Best Practice Guidelines for Cable Logging

First edition December 2000
Revised edition January 2005

These Best Practice Guidelines are to be used as a guide to certain cable logging construction procedures and techniques. They do not supersede legislation in any jurisdiction or the recommendations of equipment manufacturers.

FITEC believes that the information in the guideline is accurate and reliable; however, FITEC notes that conditions vary greatly from one geographical area to another; that a greater variety of equipment and techniques are currently in use; and other (or additional) measures may be appropriate in a given situation

Contents

Cable logging basics

What is cable logging?

Cable logging involves the extraction of stems or logs to a landing using a fixed hauler position and an elevated steel rope. This contrasts with ground-based logging where the extraction machine drives over the cutover to accumulate a drag or load.

The following factors may lead to the decision to cable log:

- Steep slopes
- Broken terrain
- Wet or soft ground conditions
- Unsuitable roading network
- Environmental issues, such as soil disturbance, visual impacts, and waterway protection.

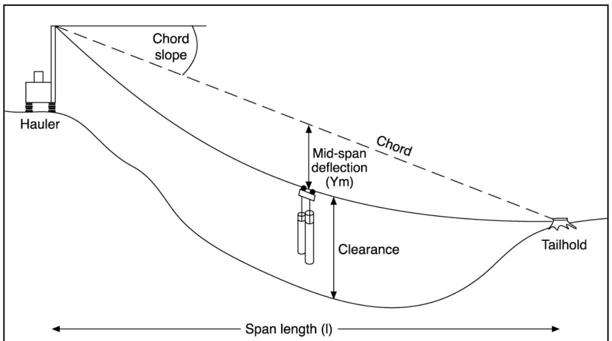
A typical cable setting

Common terms

There is a range of terms that are specific to cable logging. An understanding of these is required for the following sections of these guidelines.

Tailhold

The tailhold is used to anchor the skyline, or tailrope in a highlead or running skyline system. The most common tailholds are stumps, deadman anchors, or machines (mobile tailholds). *See* **Cable Logging Systems** (page 43) for further details.



Cable logging terms

Chord

The chord is the straight line from the top to the tower to the tailhold.

Chord slope

The angle of the chord from the horizontal. A negative chord slope indicates that the tower is higher than the tailhold. A positive chord slope indicates that the tailhold is above the tower.

Span length

The horizontal distance between the tower and the tailhold.

Deflection

The vertical height difference between the chord, and carriage or rigging located at mid-span.

Deflection is expressed as a percentage of the span length, calculated as follows:

$$\text{Deflection (\%)} = \frac{\text{Vertical distance between chord and carriage (or rigging) (Ym) x 100}}{\text{Span length}}$$

For example:
A skyline which has a span length of 400 m and a deflection of 60 m at mid-span has a 15% deflection.

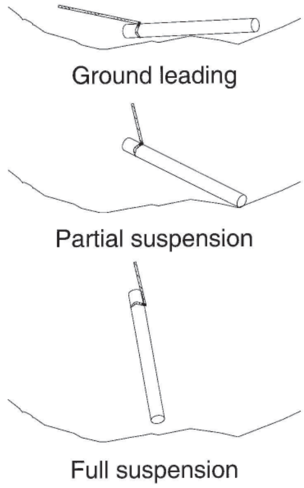
Clearance

Clearance is the vertical distance between the skyline (or mainrope/tailrope) and the ground at any point along the span. Deflection and the shape of the ground profile affect it.

Clearance affects the degree of suspension of the drag. If clearance is poor, drags will be partially suspended or ground lead. With adequate clearance, drags can be fully suspended.

Clearance can be increased by:

- Decreasing deflection
- Increasing the height of the tower and/or tailhold, or installing intermediate supports.



Degrees of drag suspension

Tension

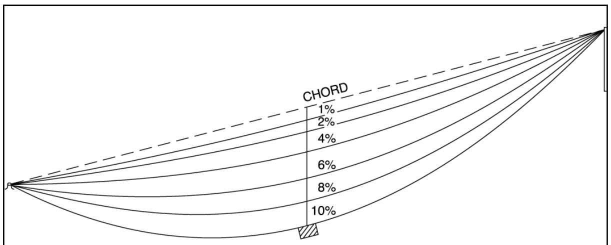
A loaded rope will be in tension. Ropes must only be loaded to their Safe Working Load (SWL). In forestry, this is 1/3 of the breaking strength of the rope.

Deflection, clearance, and tension

Deflection, clearance, and tension are all linked. If one is changed it has an impact on the other two.

Example

Loaded deflection	***Tension (kg)***
10%	3 640
8%	4 450
6%	5 825
4%	8 590
2%	16 900
1%	33 600



Changes in deflection

Increasing deflection (increasing the sag or belly in the working rope(s)) will:

- Allow heavier payloads
- Reduce ground clearance.
- Reduce skyline tension and wear on equipment

Decreasing deflection (tightening the working rope(s)) will:

- Increase ground clearance
- Increase skyline tension
- Provide more lift on a drag
- Reduce safe payloads.

Extraction cycle

The extraction cycle is one complete work cycle that starts and ends when the carriage or rigging begins to move out from the hauler. The main elements (components) of the extraction cycle are:

- Outhaul
- Breaker-outs walk in
- Breaker-outs walk out
- Break-out
- Lower rigging at landing
- Raise rigging for outhaul.
- Lower rigging
- Hook-on stems
- Raise rigging
- Inhaul
- Unhook stems

Hook-on is typically the longest time element in an extraction cycle where strops are used. Outhaul and inhaul times will vary with haul distance.

Factors affecting cable logging

The performance of a cable logging operation can be measured by:

- Safety management and outcomes
- Productivity and machine availability
- Merchantable stems or pieces left in the cutover
- Daily production
- Tree breakage

The main factors affecting cable extraction performance are as follows:

- Stand and tree characteristics
- Landing location
- Landing size and layout
- Logging crew skill and motivation
- Regulatory constraints
- Terrain characteristics
- Felling pattern and damage
- System and machine capability
- Mechanical reliability

Stand and tree characteristics

The stand and tree characterisitics that most affect performance are:

- Piece size
- Tree height
- Tree lean
- Stocking rate
- Branch habit
- Degree of windthrow

The piece size refers to the volume or weight of the stem to the first break. It dictates the ease of accumulating a large drag.

In large piece-size timber, fewer stems need to be hooked-on to build a large drag. This significantly reduces hook-on time.

In smaller piece-size timber, the opposite is true. It may be difficult to build a large drag without using four or five strops.

Breaker-outs should aim to build an optimal drag to increase productivity. An optimum drag is as large as possible without exceeding the SWL of the working rope(s) during break-out and inhaul.

The range of piece sizes available at any hook-on point will affect the building of an optimal drag. Smaller pieces can be used to "top-up" a drag. If only large pieces are available, then it will be difficult to build an optimal drag without overloading the ropes.

Tree height (stem length) will affect the ease of landing the stems. Landing size and hauler position should accommodate this by allowing adequate chute length.

The presence of windthrown trees within a stand will affect extraction speed. Windthrown trees pose added hazards for fallers and breaker-outs. More time is required to perform these tasks safely, and this will affect productivity.

Terrain characteristics

The terrain characterisitics that most affect performance are:

- Shape of the terