Lever blocks are manually operated hoists used for a variety of lifting, pulling, tensioning and material handling applications.

Lever blocks operate by levering the handle up and down to lift or lower a load and can be used at any angle.

One of the main differences between a chain block and a lever block is that the lever block has a neutral mode which enables the chain to free wheel through the block to take up the slack chain quickly.

Lever blocks are available in single or double fall configurations depending on the WLL required and utilise standard short link chain.

16.1 Lever Block Inspection

- Ensure the ID plate is clearly legible and marked with type/model, serial/batch number, nominal size and grade of load chain, rated capacity and name/identification of the manufacturer.
- Ensure the inspection is in date and the block is registered.
- Ensure that the lever block certification is current.
- Inspect frame, covers and handle for cracks, gouges, corrosion and other damage.
- Check for freewheeling function.
- Ensure raise and lower selections operate correctly.
- Check there is an end stop fitted to the chain.
- Lubricate if required. Do not over lubricate as contamination of the block clutch may result.
- Check the load chain is marked with the manufacturer's ID and grade.
- Inspect chain for wear, gouges, nicks, arc burns, twisted & bent links and corrosion.
- Inspect for correct reeving on multi-reeved units (look for twists in chain at hook block).
- Inspect load wheel for foreign material, wear and corrosion.
- Inspect sheaves for wear, freedom of movement and corrosion.
- Inspect hooks for signs of deformation, cracking, bending, arc burns and corrosion.
- Inspect safety latches for condition and operation.

16.2 Lever Block Care and Use

All persons involved in the operation of a lever block must read the manufacturer's handbook and be completely familiar with all operating procedures.

Never lift loads in excess of the WLL of the lever block.

If the lifting operation involves lifting light loads with long load chains, be aware that the chain slack may be heavier than the load and cause a 'run-back' and lower the load.

If the lever block is fitted with an overload limiter the block will cease to operate if in excess of the WLL.

It is recommended that the minimum load lifted should not be less than 10% of the WLL.

When operating a lever block, always maintain a firm footing and when necessary be secured in case of a sudden release of the load.

On a block with a pawl release lever, ensure that the pawl release lever is in the 'engaged' position before operating the block.

The pawl must not be disengaged whilst there is a load on the block hook, or the load will drop.

Confirm that the brake is functioning properly by hoisting the load a sufficient distance from its initial position, and check the brake engages when lowering the load.

Never walk or work under a suspended load, and never lift, support or transport people.

The handle on a lever block is of sufficient design length to provide mechanical advantage to meet the WLL. Overloading can only occur if the force applied is greater than the manufacturer's specifications.

Do not allow dirt or grease to accumulate in the profiles of the load chain wheel.

Listen for the 'clicking' of the ratchet pawl during use. The absence of the ratchet 'clicking' noise will indicate a malfunction in the lever block mechanism.

Lifting a load with two lever blocks is not recommended.

If the operation is unavoidable, hoist the load with care, keeping the load balanced at all times.

Never run the load chain out too far.

If excessive force is required on the lever to lift a rated load, you have not assessed the load correctly and larger or multiple units may be required for this application.

17 LUG-ALL

Lug-All is the proprietary name for the most commonly used hand winch in the Australian power industry. The Lug-All is a cable ratchet winch that is used for straining cables and setting guys.

The Lug-All has 3 modes of operation:

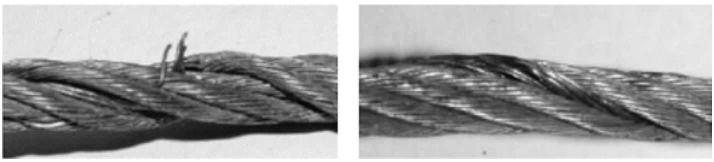
- Lifting or tensioning
- Lowering or backing off
- Free release

Lifting or lowering operations are carried out while the hoist is under load (at least 7kg).

The position of the reverse lever determines the action. Free release unwinds the cable from the drum.

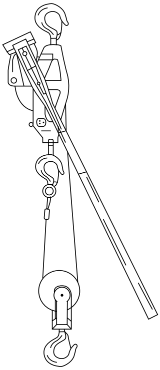
17.1 LUG-ALL Inspection

- Check cable is not wedged or jammed.
- Check operation of latches.
- Inspect cable for kinks, cuts, broken strands, fraying or abrasions.
- Check ratchet teeth for gouges, burred edges or other physical damage.
- Check the frame for cracks, gouges, corrosion and other damage.
- Check the handle condition and ensure it is securely attached.

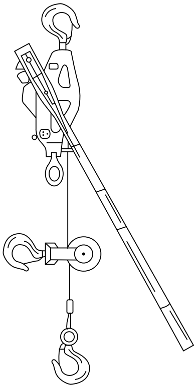


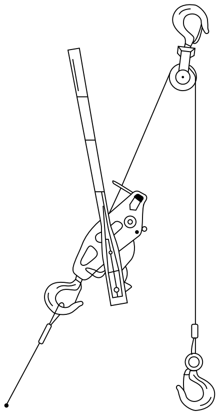
Broken and kinked strands on Lug-All cables. These cables are weakened and should be replaced before the hoist can be safely operated.

17.2 LUG-ALL Care and Use



Double rigged full capacity





Alternate rigged ½ capacity

Do not snag or pull the cable over sharp or rough edges as this will wear and fray the cable.

When rewinding the cable on the drum, apply light (4kg) tension. This assures even wrapping and will prevent the cable from “wedging” the next time it is used under heavy load.

Stop pulling when the cable clamp reaches the cable guide or pulley wheel, or the pulley wheel reaches the cable guide (depending on rig used), as continued pulling will damage parts.

Use a steady, straight pull to operate.

When operating under load, do not allow the handle to “fly” as this can cause damage to the U-frame.

A Lug-All will operate in any position; right side up, upside down or at any angle as a hoist or horizontally as a winch. The power of the winch hoist depends on whether it is single-line rigged or double-line rigged with the use of a pulley block.

Rig the winch hoist with double-line for full rated capacity or single-line for one half-rated capacity and twice the lifting distance and operating speed.

18 STRAP HOISTS

Strap hoists are used for live HV and LV work.

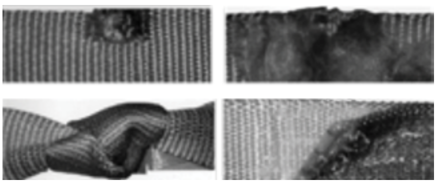
The most common type is also made by the Lug-All manufacturer and has 3 modes of operation:

- Lifting or tensioning
- Lowering or backing off
- Free release

Lifting or lowering operations are carried out while the hoist is under load.

The position of the reverse lever determines the action. Free release unwinds the cable from the drum.

18.1 Strap Hoist Inspection



Damaged webbing straps. These straps are weakened and should be replaced before the hoist can be safely operated.

Other than the webbing, inspection, care, use and rigging are as for the Lug-All cable hoist.

Check webbing strap for frayed edges, melting, charring, chemical damage, abrasive wear, cuts on the face or edges of webbing, holes, tears, snags or crushing.

19 WIRE GRIP

Haven style – used when deformation of the cable is not a factor, e.g. steel guy wire

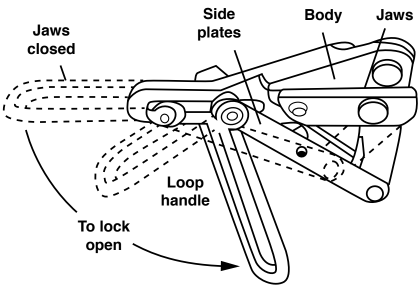
Most commonly referred to as a comealong, wire grips are used to attach hoists to conductors/cables when straining, terminating or splicing.

There are 3 common types, this page uses the terminology of the manufacturer Klein.

Parallel jaw style – for use on the widest range of conductor types and sizes

Chicago style – for use on aluminium, copper, weatherproof coated wire, PVC covered conductors and guy wire

19.1 Wire Grip Inspection



Carefully inspect jaw condition, proper alignment of jaws and all parts, and possible distortion caused by exceeding safe-load specifications. Grips should operate smoothly. Spring-loaded grips should lock open with loop handle in “Down” position and should close automatically with loop handle “Up".

General cleaning with a wire brush and lubrication of moving joints is all that is required to maintain cable grips in good condition.

Note, do not lubricate gripping surfaces of jaws.

20 WINCHES

20.1 Creeper Winch

Commonly known by the brand Tirfor, creeper winches are designed for pulling, lifting or lowering loads. They use a wire rope that is levered through the machine.

Tirfor winches work by the same general principle of utilising two sets of jaws that open and close in turn. This enables the winch rope to be pulled through by one set of jaws while the other set of jaws hold the rope in position and stop it slipping backwards under load.

The Tirfor winch principle is similar to a person pulling on a rope. One hand holds the rope while the other hand pulls on it.

20.2 TIRFOR Inspection

Check that the winch has its identification plate displaying the WLL.

Check operation of the forward and reverse operating levers. They should operate smoothly and without sticking.

Generally check the winch for any signs of wear, damage, abuse, corrosion, cracking or distortion. Check also that all nuts and bolts are secure.

Check the handle for signs of distortion and that it is the correct size and type for the model winch.

Check the anchor point for wear, distortion, cracks and corrosion.

If fitted, ensure the shear pins are intact and located correctly in the lower section of the operating levers.

Check the tapered end of the wire rope.

Check the wire rope for any signs of excessive wear, corrosion and kinking.

Check the ferrule for any signs of cracking, distortion or other damage.

Check the hook to ensure the safety catch is intact and that there is no deformation, excessive wear or corrosion.

20.3 TIRFOR Care and Use

Always read and ensure you understand the owner’s manual and safety instructions before operating the winch.

Never lift or pull a load in excess of the winch capacity.

Conduct minor operational test before use if possible.

Always use the genuine wire rope as recommended by the manufacturer or an approved equivalent.

Ensure that the winch is well lubricated. For lubrication instructions refer to the manufacturer's operating manual.

Do not use kinked rope, as this will cause the winch to malfunction.

The winch and the rope should be stored in a clean, dry and airy environment where it will be free from contamination.

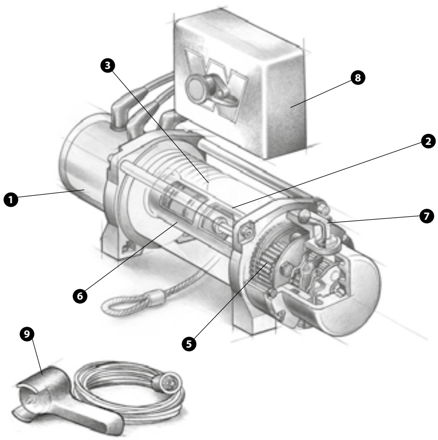
Use only the hand lever provided with the winch and do not use extension or cheater bars to gain more leverage.

21 VEHICLE MOUNTED WINCH

The use of any winch presents some risk of personal injury or property damage. That risk is greatly increased if the proper instructions and warnings are not adhered to.

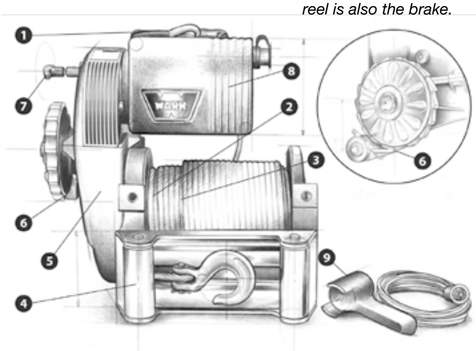
There are no national competency training standards for the operation of winches, however all manufacturers provide good safety and operating instructions for their unit.

Before using your winch, you must become thoroughly familiar with all warnings, instructions and recommendations relating to its use.



1. Motor, typically powered by vehicle battery
2. Winch drum, driven by the motor and its direction can be changed
3. Wire rope, its diameter and length determined by the winch's load capacity and design
4. Fairlead, acts as a guide when to prevent damage to rope when using the winch at an angle
5. Gear train, converts motor power into pulling force
6. Braking system, automatically applies when the motor is stopped
7. Clutch allows the operator to manually disengage the drum from the gear train
8. Control box, solenoids switch power to the motor enabling changes of direction
9. Remote control, allows the operator to stand clear of the wire rope while operating the winch

***Inset below:** There is a stopper on the side of the winch body for this large diameter reel. In fact, this reel is also the brake.*



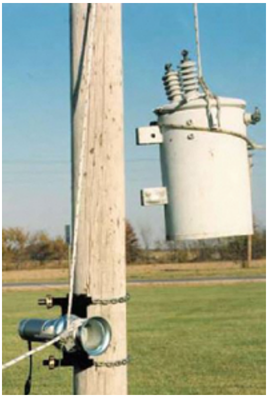
21.1 Vehicle Mounted Winch Inspection

Inspect the wire rope before and after each winching operation. If the wire rope has become kinked or frayed, it needs to be replaced. Be sure to also inspect the winch hook and hook pin for signs of wear or damage.

Keep all winch parts free from contaminants. Use a clean rag or towel to remove any dirt and debris. If necessary, unwind winch completely (leaving a minimum of 5 wraps on spooling drum), wipe clean, and rewind properly before storage. Using a light oil on the wire rope and winch hook can keep rust and corrosion from forming.

Inspect the remote control for damage. Be sure to cap the remote socket to prevent dirt and debris from entering the connections. Store remote control in a protected, clean, dry area.

22 CAPSTAN WINCH



Strictly speaking, a capstan winch is one where the drum is mounted vertically, however the term is applied to any drum type winch that plays line out at the same time that it is recovering line.

Most commonly used in the VESI as a pole mounted portable hoist.

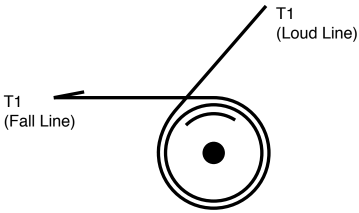
As with vehicle mounted winches, there are no national competency training standards for the operation of capstan winches, however all manufacturers provide good safety and operating instructions for their unit.

Never add or remove turns of rope while a load is suspended.

Use the same number of turns to lower a load as is required to raise the load.

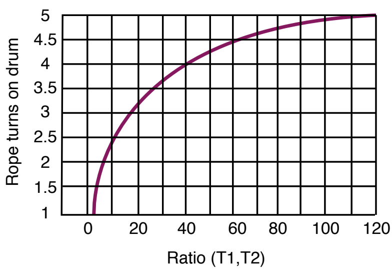
Never use so many turns of rope that no pull is required on the fall line to activate the load.

A minimum of 3.5 turns is recommended for any capstan winch.



As shown in the figure at left, capstan winches offer a powerful mechanical advantage which is dependent on how many turns are made on the drum.

Mechanical Advantage of Series 90 Hoists



It can be seen that 3.5 turns on the drum gives a mechanical advantage of 30. This means for every kg of pull on the fall line, the hoist applies 30kg to the load line. Thus, a 600kg load can be lifted with 20kg pull on the fall line using 3.5 turns of rope on the drum.

Another example: 4 wraps of rope = 1:44 ratio. That is, 1kg pull on fall line develops 44kg on load line. Therefore, 20kg of pull develops 880kg of lift.

22.1 Capstan Winch Inspection

Check for unusual sounds during drum rotation.

Excessive grease or lubricant leakages, corrosion and heat damage.

Cracked or warped components.

Missing bolts and fixtures (lost or damaged bolts and brackets must be replaced with the same type and grade high tensile parts).

22.2 Capstan Winch Use and Operation

Capstan winches are for lifting equipment only, never for lifting people or loads over people.

Mount brackets so that the load pulls the bracket against, rather than away from the pole.

The proper choice of rope, blocks, and slings is critical.

Example, if lifting a 200kg transformer, any block used must be rated at 500kg minimum because at the same time the 200kg load is pulling down on the block, so is the winch applying 200kg to lift the load. With friction adding an additional load of approximately 10% the total becomes 440kg.

Rope to be used on a capstan winch needs three properties:

a) Adequate WLL

b) Good frictional characteristics

c) High temperature melting point

As rope goes around a capstan drum, it must slide a minute amount to advance across the drum. This creates friction which causes heat. If the drum is allowed to rotate without advancing the rope, heat builds up quickly and can melt plastic ropes.

Always mount a capstan winch using the bracket and bolts supplied. If lost or damaged they must be replaced with the same type and grade high tensile parts.

Tighten fasteners evenly to share load across the mounting bracket.

Align the capstan winch so the rope will feed perpendicular to the drum axis and onto the larger radius of the drum near the motor end.

Do not allow load line to rub on the pole or other objects.

Re-tighten mounting chains after initial loading to compensate for seating of the bracket into the pole.

If fitted, always use the rope lock to secure the fall line when not lifting.

CABLE SLEEVES

A cable sleeve is a woven sleeve and eye which fits onto a cable to become an attachment point for hauling the cable. Also referred to as a grip, sock, stocking or puller.

Because of its helical design a cable sleeve will “shrink” onto the cable when fitted.

As load is applied to the cable sleeve, via the hauling rope, the effective grip increases in proportion to the load placed upon it.

A properly selected and fitted cable grip, used during correct operating procedures, should never slip.

Wire Cable Sleeves

The standard cable sleeve for aluminium and copper conductors.

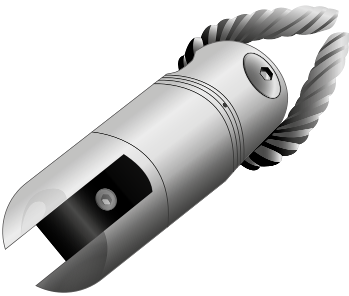
Made from a multi-weave progressive construction technique, they are of various plys, (depending on cable size and axial load requirements).

Non-Conductive Cable Sleeves

These are a tubular sleeve especially designed for use with ABC cables.

These grips are constructed from nylon strand and fitted with an aluminium alloy ferrule.

Cable sleeves are commonly used with swivels that are designed to release torque that can build up in a twisting cable when running overhead conductors.



Swivels

Swivels are installed between cable sleeves and either the existing cable or a hauling rope (depending on the method used).

They are designed to release torque that can build up in a twisting cable when running overhead conductors.

23.1 Cable Sleeve Inspection

Wire

Look for dirt/contamination on the grip. If dirty (e.g. soil or mud) wash off with plain water and dry.

If contaminated by something other than dirt, wash with a suitable cleaner and dry, e.g. degreaser for excessively oily sleeves.

Starting at the eye, look for kinked, pulled, broken or abraded wire strands. If these faults are present the sleeve should be replaced.

Nylon

Look for dirt/contamination on the grip. If dirty (e.g. soil or mud) wash off with plain water and dry.

If contaminated by something other than dirt, it may be advisable to remove the sleeve from service. Some types of contamination (e.g. oil) can affect the nylon and the extent of potential damage cannot be determined by sight.

Starting at the eye, look for kinked, pulled, broken or abraded strands of nylon. If one or more strands are affected by these faults the sleeve should be replaced.

Check the colour, the nylon should be a clear or coloured transparent colour, if it has changed to a milky opaque – replace.

Examine the grip for "elasticity". Manipulate the grip; it must feel "springy" soft. If the grip feels hard – replace.

23.2 Cable Sleeve Care and Use

Do not use cable sleeves that have a thimble fitted to the eye. These can damage and will often jam in cable rollers.

Always ensure the entire plaited length of the stocking is in contact with the cable to be hauled.

Ease out any 'bubbles' or slack in the stocking to ensure maximum contact of grip to cable.

Always tape over the fastening at the mouth end to ensure a smooth transition from stocking to cable.

Part 2

STRAINING AND TERMINATION OF OVERHEAD CONDUCTORS

CONTENTS

STRAINING AND TERMINATION OF OVERHEAD CONDUCTORS

There are four basic methods of stringing conductors:

- Pull through conductors with previously run out ropes using mechanical means.
- Pull through new conductors with existing conductors (re-conductoring) using mechanical means.
- Run conductors out along ground using a vehicle or by hand and then lifting into position.
- Run conductors off drum by mechanical means or by hand and pass over successive poles.

Which method to use is dependent on factors such as location, access, availability of equipment, length of run, ease of obtaining shutdowns and size of cable to be run.

When establishing the job site it is important during the hazard assessment process to take into consideration:

- Public safety, traffic control including driveways, pedestrians
- Condition of poles and crossarms
- Nearest live circuits including over/under crossings / induction
- The terrain, which can impact strain and tension on conductors/cables
- Space to set up cable recovery units and cable trailers
- Space to allow EWP setups
- Vehicular and pedestrian traffic flows
- Road and driveway crossings
- The condition of existing poles and crossarms
- Positioning of equipment

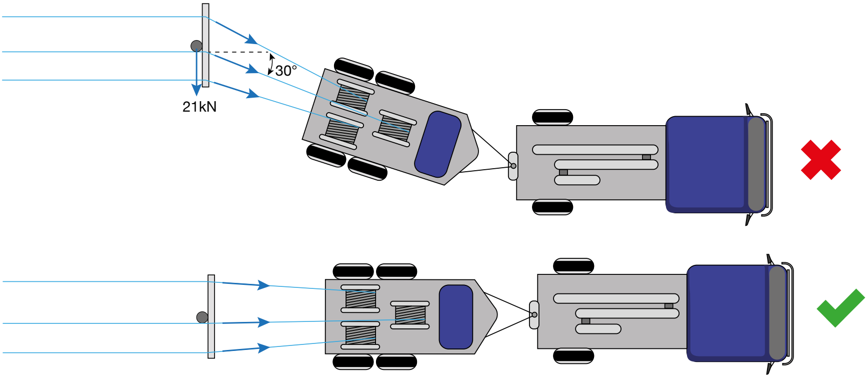
Existing bridging arrangements must be recorded so that they are restored correctly, this can be done by making diagrams.

1 JOB SETUP

Positioning equipment;

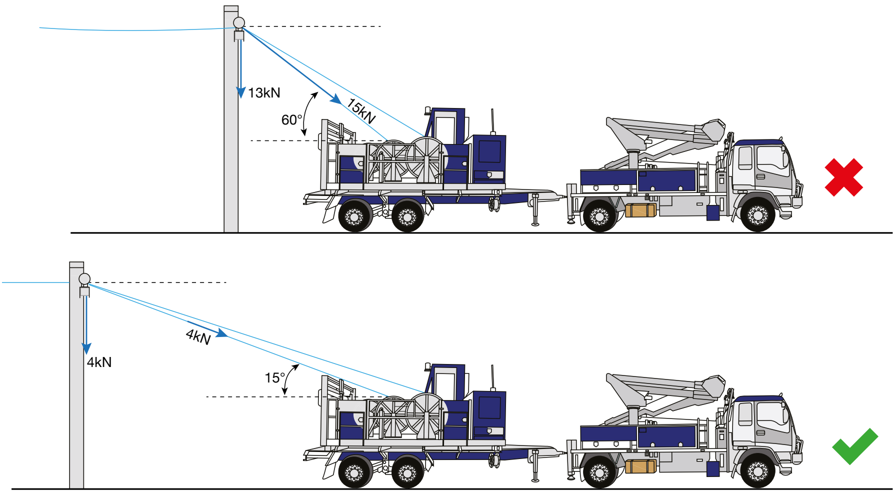
- When deciding the direction of the cable pull, take into account access for the positioning of cable drums, recovery and tensioning units.
- If used, the positioning of the cable tensioning unit (winch or general task truck) is very important.
- When using a winch or general task truck to strain cable, eliminate the likelihood of equipment failure by keeping the straining units in line with the general cable run.
- Failure of a roller due to sideways loading will result in the conductor whipping into the pulling line.

If the conductor is not correctly aligned with the pull of the conductors, large increases in sideways force can rapidly manifest.



Additionally it is important that when straining using any type of winch that the angle between the ground and winch rope should be no greater than 22°.

Otherwise more tension is required to strain the conductors and excessive downward forces will be applied to the rollers and crossarm.

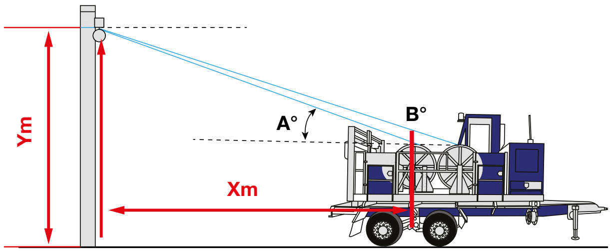


Ym	Xm
5	14
6	16
7	18
8	20
9	22.5
10	25
11	27.5
12	30
13	32
14	34.5
15	37
16	39.5
17	42

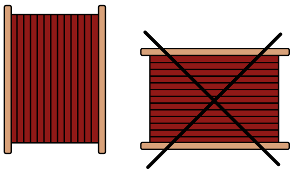
Table 1 can be used to determine the distance required between the pole and the cable drum to maintain 22° between the cable and the ground.

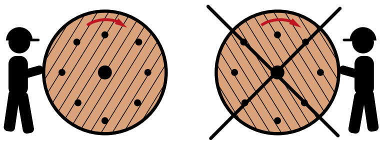
To determine X, measure Y (the distance from the ground to the cable roller) and find the relevant distance in Table 1. E.g. for a pole where the distance from the ground to the cable roller is 8m, the nearest cable drum should be 20m from the pole to maintain an angle of less than 22°.

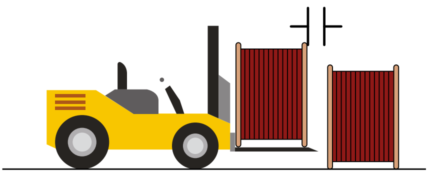
NOTE: when using a cable trailer with multiple cable drums, the drum furthest from the pole can be ignored as the angle will always be less than the drum nearest the pole.



2 HANDLING CONDUCTORS/CABLES







Conductors and cables are valuable products and can be easily damaged by poor handling.

Use and store cable drums in an upright fashion. This is how the drum is designed to be handled and this minimises entanglement.

When the drum must be rolled for some reason, always roll the drum in the direction of the arrow. This way, the cable will not unwind or loosen on the drum. The arrow also indicates the direction the cable is wound on, which allows covered drums to be loaded in the correct direction.

When stored use chocks to prevent drum from rolling.

When lifting the drum, use a shaft through the centre of the drum and a spreader beam. If these are not available, lift with as long a rope as possible, so that the sides of the drum are not damaged.

When lifting with a forklift, the forks must be longer than the width of the drum being lifted.

When moving the drum, tilt the truck mast so that the drum remains in the fork and the points do not touch the ground. Raise the forks of the forklift at least 150mm above ground. Insufficient clearance may cause the drum to be dragged on the ground and eventually become damaged or drop off the forks, especially if the ground surface is uneven.

Do not release the drum until the truck has stopped completely. Do not push the drum with the truck.

Leave sufficient room between drums so that the fork does not damage the drum.

Conductor Weight

It is important to maintain an awareness of the weight of and tension in conductors to avoid shock and out of balance loads or the overloading of equipment.

This table shows the standard weight of the most common conductors and cables used in the VESI.

Conductor		Linear Mass (kg/m)
Type	Stranding & Wire diameter (mm)	
AAC	7/2.50	0.094
	7/3.00	0.135
	7/3.75	0.212
	7/4.75	0.340
	19/3.25	0.433
	19/3.75	0.578
	19/4.75	0.926
	37/3.75	1.130
ACSR	3/4/2.5	0.193
	6/1/2.5	0.119
	6/1/3.75	0.268
	6/4.75,7/1.60	0.404
GALVANISED STEEL	3/2.75	0.118
	7/2.00	0.177
	7/2.75	0.326
	19/2.00	0.483
	19/2.75	0.888
CU	7/1.63 (7/.064)	0.130
	7/2.03 (7/.080)	0.204
	7/2.64 (7/1.04)	0.344
	19/2.11 (19/.083)	0.599
	19/2.57 (19/1.01)	0.887
CdCu	7/1.63 (7/.064)	0.130
	7/1.85 (7/.073)	0.171
	7/2.36 (7/.093)	0.277
	7/2.87 (7/.113)	0.409
	19/2.26 (19/.089)	0.691

LVABC	2 x 25	0.20
	3 x 25	0.30
	4 x 25	0.40
	4 x 35	0.52
	4 x 95	1.35
	4 x 150	2.02
Source: ECV Drawing VX9/7020/30 K		

Conductor Tension

An understanding of conductor tension is important to manage equipment and avoid shock loads.

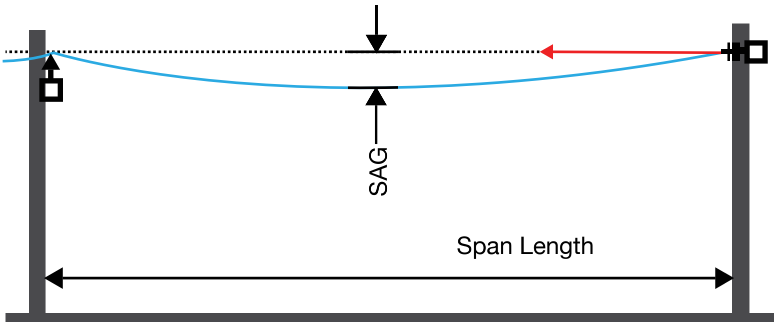
This formula can be used to determine conductor tension where the supports are on similar levels:

$$T = \frac{W \times S^2}{8 \times Sag}$$

Where

T = Tension in kg's
W = Weight of conductors per metre
S = Span length

This sample calculation determines the tension of a single conductor in a 60m span of 19/3.25 having a sag of 1.25m. The weight of the conductor is 0.433 kg/m



$$T = \frac{0.433 \times 60^2}{8 \times 1.25}$$

$$T = \frac{0.433 \times 3600}{10}$$

$$T = \frac{1558.8}{10}$$

T = 155.88kg or rounded to 160kg

Conductor Weight

An understanding of conductor weight is important to calculate conductor tensions, determine lifting equipment ratings and to avoid manual handling injuries.

This formula can be used to determine conductor weight at any point on the network:

$$Wt = W \times \frac{\text{Span 1} + \text{Span 2}}{2}$$

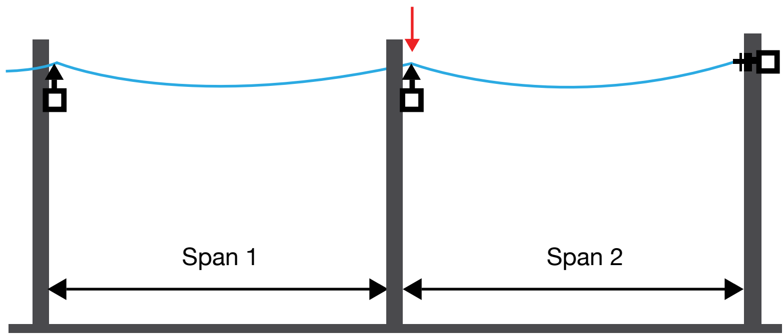
Where

Wt = The weight being measured

W = Weight of conductors per metre

This sample calculation determines the weight of a single 7/4.75 conductor in a

Conductor Weight (Wt)



situation where Span 1 = 80m and Span 2 = 70m

$$Wt = W \times \frac{\text{Span 1} + \text{Span 2}}{2}$$

$$Wt = .340 \times \frac{80 + 70}{2}$$

$$Wt = .340 \times \frac{150}{2}$$

$$Wt = .340 \times 75$$

$$Wt = 25.5\text{kg}$$

3 CONDUCTOR INSTALLATION

There are four basic methods of stringing conductors:

- Pull through conductors with previously run out ropes using mechanical means.
- Pull through new conductors with existing conductors (re-conductoring) using mechanical means.
- Run conductors out along ground using a vehicle or by hand and then lifting into position.
- Run conductors off drum by mechanical means or by hand and pass over successive poles.

Which method to use is dependent on factors such as location, access, availability of equipment, length of run, ease of obtaining shutdowns and size of cable to be run.

Pull through conductors with previously run out ropes using mechanical means.

- Use only polypropylene rope for this method (minimum size $12mm^2$)
- Ensure ground contact is absolutely minimised, particularly on sealed or paved surfaces
- Ensure earth rollers are used if energised circuits are within the re-conductoring area
- Ensure recovery equipment is setup in line with conductor pull
- Ensure cable sleeves are fitted securely
- Use splices or compression sleeves to sleeve out existing strains
- Follow the cable lead through rollers and be ready to communicate to recovery unit if required
- Always release conductor tension before attempting to free a jammed roller
- Hang conductors at cable trailer end and strain with recovery unit

Pull through new conductors with existing conductors (re-conductoring) using mechanical means.

As for previous method plus:

- Join old and new conductors using sleeves and helical terminations.
- Ensure condition of existing cable and if necessary pull $12mm^2$ rope through with old conductor where old conductor is brittle or not strong enough to pull in new cable, (e.g. 7/.064 copper)
- Typically the new conductor is heavier than the conductor being replaced. This means there will be less sag in the old conductor and this should be watched closely

Run conductors out along ground using a vehicle or by hand and then lifting into position.

- Least preferred option
- Suitable for short cable runs of no more than 5 spans
- Should only be done on grassed ground surfaces
- When done on paved or sealed surfaces can cause excessive damage to conductors/cables
- When done on sandy surfaces can embed grit in the cable causing excessive wear over time
- Can be issues when lifting past tee offs, guys, services, spreaders and trees

Run conductors off drum by hand and pass over successive poles.

- Suitable for short to medium runs of conductor/cable
- Care needs to be taken to minimise ground contact
- When re-conductoring, old conductor still needs to be let back safely and recovered
- Can be issues lifting past LV spreaders
- Finish the cable run by hanging at the last pole and straining at the cable drum end. This will minimise conductor wastage

3.1 General Stringing Instructions

Conductor that is kinked, twisted or damaged during installation must be sleeved out. If the damage is not too great, sometimes it is preferable to do this after the cable is terminated to avoid running compression sleeves through rollers.

Avoid shock loads on poles and conductors. This can occur when lowering existing conductors or when any part of the conductor run jams in a roller.

Ensure personal separation on conductive structures and use bonding equipment as required.

Do not work inside the bite of an angle as a failure of equipment or the conductor can result in serious crushing injuries.

Climb down from poles before the cable pull commences.

Use lifting aids or cranes if required. EWPs can be used to lift but must not exceed SWL.

Communication between the recovery unit, cable trailer and person following the cable lead is essential, particularly where line of sight between all three is not maintained.

3.2 Raising Conductors

The optimum method to raise conductors is to use the cable recovery unit, however conductors can be raised with vehicle mounted winches, capstan winches, by hand and by using a vehicle.

For very long spans of steel it is good practice to splice the two outer conductors together and use an equalizing block to maintain equal tension. This eliminates the risk of applying excessive torsion to the pole where the conductors are hung.

It is important that all hazards are considered prior to raising the cables, particularly on long runs and when using mechanical methods; these include:

- Vehicle and pedestrian traffic including driveway crossings
- Trees
- LV spreaders
- Out of balance loads

3.3 Straining Conductors

After the conductors have been raised to near their final height and prior to fitting off with helical terminations, they are supported using:

- A Lug-All
- Wire grip (crescent clamp, comealong)
- Sling, chain or Dee shackle

The Dee shackle method is used when terminating HV. By using the Dee to attach the Lug-All to the socket thimble on the HV insulator, no sag is lost due to slack in the cable during termination.

This image shows a pole well setup for terminating HV conductors.

- Cables supported under the crossarm and connected directly to the recovery unit
- Lug-Alls connected directly to polymeric insulators
- EWP and lineworker well positioned to sight conductors and communicate with ground workers

3.4 Sagging Conductors

Conductor sag is the vertical distance between the lowest point in a span to an imaginary straight line between the resting places of the conductor from pole top to pole top.

The specific information for sagging conductors is provided in the conductor schedule of a detailed route plan (DRP). Below is an example that shows each series of poles, the conductor size, mean equivalent span (MES), route length and stringing (or sag) chart for both HV and LV.

FOR CONSTRUCTION DETAILS SEE DRG. No. UE9/7023 & 7029 SERIES

22kV CONDUCTORS

SERIES	CONDUCTOR	MES	STRING TO	ROUTE LENGTH
(E) POLE 9863633 - (E) POLE 9867724	3 - 19/3.25 AAC	-	VX18/25	33.4
(E) POLE 9867724 - (E) POLE 9867730	3 - 19/3.25 AAC	45	VX18/22	267.5
(E) POLE 9867727 - (E) POLE 9863724	3 - 19/3.25 AAC	34.0	VX18/25	34.0
(E) POLE 9863724 - (E) POLE 9867729	3 - 19/3.25 AAC	45.9	VX18/22	228.0

LV CONDUCTORS

SERIES	CONDUCTOR	MES	STRING TO	ROUTE LENGTH
(E) POLE 9863633 - (E) POLE 9867724	4 - 19/3.25 AAC	-	VX18/25	33.4
(E) POLE 9867724 - (E) POLE 9867730	4 - 19/3.25 AAC	45	VX18/22	267.5
(E) POLE 9867727 - (E) POLE 9863724	4 - 19/3.25 AAC	34.0	VX18/25	34.0
(E) POLE 9863724 - (E) POLE 9867729	4 - 19/3.25 AAC	45.9	VX18/22	228.0
(E) POLE 9867729 - (E) LV POLE	4 x 95mm? LV ABC	32.3	VX18/340	32.3

To ascertain the exact measurement of sag required for any particular run of conductor, an understanding of sag charts is needed.

Sag charts show the required sag for various combinations of conductor, stringing tension, span length and temperature.

Stringing tension is the tension measured on a correctly sagged conductor, expressed in kilonewtons (kN).

In this instance, temperature is the design temperature of the conductor, (not the ambient air temperature). This may vary from network to network. This exercise references a United Energy standard which uses a design temperature of 50°C.

Mean equivalent stringing is a method of sagging with the same tension in all spans of a series between fixed strain points. A span length representative of the series is calculated mathematically and the theoretical mean equivalent span (MES) is the basis for sagging.

The MES of a series of spans is the hypothetical isolated span which has the same response to changes in temperature and wind as would the whole line between fixed strain points were the conductor free to move over the intermediate supports.

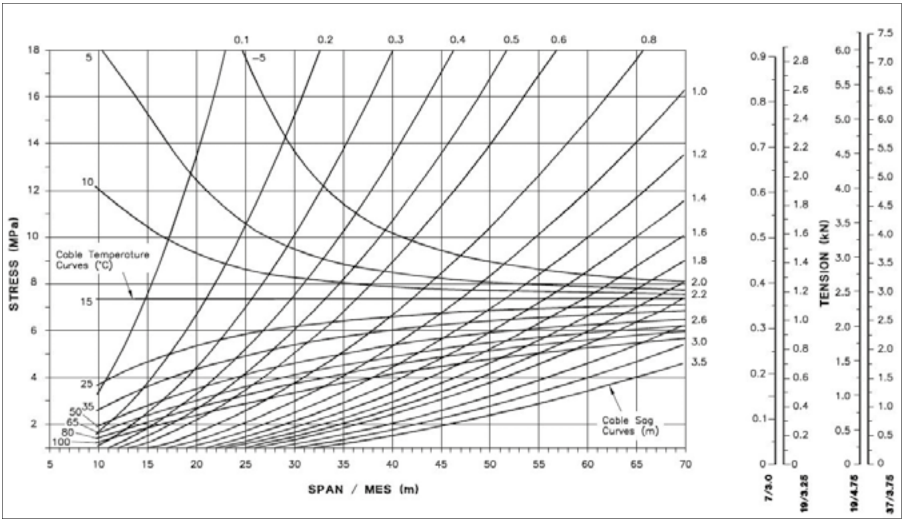
Formula for MES where t_1, t_2, t_3 etc. = span lengths

$$\text{MES} = \frac{t_1^3 + t_2^3 + t_3^3 + t_4^3 \ldots\ldots}{t_1 + t_2 + t_3 + t_4 \ldots\ldots}$$

3.5 Sag Charts

To ascertain the exact measurement of sag required for any particular run of conductor, an understanding of sag charts is needed. Sag charts show the required sag to achieve the **same tension** from conductor, span length and temperature. The tension graph on a sag chart is the tension measured on each correctly sagged conductor, expressed in kilonewtons (kN).

The temperature curves on a sag chart serve two purposes:



1. Designing:

When designing overhead networks, sag charts are used to ensure required clearances are maintained for the sag at maximum design conductor/cable temperature. A calculated MES and determined attachment points (to maintain clearances) allows designers to determine required pole strength and the rating of stays. Designers use a network's standard <u>design temperature</u> for conductors/cables based upon conductor / voltage combinations.

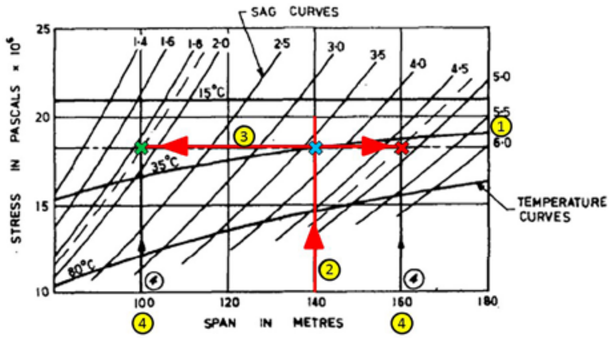
2. Installing:

When installing conductors, sag charts are used to determine the sag measured in metres. To do so, the same temperature curves are used, but the reference point is the <u>ambient air temperature</u> measured when the conductors are actually being strained.

3.6 Reading Sag Charts

To find the sag in the span of a series:

1. Determine the air temperature (35°C for this example)
2. Determine the tension in the conductor by following a vertical line from the MES to the temperature line
3. Follow a horizontal line from the point where the vertical line from the MES meets the temperature line to the span length which is being measured
4. Read off the sag from the sag curve



MES of 140m

Sag in 100m span = 1.9m

Sag in 160m span = 4.8m

Exercise

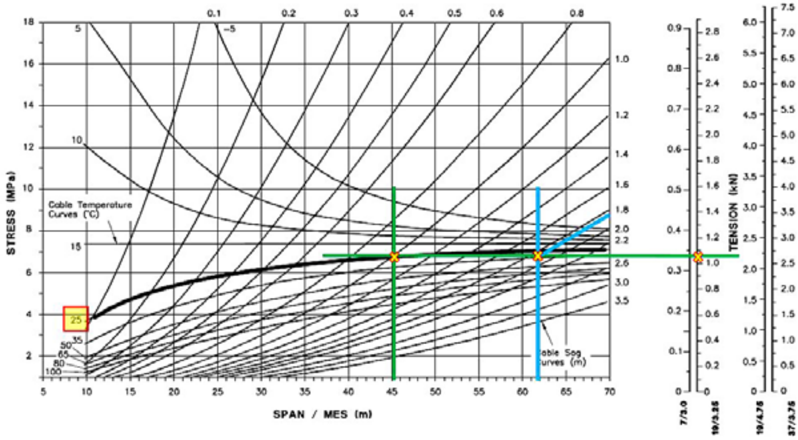
This conductor schedule shows us that we need to refer to stringing chart VX18/22 and that for one of the series of poles, we need to apply an MES of 45.0

For this exercise we will measure the sag in a 60m span of 19/3.25

FOR CONSTRUCTION DETAILS SEE DRG. No. UE9/7023 & 7029 SERIES				
22kV CONDUCTORS				
SERIES	CONDUCTOR	MES	STRING TO	ROUTE LENGTH
(E) POLE 9863633 - (E) POLE 9867724	3 - 19/3.25 AAC	-	VX18/25	33.4
(E) POLE 9867724 - (E) POLE 9867730	3 - 19/3.25 AAC	45	VX18/22	267.5
(E) POLE 9867727 - (E) POLE 9863724	3 - 19/3.25 AAC	34.0	VX18/25	34.0
(E) POLE 9863724 - (E) POLE 9867729	3 - 19/3.25 AAC	45.9	VX18/22	228.0

LV CONDUCTORS				
SERIES	CONDUCTOR	MES	STRING TO	ROUTE LENGTH
(E) POLE 9863633 - (E) POLE 9867724	4 - 19/3.25 AAC	-	VX18/25	33.4
(E) POLE 9867724 - (E) POLE 9867730	4 - 19/3.25 AAC	45	VX18/22	267.5
(E) POLE 9867727 - (E) POLE 9863724	4 - 19/3.25 AAC	34.0	VX18/25	34.0
(E) POLE 9863724 - (E) POLE 9867729	4 - 19/3.25 AAC	45.9	VX18/22	228.0
(E) POLE 9867729 - (E) LV POLE	4 x 95mm² LV ABC	32.3	VX18/340	32.3

If we have an ambient air temperature of 25°C, a MES of 45 and a 62m span of 19/3.25, we will record a sag of 1.85m This can also be measured as 1.08kN of tension.



3.7 Measuring Conductor Sag

There are three proven methods to measure the sag distance:

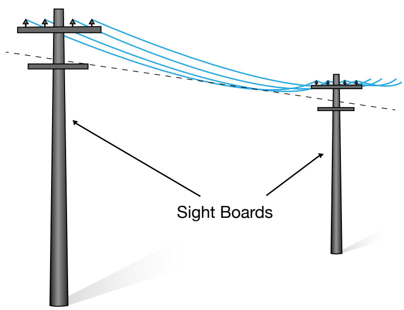
a. Sight sagging with boards

b. Wave sagging (not used in termination spans)

c. Tension method with dynamometer

Sight sagging

1. Fit boards on consecutive poles at the sag distance down from conductor.
2. Ensure sight boards are level.
3. From a ladder or EWP sag conductors until they are lined up with boards.



Wave sagging

Not recommended for termination spans (return wave dampened).

1. Bring conductors up to estimated sag.
2. Reference correct sag chart and convert sag to time.
3. Strike the conductor with enough force to generate 3 return waves (note a sharp tug on a rope over the conductor allows this to be done from the ground).
4. Rest striking object or rope on the conductor to better see the return wave and stop the stop watch on the return of the third wave.
5. Tighten the conductor if stop watch shows a longer time than required and slacken the conductor if the reverse applies.
6. Re-check after each adjustment and on completion of terminations.

Tension method sagging

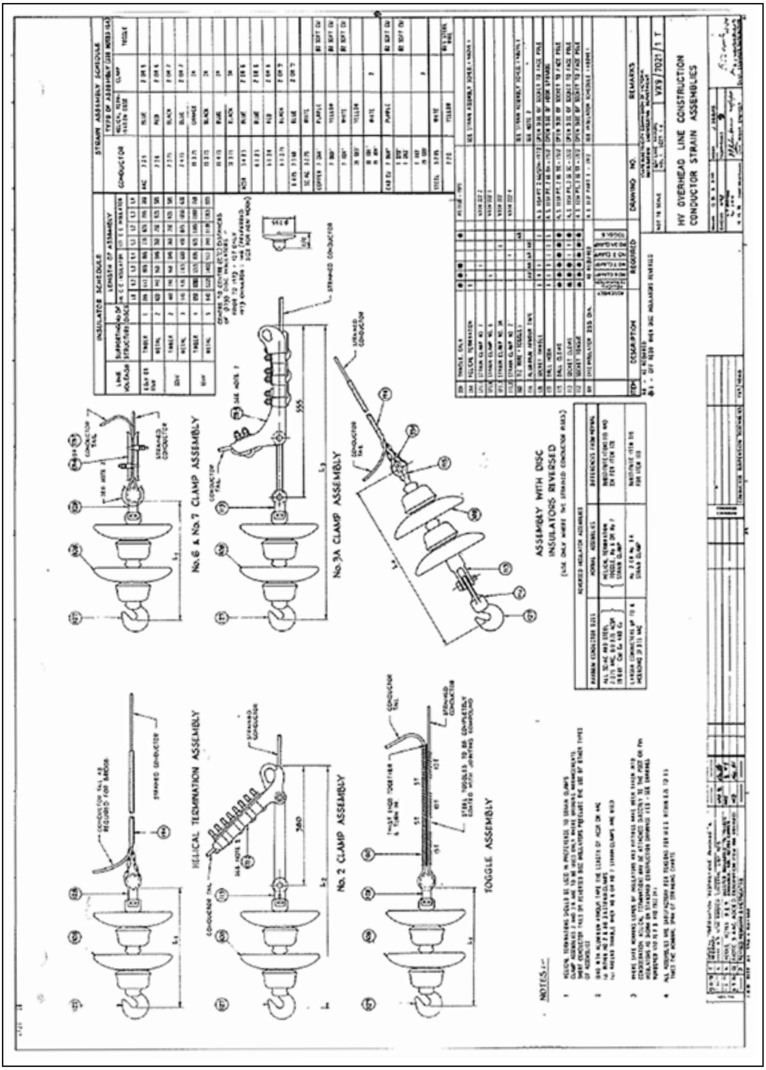
1. Set up equipment to strain as usual but with a dynamometer placed between the comealong and the straining tool (lever block or Lug-All).
2. Strain conductors until tension reached.
3. Confirm conductors are level by sight.

3.8 Standard open wire strain assemblies

Drawing VX9 / 7021 / 1T is the legacy standard for HV terminations. This drawing has been updated and maintained by all VESI network operators to current standards.

Older style clamp and toggled terminations are still commonly found when maintaining overhead structures. These styles are no longer used on new constructions.

The disc and/or polymeric insulator plus helical termination is now the most common method used to terminate HV conductors.



3.9 Helical Terminations

Helical terminations work on the principle that the normal behaviour of a cylindrical, helically wound material will tighten if it is placed under outward tension.

A properly fitted helical termination will not slip but only get tighter as greater tension is applied.

To perform to its full potential, a helical termination shall be completely wrapped on. When used for temporary purposes a helical termination shall be either completely wrapped on or with one wrap left off but secured with a cable zip tie.

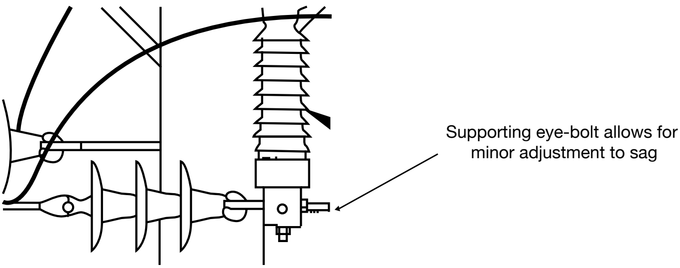
The lining of a helical termination is a poor conductor, meaning that electrical connections shall not be made to it.

It is important to avoid damaging conductors when fitting helical terminations.

After conductors have been sagged it is important that the sag is not distorted during the termination process.

To avoid this the conductor and strain arrangement should be setup in as straight a line as possible and maintained in this manner until complete.

Minor adjustments can be made to HV terminations by the use of the eye-bolts supporting the HV insulators.



Part 3

REMOVAL AND REPLACEMENT OF CROSSARMS AND PRE-FORMED STEEL COMPONENTS

CONTENTS

REMOVAL AND REPLACEMENT OF CROSSARMS AND PRE-FORMED STEEL COMPONENTS

There are three basic methods of installing crossarms:

- At ground level prior to a pole being erected *(this handbook will not address this method)*.
- From a ladder using a rope tackle.
- From an EWP.

Which method to use is dependent on factors such as location, access and availability of equipment.

This handbook only addresses the underpinning rigging techniques and methodology for this task and treats each example as being performed on a de-energised asset.

Where work is performed on a live asset, normal live work controls shall be applied.

When establishing the job site it is important during the hazard assessment process to take into consideration:

- The terrain, which can impact the stability of ladders and EWPs
- Space to establish drop zones if required
- Space to allow EWP setups
- Vehicular and pedestrian traffic flows
- The condition of the pole and crossarm
- The condition of adjacent poles and crossarms
- For anchor and tee-off crossarms, it is also important to record the exact existing bridging arrangements so that they are restored correctly, this can be done by making diagrams

1

CROSSARM WEIGHTS

It is important to maintain an awareness of the length and weight of crossarms to avoid overloading of equipment and manual handling injuries.

These tables shows the standard weight (kg) of the most common crossarm sizes used in the VESI.

Crossarm (steel)	Weight	Crossarm (timber)	Avg. Dry Weight	Max. Weight
LW 10	17	LV 11	24	30
LW 21	30	LV 13	32	40
LW 20	22	LV 15	43	60
LW 22	37	LV 51	30	40
SL 2	24	LV 53	42	50
SL 12	23	LV 55	56	70
SL 21	44	HV 10	24	N/A
SL 22	56	HV 20	30	N/A
SL 23	69	HV 23	60	N/A
SL 24	54	HV 24	85	N/A
SL 26	84			
SL 27	82			
SL 28	100			

Crossarm (timber)	Avg. Dry Weight	Max. Weight
LV 11	24	30
LV 13	32	40
LV 15	43	60
LV 51	30	40
LV 53	42	50
LV 55	56	N/A
HV 10	24	N/A
HV 20	30	N/A
HV 23	60	N/A
HV 24	85	N/A

2 # CONDUCTOR WEIGHT AND TENSION

Refer to Part 2.

3 # EWP METHOD

After establishing appropriate traffic and pedestrian controls, it is important to establish drop zones when working from an EWP. This minimises the risk of injuring persons working in or near the area directly below the basket.

When loading the EWP basket, it is important to prevent manual handling injuries.

The following is recommended when loading the EWP:

- Lower EWP basket as close to ground as possible; and
- Use two person lifting techniques

The total SWL of the EWP is the maximum weight that can be carried including persons, PPE, tools, materials and equipment. Be certain of and <u>do not</u> exceed the SWL of the EWP.

If the crossarm can be stored safely in the basket, this is preferred. This is typically possible when the crossarm is < 2m long.

If the load cannot be safely transported inside the basket it will have to rest on the rim of the EWP basket. In such circumstances, the crossarm must be restrained. Methods that can be used to secure the load include:

- Using a material handler, (where fitted);
- Using approved securing straps installed into or onto the EWP basket (or in some instances under a basket liner);
- Using a handline through a running block to prevent uncontrolled release of the material; and
- Using an approved and rated adjustable lanyard attached to the rated anchor point of the EWP, with engineering approval.

These two images show two established industry methods for crossarm restraint on EWP baskets. Versions of this type have been implemented across Victoria and proven to be the most effective method of restraining a crossarm on an EWP basket.

These restraint types are secured to the basket by hooking the outer edge of the device between the lip of the basket liner and the outer edge of the basket.

Restraints should be inspected prior to use and loads be evenly distributed across the basket.

The straps should always be fastened in a manner that allows easy access to the release button in case it needs to be urgently released.

There will be times during the lift that it may not be practical for the crossarm to be restrained due to the proximity of services or other assets. The load may be unrestrained under the following conditions:

- The unrestrained state is maintained for the shortest duration possible;
- the size of the drop zone is increased to a minimum of five metres during the time the load is unrestrained; and
- The load is restrained once the assets have been negotiated

Steady and controlled movement of the EWP must be maintained during raising, lowering and slewing operations of the EWP to ensure control of the load is not lost.

The crossarm cannot be restrained when fitting to the kingbolt. During this stage of the work, the crossarm must be held by a person at all times until it is fitted securely to the pole (or vice-versa when removing).

This period shall be minimised through careful positioning of the EWP basket and prior to the crossarm being unrestrained, the crew working aloft must visually and verbally confirm the drop zone is clear of those co-workers working on the ground.

The restraint should be removed from the basket when not in use to prevent any interference with other work and to prevent it slipping from the basket.

4 LADDER METHOD

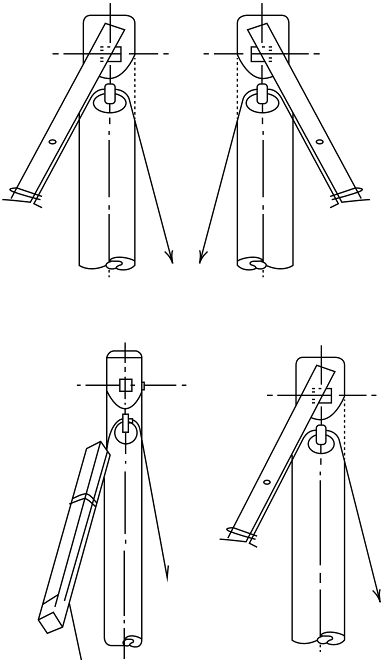
There are many occasions where a crossarm needs to be replaced and there is no safe access for an EWP. This means that the crossarm will have to be replaced by working from a ladder.

The following describes the correct method for replacing the upper and lower crossarms on a standing pole when working from a ladder.

The job setup is the same for an EWP including:

- Public safety, traffic control including driveways, pedestrians
- Condition of poles and crossarms including adjacent assets
- Nearest live circuits including over/under crossings / induction
- The condition of the pole and crossarm
- The condition of adjacent poles and crossarms
- Recording existing bridging arrangements
- Pre-inspection of rigging equipment

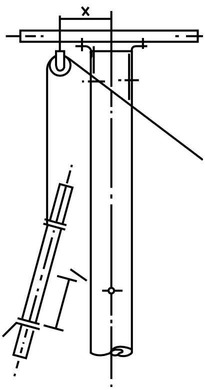
4.1 Top Crossarm



1. Rig a snatch block as shown (right or left hand as required).
2. To ensure sufficient lift, keep the sling short and close to kingbolt.
3. Using a round turn and timber hitch, attach handline to lower end of crossarm and position rope to pull along bottom edge of crossarm.
4. Lash the handline 200mm from the top end of the crossarm using a reef knot.
5. Check snatch block position.
6. Raise the crossarm and stop with the lashing just short of the snatch block.
7. Remove the lashing and balance the bottom surface of the crossarm on the kingbolt.
8. Keeping crossarm vertical, slowly raise until correctly lined up with the kingbolt. This minimises the weight carried by the lineworker.
9. Rotate crossarm to horizontal and fit nut and washer if not already done so.
10. Tighten, square and fix with galvanised coach screws.
11.

4.2 Bottom Crossarm

1. Attach handline to new crossarm as close as possible to the kingbolt hole (position rope to pull along top edge of crossarm).
2. Lash the handline 200mm from the top end of the new crossarm using a reef knot.
3. Rig a snatch block as shown (right or left hand as required).
4. Note distance X should be the same distance from the snatch block to the centre line of the pole, as it is from the knot to the kingbolt hole on the replacement crossarm.
5. Raise the crossarm and stop with the lashing just above the kingbolt hole.



6. Remove the lashing and take the out of balance load only as the crossarm is raised further.
7. Steer the upper end horizontally across to the opposite side, (crossarm may rest on kingbolt when doing this).
8. Stop when the hole lines up with the kingbolt.
9. Fit nut and washer, tighten, square and fix with galvanised coach screws.

4.3 Bottom Crossarm with Two Blocks

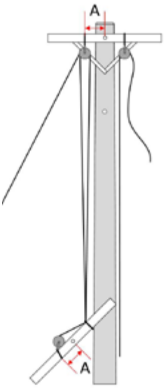


Figure A

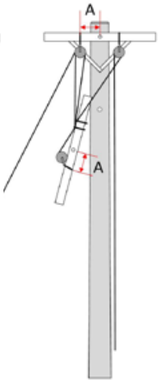


Figure B

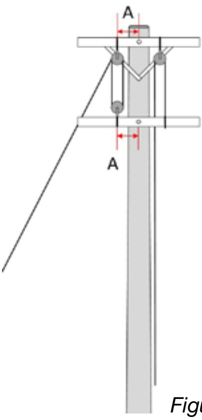


Figure C

1. Rig a tackle as shown in Figure A by fitting a sling, snatch block and tackle to the existing crossarm at the correct distance from the kingbolt.
2. Attach the tackle to the crossarm to be erected at a distance matching the supporting sling (measure this distance from the kingbolt hole as shown).
3. Lash the tackle rope around the upper end of the crossarm to keep the crossarm vertical.
4. If required, tie a tag line to the lower end of the crossarm to be raised.
5. Haul the tackle until the crossarm is positioned as shown in Figure B and attach the second tackle to the upper end of the crossarm.
6. When the second assistant takes the weight on the second tackle, remove the lashing.
7. Adjust the crossarm to the horizontal position and the correct height as shown in Figure C.
8. Push the crossarm onto the kingbolt.
9. Square the crossarm and fit the braces, mark and drill the coach screw hole and fit the coach screw and tighten.

5 SQUARING AND FIXING CROSSARMS

When the crossarm is being attached to a pole prior to it being raised, the most suitable method to ensure it is square is to use string that has minimal stretch.

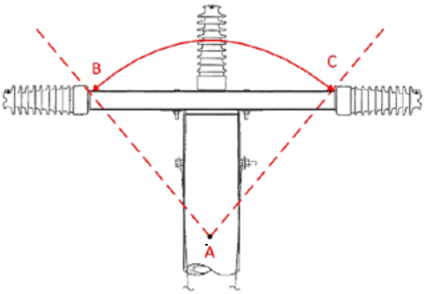


Figure 1

a. Semi-tighten the crossarm to the kingbolt or L brackets

b. Using a nail, fix the string to the centre line of the pole approximately 2m below the kingbolt or centre line of the crossarm

c. Use the string to measure the distance between A-B and A-C as shown in Figure 1

d. Adjust the crossarm until the distances are the same

e. Tighten crossarm and fix with coach screws

When the crossarm is being attached to an existing pole that is already standing, use a ground worker to visually ensure the crossarm is level.

The visual appearance of a pole is important, meaning that it may not be suitable for the crossarm to be perfectly horizontal.

The allowable lean for a pole is up to 5 and this should be taken into account when squaring a crossarm in this manner. If the crossarm replacement is being performed along with pole straightening, this should be taken into account.

Crossarms shall be fixed in place using galvanized steel bolts, screws and washers in accordance with the relevant network operator's design standards.

6 PRE-FABRICATED STEEL COMPONENTS

Where the galvanising on steel components has been damaged during transport or during construction work the integrity of the corrosion protection must be maintained by application of a suitable cold galvanised paint to minor damage or by complete replacement of any significantly damaged components.

Steel components shall be attached to poles using galvanised or stainless steel fixings.

Components shall be attached in accordance with the relevant network operator's requirements for washers, spring washers, grease and screw size.

Where a steel component being raised in an EWP does not fit in the EWP basket, the same technique as for crossarms shall be utilised.

7 POLE LEAN

The allowable lean for a pole is up to 5 towards the kerb and 10 in any other direction and this should be taken into account when squaring a crossarm in this manner. The calculus to precisely measure pole lean is more complex than is required for in-field situations, therefore the method used by asset inspectors is considered suitable.

To measure lean using a vertical line of sight from horizon, estimate the number of pole head diameters off the vertical line and consult the table below.

Pole length (m)	12.5 – 14m	15.5 –17m	18.5-20m	21.5m	23m
of pole head diameters	4	5	6	7	7.5

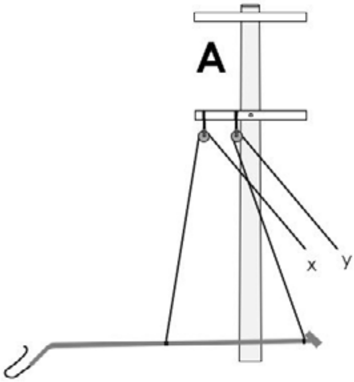
8 PUBLIC LIGHTING BRACKET

a. If an EWP is available, leave lantern off and install when bracket is fixed to pole

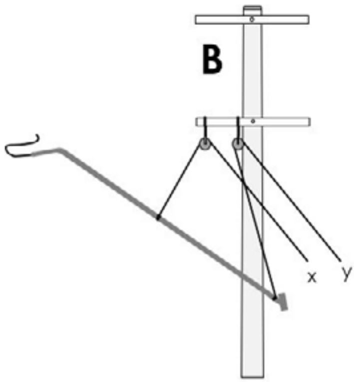
If an EWP is not available fit lantern and stay to bracket

Attach two snatch blocks to LV crossarm as shown in `A'

Secure handlines to PL bracket using a clove hitch secured with a half hitch.

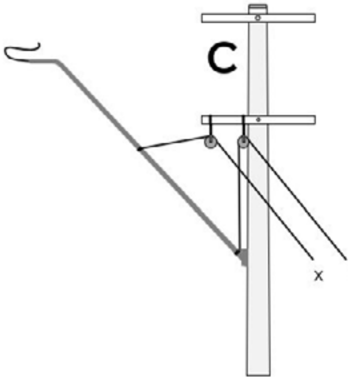


b. Raise bracket slowly and in a level fashion using ropes `x' and `y' until the mounting bracket end is level with the pre-drilled supporting hole.



c. When the mounting bracket is level with the supporting hole, raise the lantern end by pulling on rope x.When the bracket is angled and positioned correctly on the supporting bolt, finish fixing to the pole according to the appropriate construction drawing

Reverse steps A-C to remove bracket



Part 4

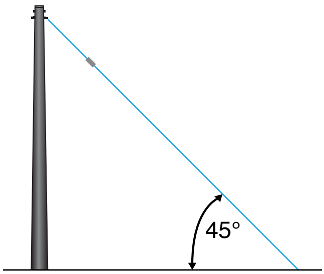
ERECTING, DISMANTLING AND MAINTAINING STAYS

CONTENTS

ERECTING, DISMANTLING AND MAINTAINING STAYS AND GUYS FOR DISTRIBUTION ELECTRICAL STRUCTURES

1 STAYS GENERAL

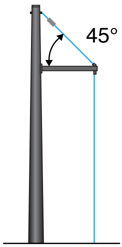
Stays are made of steel wire and connect a pole to a secure object (a ground anchor or another pole) to provide a supporting force in the opposite direction to any force that would overload the pole. There are 3 common types of stays:



Ground stays

The most common type of stay. At 45 represents the strongest standard angle suitable to most situations.

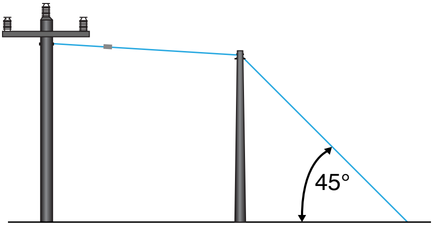
Usually fitted with a warning device, normally a PVC tube split in a spiral fashion.



Sidewalk stays

Installed where ground stays will not work because of a lack of space around the pole. Usually caused by a footpath or driveway.

Must always be fitted with a warning device.



Aerial stays

Installed where ground stays will not work because of a lack of space around the pole. Usually caused by a road meaning the stayed structure is on one side and another pole plus the actual bed log or screw in anchor is on the other side.

Usually fitted with a warning device.

Dependent on the Asset Owner's Design and Construction standard the back stay may or may not have an insulator fitted.

2 STAY COMPONENTS




5 stay on a concrete pole, 5 stay on a wood pole, stay collar on a concrete pole, GY3 insulator

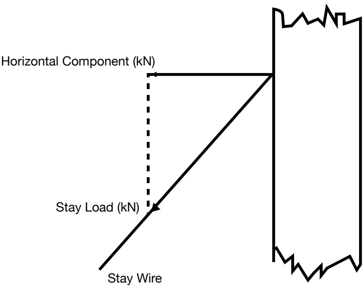
3 STAY SIZES

Stays used on VESI assets come in two sizes, 5 and 8. The table below shows the materials and hole depths for each:

Stay	Wire size	Insulator type	Dia. of ground rod	Length of ground rod	Length of bed log	Depth of hole
5	SC/GZ 19/2.75	GY3	24mm	3000mm	1200mm	2000mm
8	SC/GZ 19/2.75	GY3	36mm	3700mm	1500mm	2400mm

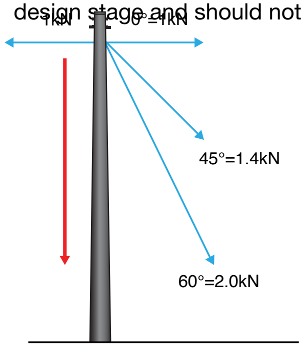
Factors that influence the stay size include conductor size and tension, pole footing strength, angles/deviations and the length of a run of conductor.

Stay size is determined by the horizontal loading on the pole. The maximum allowable horizontal loading is shown below:



Number	Angle	Allowable Horizontal Loading (kN)
5	60	24
	45	34
	Aerial	46
8	60	48
	45	68
	Aerial	93

Determining the stay size is a complex calculation undertaken during the design stage and should not be estimated by lineworkers.



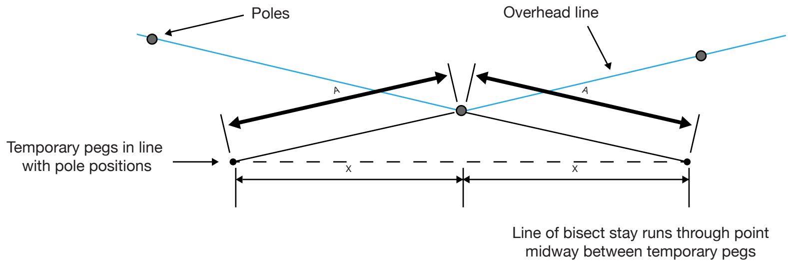
The greater the angle between a stay and the ground, the greater the load on that stay. The diagram below shows this effect.

A standard 45 stay works at 140% of the line tension, a 60 stay at 200%.

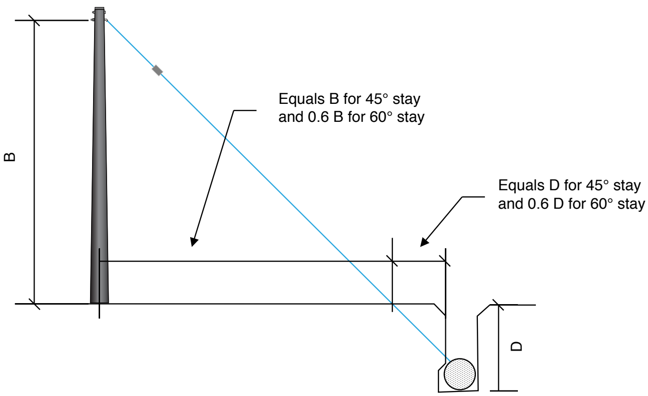
Whilst an in-line stay at 0 would carry the least load, this obviously cannot be attached to ground. In either case, note that as indicated by the red arrow, the downward forces on a pole are increased when a stay is installed.

4 STAY POSITIONING

Whilst lineworkers do not have to determine the size of stay installed, it is important to understand how to accurately set out a stay so that it performs at maximum efficiency. For an inline or termination stay this is simply a method of installing the stay in line with the pole line. For a bisect stay the simplest method to accurately determine the bisect angle is shown below. For this calculation A = A and X = X



The distance of the stay hole from the pole is dependent on the stay size. Measure from the pole the correct distance which is calculated as shown below.



5 STAY ROD INSTALLATION

Note that powered mobile plant (e.g. a backhoe) may be used to lift, lower and transport freely suspended loads; that is, the load is not pinned to the boom or on tynes but is suspended by slings or chains from a purpose designed lifting point, jib attachment or quick hitch.

Such lifting points should be designed so that:

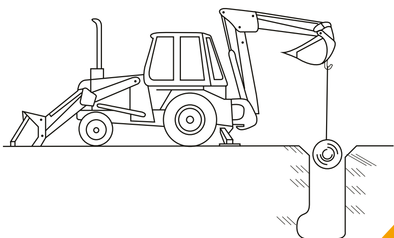
- accidental unhooking of the load cannot occur,
- the sling cannot become detached from the lifting point, and
- slings will hang clear of the boom or boom attachment.

There are two methods of anchoring stays in the ground:

- Bed log method
- Screw anchor method.

5.1 Bed Log Method

1. Using a backhoe, dig the bed log hole to the correct depth:
2. 2.0m for a № 5
3. 2.4m for a № 8
4. If possible create an undercut using the backhoe and/or crowbar
5. Do not enter an unsupported trench > 1.5m unless it is shored and notification has been made to WorkSafe
6. Using a crowbar, create a channel in line with the pole positions



7. Using the backhoe, lower the bed log into the hole with the stay rod fitted
8. If undercut is made, lever bed log into undercut
9. Use stay rod to ensure line of stay is correct, adjust as required
10. Return earth in reverse order it was removed
11. Ram frequently
12. Reinstate surface as required

5.2 Screw Anchor Method

Screw anchors provide great advantages when installing stays in areas where there are other assets that will restrict a bed log installation.

A screw anchor is installed by using a pendant type auger fitted with special screw anchor installing tools which include a pressure gauge.

Screw anchors can be used in poor ground such as swamps and fine sand provided a minimum holding strength is proven.

There are more than one type of screw anchor and reference should be made to network operator standards.

It is essential to ensure that at all times during installation that the anchor screws steadily down. Failure to screw in correctly will cause the anchor helixes to churn out and result in a defective installation.

If correct pressure is not achieved and/or the length of rod remaining above ground is >300mm, then a bed log must be used.

These images show the hole created by a vacuum excavator that has checked for other assets and an installed screw anchor.

As can be seen, minimal interference has occurred to the nature strip and minimal waste is created.

Care must be taken to avoid entanglement with rotating machinery when installing screw anchors.

6 STAY WIRE INSTALLATION

6.1 5 Stay

When installing stays on new overhead structures, it is best to prepare the stay for installation and leave the final fitting until tension is applied to the new conductors. The pole can then be straightened to a perfect vertical position using the stay.

1. Using a purpose designed bracket or suitably rated D shackle, fit the extended cables of a double rigged Lug-All to the stay rod at ground level
2. Use a haven style wire grip to attach the handle end of the Lug-All to the stay wire
3. Tighten stay ensuring pole remains plumb
4. Monitor stay rod to ensure it does not come out of ground excessively
5. Fix off stay with 19/2.75 helical termination
6. Fit warning device

6.2 8 Stay

As with № 5 stay, for new work leave the final fitting until tension is applied to the new conductors so the pole can be straightened using the stay

1. Fit a Lug-All to the stay wire using two haven style wire grips at either end
2. Tension stay wire
3. Monitor the GY3 insulator to ensure it retains an upright position
4. Tighten stay ensuring pole remains plumb
5. Monitor stay rod to ensure it doesn’t come out of ground >300mm
6. Fix off stay with 19/2.75 helical splice
7. Fit warning device

7 STAY REPLACEMENT

Lines constructed prior to the mid 1970's may have the now obsolete 3, 4, 6 or 7 size stays installed. Where redesign is taking place, these stays may be re-used if the horizontal loading does not exceed the following:

Number	Angle	Allowable Horizontal Loading (kN)
3	60°	7
	45°	11
	Aerial	15
4	60°	12
	45°	18
	Aerial	24
6	60°	28
	45°	40
	Aerial	55
7	60°	39
	45°	55
	Aerial	75

The following principles apply to the replacement of any type of stay:

- Proper inspection of the stay, the pole and adjacent structures shall always be made prior to replacing a stay
- Shock loads must be avoided at all times
- Temporary support must be installed prior to the removal of an existing stay
- All new stays shall be installed according to the relevant network operator's design standards

7.1 Stay Inspection and Maintenance

Old style wire toggle

Old style wire splice

When inspecting existing stays, the following should be considered:

- Evacuation or erosion of ground around anchor point
- Condition of anchor rod
- Mechanical damage or stranding of toggles
- Deep or pitted corrosion in the metal stay/guy
- Soil covering stay/guy wire
- Condition of stay pole (if used)
- Weakened or damaged poles
- Areas of recent excavation around pole
- Signs of termite activity and/or fungal growth in pole
- Pole fittings damaged or missing
- Broken or damaged earth straps or electrodes on steel poles

Part 5

POLES

POLE ERECTION INTO AND REMOVAL FROM OVERHEAD CONDUCTORS

1 POLES GENERAL

The primary reference documents for pole installation and replacement are the Asset Owner's Design and Construction Standards.

These standards should be read in conjunction with site specific procedures, work instructions and drawings for all workers performing pole erection into, or removal from, overhead conductors (live or isolated).

Other reference materials will include:

- SWMSs
- VESI Fieldworker Handbook
- Manufacturer's instructions for plant and equipment operation
- VESI Rigging Handbook
- For equipment inspection and selection, refer to Part 1.

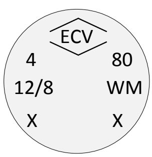
2 POLE TYPES

Wood Poles

Wood poles are the most commonly used type of pole in Victoria and are the standard pole for all networks. Approximately round with the same strength in every direction, they are easily handled and can be rolled on flat ground using the appropriate handling equipment.

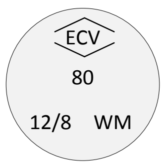
Wood poles shall not be dropped on rough surfaces or the crossarm, particularly if the pole has any knots or cracks as this can severely fracture or weaken the pole.

Wood pole types are recognised by an identification disc inserted into the surface. Two common disc types are shown below with the information described clockwise beginning at the top.



Pressure treated poles

Standard monogram, year of treatment, timber species, treatment locality code, contractor code, length and strength, month of treatment



Non-pressure treated poles

Standard monogram, timber species, length and strength, year of supply

Concrete Poles

Not commonly used in Victoria (and differing from spun concrete poles), these poles are made up of a frame of steel bars tied together and contained by high grade dense concrete. The steel bars are strong in tension and the concrete is strong in compression.

Concrete poles must be checked for any damage from transporting such as surface cracks and missing concrete before installing. Concrete poles are a conductive structure and shall be earthed/bonded.

Spun Concrete Poles

Round and hollow in section, spun concrete poles are manufactured using centrifugal force to press the concrete out into the reinforcing frame. They have a good surface finish and a uniform strength in all directions.

Spun concrete poles can be easily damaged when transporting and during erection. Always check for general transport damage, dents, surface cracks or other defects before installing. Drilling, cutting or grinding operations to any concrete pole must have engineering pre-approval before starting.

Concrete poles are identified by information impressed into the concrete surface during the manufacturing process. This image is taken from a 12.5/8 substation pole supplied in 1988.

Steel Poles

Made from a thin walled tubular steel construction, steel poles can be easily damaged from excessive wall pressure, high shock loads and associated bending forces if handled and rigged incorrectly.

Larger poles are commonly manufactured in modular construction, they should always be checked for transport damage, dents, cracks or coating defects before installing.

Drilling, cutting or grinding of steel poles cannot occur without engineering pre-approval. Steel poles are conductive structures and shall be earthed.

Fibre Reinforced Cement Poles

FRC poles are manufactured using glass fibres and a mix of cement and metakaolin. FRC poles are non-conductive and do not have earthing ferrules. While similar in appearance to a concrete pole, they can be identified by the candy cane stripe look.

FRC poles are significantly lighter than concrete poles and the majority of fittings are applied with brackets and bands and by using gain plates.

Self tapping screws can be drilled directly into FRC poles to affix saddles.

POLE WEIGHTS AND HOLE DEPTHS

Pole weights can vary due to wood density and moisture content. When consulting the table to the right, always refer to the greater weight when selecting lifting tackle or undertaking any kind of pole handling.

Wood Poles		
Size	Approximate weight (kg)	Hole Depth
11/5	500 – 900	2.1
11/8	700 – 850	2.1
11/12	800 – 1600	2.1
12/5	600 – 750	2.2
12/8	800 – 950	2.2
12/12	1000 – 1200	2.2
12.5/5	850 – 1100	2.3
12.5/8	850 – 1100	2.3
12.5/12	1100 – 1200	2.3
13/5	800 – 1100	2.3
13/8	1000 – 1200	2.3
13/12	1200 – 1700	2.3
14/8	1100 – 1400	2.4
14/12	1200 – 2000	2.4
15.5/12	1400 – 1650	2.5
17/12	1700 – 1900	2.5
18/12	1800 – 2100	2.6
18.5/12	1800 – 2150	2.6
20/12	2100 – 2400	2.7

Size	Approximate weight (kg)	Hole Depth
13/3	1400 – 1550	2.3
11/8	1500 – 1650	2.1
11/12	1900 – 2000	2.1
12/8	1750 – 1950	2.2
12/12	2100 – 2300	2.2
12.5/8	2200 – 2400 (Sub)	2.3
12.5/12	2250 – 2450	2.3
13/8	2000 – 2200	2.3
13/12	2300 – 2500	2.3
14/8	2200 – 2400	2.4
14/12	2600 – 2800	2.4
15.5/12	3100 – 3250	2.5
17/12	3300 – 3800	2.5
18/12	3500 – 4000	2.6

4 POLE SPECIES

Class 1 (Mainly dressed but some natural round poles are used)		Class 2 (Mainly natural round but some dressed poles are used)		Class 3 (Mainly creosote but some CCA treated poles are used)	
Species	**Code**	**Species**	**Code**	**Species**	**Code**
Grey Box	GB	Blackbutt	B (Also BB)	Messmate	MS (Also MM)
Grey Gum	GG	Spotted Gum	SG	Silvertop Ash	MT (Also GG)
Grey Ironbark	GI	White Stringy-bark	WS (Also WSB)	Mountain Grey Gum	CG
Red Bloodwood	RW	Yellow Stringy-bark	YS (Also YSB)		
Red Ironbark	RI				
Tallowwood	TW			Radiata Pine (Class 4)	PR
White Mahogany	WM				
White Topped Box	QB				

Periods of Use

Pre 1947	Metro – dressed Class 1 timbers. Other – mixture of dressed and natural round Class 1 & 2
1947 > 1956/57	Mainly natural round Class 2 (WS and YS) but some dressed Class 1 & 2
1956 > 1971	Wholly Class 3 timbers, creosote pressure treated. **NOTE**: In this period, the Mountain Grey Gum poles were identified GG, but they should not be confused with the highly durable Grey Gum which had been bought in the dressed condition and also in smaller numbers from 1972 to 1983 for pressure treatment. Gippsland region continued to use untreated white and yellow stringy-bark throughout this period and right up to 1976.
1972 > 1983	Creosote pressure treatment continued in this period. Poles treated were mainly Class 3 and some Class 1 & 2. Mountain Grey Gum were properly identified MT from the introduction of metric poles
Mid 1983	Dressed Class 1 poles only
1996	CCA treated poles introduced across Victoria

5 REINSTATED POLES

The reinstatement of poles by reinforcement (or staking) is permitted on VESI networks. Reinforced poles fitted with a label as shown (*or similar*) are to be treated as serviceable poles for the purposes of works. Note that the type of work permitted may vary from network to network.

Where a reinforced pole fails a Safe to Climb test, it shall be made safe in accordance with Service Provider's procedures and the VESI Fieldworker Handbook.

5.1 Pole Handling

Poles must be unloaded at depots and worksites in a safe and controlled manner using a crane or pole loader.

Where neither a crane or pole loader can be used, any other method shall be supported by a risk based approach covering staff safety and low risk of damage to pole.

Damage to wood poles can reduce the chemical barrier protecting the timber. Damage to concrete poles caused when handling and lifting can result in cracking or pieces of concrete to spall out which in turn can initiate corrosion of the structural steel core.

This image shows a concrete pole suffering from severe deterioration of the supporting steel frame. This has been caused by poor handling, resulting in cracks to the concrete which allows water to enter the concrete and corrode the steel formwork.

All equipment used for loading, unloading or moving poles shall be fit for purpose and in accordance with any relevant work instructions and procedures. Pole slings and/or chains shall be appropriately rated and fitted by a licenced Dogger.

Workers shall not stand on pole stacks and chocks and bearers shall be used on uneven ground and pole stacks. Poles shall be rotated or rolled using a cant hook or pole strap.

6 LOADING OR UNLOADING POLES FROM A VEHICLE

All equipment used for loading, unloading or moving poles shall be checked fit for service prior to use. Pole slings and / or chains shall be appropriately rated and fitted by a licenced Dogger.

To prevent damaging equipment and materials, it is important to avoid shock loads when handling poles. Chocks and bearers shall be used on uneven ground and pole stacks. Pole stacks create many trip and slip hazards and workers should not stand on them. Poles shall only be rotated or rolled using a cant hook or pole strap.

Where poles are being moved using mobile lifting plant such as a Hiab or PERU, the pole should be rigged by means of a single sling attached at, or just above the point of balance. For wood poles use chain or a suitable wire sling, i.e. Superflex. For concrete poles synthetic slings are used so as to not damage the surface of the pole and expose the reinforced steel interior.

Where no specific requirements have been set down the pole shall be rigged by means of a Double Legged Sling with a sling angle no greater than 60 degrees or a Single Sling attached just above the point of balance.

This sling should be kept as short as possible to limit the amount of movement between the attachment point of the lifting appliance and the load. If required a tag line can be attached to the most suitable end of the pole when handling for stacking.

7 SINKING POLE HOLES

When working near underground assets, it is a requirement to comply with WorkSafe Guidelines to work near Underground Assets and the Asset Owner's Design and Construction Standards.

Where the site is accessible and to avoid manual handling injuries, maximum use should be made of the mechanical plant available for the excavation of pole holes.

Where utility services or other obstructions exist, non-destructive or hand excavation must be used until the work area is cleared and mechanical boring equipment can gain access and be used safely.

For new poles, locations are identified by survey techniques and marked with a peg. Clearances to other assets are taken into account at this stage but do not guarantee their location and care should be taken to avoid damaging them.

Where vehicle access is possible, pole holes are dug using a mechanical auger and the pole erected by jib or boom.

Check pole sinking depth in the pole depth chart on page 104.

If the work site is to be un-manned and is subject to pedestrian traffic and/or stock movement, then any excavated holes need to be covered and protected with a rigid barrier.

Where rock conditions make excavation with a borer difficult then a rock breaker machine may be required. A final option would be to use a specialist contractor licensed to use explosives to excavate hard rock. In this case all necessary permits and safety requirements must be in place for staff and those members of the public on whose property the work is to be carried out.

8 STANDING POLES

Pole erector recovery units (PERU) are the primary item of plant used to stand poles. Operators of PERUs must be licensed by WorkSafe. A licensed dogman is required to select the equipment and direct movement of the load when it is being lifted.

Care shall be taken to avoid working under suspended loads and to establish exclusion zones.

Whilst erecting poles it is a hazard to be distracted when there is an open pole hole representing a fall/tripping hazard and workers should maintain a high awareness of open holes.

Selection of the wrong sling can cause poles to readily slip and create a hazard to nearby workers.

For wood poles – use chain or suitable wire slings i.e. superflex.

For concrete poles – use synthetic fibre, chain with synthetic cover, suitable wire slings i.e. superflex.

Always ensure that the sling is attached as high as possible above the centre of balance of the pole.

If the load is out of the operator's view at any stage during the lifting process, the movement of the load must be directed by a qualified dogger or rigger.

Cranes may only be used with all stabilisers extended in accordance with the crane manufacturer's instructions. Timbers or other pads specified by the crane manufacturer are to be provided under the stabiliser feet. Hooks must be provided with spring-loaded safety latches, and must be adequately maintained. Cranes must only be used with a load suspended vertically from the hook. The crane is not to be used to drag a load across a supporting surface.

When lowering the pole into the hole:

- Lower the pole at creep speed or as slow as reasonably practicable
- Use a tag line to control the base of the pole
- Make sure the pole does not bind in the hole
- Avoid excessive contact with existing overhead conductors
- Ensure tension is kept on the crane winch line at all times
- Keep the pole as vertical as possible
- When a suitably rated crane is use, the pole can be slung near the very top and lifted over and through existing overhead conductors

8.1 Raking and staying poles

A pole which is to be subjected to a horizontal force (e.g. angle or termination pole) should be raked (not more than 2 heads) so that the resultant force tends to pull the pole to the vertical.

The vertical position is to be established by sighting with a plumb bob and the pole is then erected at an angle to the vertical.

A pole which is to be subjected to unbalanced loads which would exceed the permissible design load limits of the pole must be stayed in accordance with network standards prior to attaching the unbalanced loads to the pole.

If a concrete, fibre cement, fibre plastic or steel pole is used, additional precautions may be required to protect the concrete from crushing by the stay wire.

8.2 Pole foundations

To ensure the stability of erected poles, approved type back filling is to be used.

Should backfilling be carried out using spoil from the pole hole, a final bearing capacity in excess of 300 kPa/m2 is required around the backfilled area. This is easily achieved by using a hydraulic or manual ram and compacting every 150 mm of fill up to the ground line. The 350 mm below ground level to the actual ground level should be filled with a loamy type soil to facilitate future inspections.

Alternatively, the hole is to be layer back filled with DGB-10 road base or other approved type of back filling.

9 SITE RESTORATION

Ground displaced by the excavation of power pole holes and the erection of poles, must be restored in accordance with the work instruction and network standards.

Unpaved areas:

Backfill material needs to be firmly tamped down so that it finishes slightly below the general ground level allowing for a clean filling.

Paved Areas:

The hole is backfilled and tamped. Any excess backfill material must be removed and a suitable coating applied, e.g. bituminous for road surfaces or concrete paving reinstated.

9.1 Pole Removal

Poles can either be removed entirely, or if the network operator permits, cut off approximately 300mm below ground level. In either case, the ground shall be appropriately reinstated.

As a pole in the ground represents an unknown load it can readily exceed the Safe Working Load (SWL) of the PERU without the use of a Pole Jack. It is therefore necessary to release the ground forces from the pole footing prior to using the PERU crane function for extraction.

The use of the Pole Jack is the approved method to release the ground forces associated with the pole footing.

Where access restrictions prevent the use of a Pole Jack other means such as the use of Non-Destructive Digging (NDD) or mechanical excavations may be used to release the pole footing ground forces.

As Pole Jacks are not suitable for use on concrete or steel poles the pole footing ground forces shall be released by excavating around the pole footing. Staked poles also require excavation around the pole footing prior to removal.

In some instances there may be the need to sectionalise wood poles for their removal. This can be done by cutting away a section of the pole at a time. In this case ensure that the PERU crane is attached above the point of balance prior to cutting.

9.2 Completion

a. Inspect completed work for site specific compliance
b. Complete tests and documentation
c. Remove all tools, plant and equipment
d. Remove all materials/waste
e. Correctly dispose of waste/contaminated material
f. Restore surface to working area
g. All working team sign off the work permit
h. Confirm network status
i. Work-party debrief

9.3 Pre-Dressing Poles

Crossarms will normally be bored to take insulator pins before fitting and where a new pole is being erected the arms and insulators can be fitted to the pole while it is on the ground.

Any wooden pole which has an appreciable bend in it should be erected with the bend in line with the overhead line and not at right angles to it. This needs to be remembered when setting out the position to fit the crossarms and braces.

Part 6

ERECTING AND REMOVING SUBSTATIONS AND ELECTRICAL EQUIPMENT

CONTENTS

ERECTING AND REMOVING SUBSTATIONS AND ELECTRICAL EQUIPMENT

1 GENERAL

The installation of electrical equipment such as transformers, gas switches, ACRs, fuse units and capacitor banks is typically standard work for electrical lineworkers. The majority of electrical and structural equipment is installed from (and carried within) an EWP.

Larger items such as transformers are erected using a crane, however in many instances, access and ground conditions dictate that other methods such as rope tackles or winches need to be used.

When establishing the job site it is important during the hazard assessment process to take into consideration:

- Public safety, traffic control including driveways, pedestrians
- Condition and serviceability of poles
- Nearest live circuits
- The terrain
- Space to allow EWP and/or mobile crane setups
- Drop zone management

When installing and/or replacing electrical equipment, the primary reference documents are the Asset Owner's Design and Construction Standards. These standards should be read in conjunction with site specific procedures, work instructions and SWMSs.

2 HANDLING ELECTRICAL EQUIPMENT

Typically, overhead electrical equipment such as transformers, ACRs and capacitors are the most expensive and fragile items used in overhead infrastructure. As such, great care should be taken when lifting, transporting and installing these items.

Latchlok hook

Due to the potential for damage and/or oil leaks, all of these types of electrical equipment must be maintained in their normal upright position. Gas switches are an exception to this rule and can be mounted vertically in accordance with network operator standards.

All of these equipment types are fitted with rated lifting points by the manufacturer. These are the only approved lifting points on these items and no other makeshift lifting points should be used.

Lifting chains with 'Latchlok' hooks are preferred for lifting transformers and the hooks of a multi-leg sling should be positioned so that they face outward from the load. Alternatively, rated chain with D shackles is acceptable.

Only licensed personnel may operate forklifts or cranes to load this type of equipment. For transport all of these equipment types shall be secured with rated ratchet or chain tiedowns / turnbuckles via the lifting points. Equipment should be inspected prior to transport and if new equipment is leaking, it should not be used. (Note that oil sweating through gaskets is not considered leaking). Equipment that has been removed due to a fault, or replaced should be carefully inspected and if leaking should be transported in a spill tray.

3 EQUIPMENT TYPES

3.1 Transformers

Overhead transformers are either mounted on platforms or directly on to the pole. Pole mounting was historically limited to transformers of around 100kVA rating, however modern transformers are now lighter and more efficient and it is common for transformers up to 300kVA to be pole mounted.

Platform mount

Pole mount

Slots for pole mount

Some platform mounted transformers are placed on timber bearers to minimise the potential for vibration. When positioning the transformer on the platform it should be placed as close to the pole as possible whilst maintaining clearances.


Lifting points on 22kV transformer

As noted previously, transformers are fitted with lifting points and these are the only approved points for applying lifting tackle.

A lineworker shall give normal signals to the crane operator to allow placement of the transformer on either the platform bearers or mounting bolts.

Smaller transformers can be raised using a block and tackle, winch or EWP fitted with a lifting jib attachment. See Part 1, for further details on the safe operation of winches and tackles.

If the network operator standard requires, restraining straps shall be fitted around the pole and to the transformer tank on platform mounted transformers.

3.2 Automatic Circuit Reclosers (ACRs) & Capacitor Banks

ACRs and capacitor banks are complex items of equipment and extreme care should be taken when handling them. Capacitor banks are normally installed inside a heavy duty aluminium mounting frame which has lifting points for balanced lifting with chains or slings.

Both ACRs and capacitor banks are pole mounted and their installation is as for pole mounted transformers. ACRs also require the installation of subsidiary equipment such as control boxes and communications antennas.

Capacitor bank

ACR

3.3 Gas Switches

Gas switches are insulated with sulfur hexafluoride (SF_6) gas and consequently are typically much lighter than oil filled equipment of similar size. Gas switches are usually installed closer to HV than other electrical equipment. Installation is commonly performed using an EWP jib extension via G&B method.

Gas switches are hung on a galvanised steel strut.

Two examples of gas switch mounting

4 PREFABRICATED STEEL COMPONENTS

The majority of steel components are attached to poles prior to the pole being erected. When they are being fixed to poles that are already standing, the weight of these components must be taken into account, particularly when using an EWP. The table below summarises the weight of some commonly grouped materials, equipment and basket liners:

Item	Description	Weight (kg)
22kv Conductor strain assembly	1 x insulator strain polymer - silicon 1 x socket clevis 1 x socket tongue 1 x 20mm x 350mm eyebolt	2.7
66kv Conductor strain assembly	1 x insulator strain polymer - silicon 1 x socket clevis 1 x socket tongue 1 x 20mm x 350mm eyebolt	5.5
24kv Lightning arrester “bushfire approved” ABB	1 x Lightning arrester with mounting bracket	5.9
22kv Insulator pole mounted assembly	1 x Insulator -line post (9 shed) 1 x 180mm x 24 stud 1 x 24mm washer	12.8

22kv Insulator pole mounted assembly	1 x Insulator -line post (5 shed) 1 x 180mm x 24 stud 1 x 24mm washer	11.8
22kv HV fuse assembly crossarm - boric acid	1 x Fuse holder, hinged dropout, Boric acid 1 x fuse link Boric acid 1 x bracket fuse crossarm mounting 1 x bolt M20mm x 140mm 1 x 20mm washer	14.6
22kv HV fuse assembly cross arm - powder filled	1 x Fuse holder, hinged dropout, powder filled 1 x fuse link powder filled 1 x bracket fuse crossarm mounting 1 x bolt M20mm x 140mm 1 x 20mm washer	22.1
22kv HV fuse assembly pole - boric acid	1 x Fuse holder, hinged dropout, Boric acid 1 x fuse link Boric acid 1 x bracket fuse pole mounting 1 x bolt M20mm x 140mm 1 x 20mm washer	16.3
22kv HV fuse assembly pole - powder filled	1 x Fuse holder, hinged dropout, powder filled 1 x fuse link powder filled 1 x bracket fuse pole mounting 1 x bolt M20mm x 140mm 1 x 20mm washer	23.7
Pole top assembly	1 x "P" bracket 1 x flat washer 24mm 1 x conical washer 24mm 1 x bolt M24 x 300mm	8
MSI	1 x mid span isolator with turn buckle	13.5
Ampact tool	1 x Ampact head and power unit	3
Crossarm L bracket	1 x set of brackets	5
LV inter crossarm "kit"	4 x LV pins 4 x LV Insulators 4 x M20 Washer	7.04
Crossarm assembly	2x crossarm braces 2 x m12 x 140mm bolt 1 x coach screw 16m x 130mm 2 x washer spring conical 12mm 2 x flat washer 12mm	3.2

LV strain crossarm "kit"	4 x LV pins 4 x LV Insulators 4 x M20 flat Washer 4 x M20 conical washer 8 x "F" bracket 8 x Shackle Insulators 4 x M12 x150 bolt 4 x M12 flat washer 4 x M12 conical washer 8 x M12 x 130 bolts	18.3
LV term "kit"	4 x LV pins 4 x LV Insulators 4 x M20 x 130 bolts 4 x M20 Washer 4 x "F" bracket 4 x Shackle Insulators 4 x M20 conical washers	12.7
Kingbolt	1 x M24 x 350mm bolt 2 x M24 flat washers 1 x M24 conical washer	2.6
EWP Liners:		
Sherrin 13m and 16m	Liner weight is Included in SWL of 250kg	30
Versalift	Liner weight is included in the SWL of 160kg	25
GMJ	SWL includes liner	55
Vemco – AT37 and AT30	SWL 159KG does not include weight of liner	23
Vemco - TA45	SWL 272kg does not include weight of liner.	35
Vemco - TA55	SWL 300kg does not include weight of liner	35
Hydraulic drill	Drill and hoses	4.5
Test Equipment	megger, multimeter	1
Test Equipment	5k Megger	4
EWP Tool apron		27
HV Flat Mat		3.4
HV Hard Cover		1.26
LV Flat Mat		1.8
"Tiger" Tail		1.25

5 FIXING

All equipment shall be fixed in place using stainless steel, galvanized, high tensile steel bolts, screws and washers in accordance with the relevant Network Operators Design Standards.

The design standards of all network operators describe fixing hardware requirements in the material schedule attached to each design drawing.

6 EQUIPMENT REMOVAL AND DISPOSAL

When equipment is being removed as part of an overall demolition, the sequence of works should be determined prior to commencement and is generally in the reverse order to that of the construction of the structure.

The structure to be demolished and all its components must be maintained in a stable and safe condition at all stages of the demolition and may require temporary support of the structure or apparatus as necessary.

Drop zones shall be established where practicable and hardware and apparatus should be correctly lowered to the ground and not allowed to fall freely.

There is a need to consider the reduction of the environmental footprint and the mitigation of potential environmental incidents when retiring or demolishing electrical hardware and apparatus.

All waste should be transported in vehicles suitable for the waste that ensures no material is lost to the environment.

As some waste can be considered hazardous there may be a need to follow legal requirements with regards to licensed transport and tracking.

Some of the hazardous materials contained within electrical hardware and apparatus can include:

- Asbestos
- PCBs *(polychlorinated biphenyl)*
- SF6 *(sulfur hexafluoride)*
- CCA *(copper chrome arsenic).*

7 HAZARDOUS MATERIALS

HAZARDOUS MATERIALS

Material	Found in	Hazard	Licensed transport / disposal?
• PCB [+]	• LV/HV capacitors • PL control boxes • Some transformers	• Environmental buildup and potential carcinogenic	• Transport – YES • Disposal – YES
• SF_6 [x]	• HV metal clad switch-gear	• Global warming effect 25000 x CO2 • Asphyxiant in large volumes	• Transport – NO • Disposal – YES
• CCA [o]	• Preserved timber	• Low level poisoning from arsenic • Fumes when burning	• Transport – NO • Disposal – YES
• Asbestos	• Electrical insulation and barriers • Building products • Conduits/pipes	• Inhalation of free form air-borne fibres resulting in asbestos related disease	• TRANSPORT NO – if < 50kg or 50L YES – if > 50kg or 50L • DISPOSAL YES

[+] Polychlorinated Biphenyl

[x] Sulfur Hexafluoride

[o] Copper Chrome Arsenic

CONTENTS

VESI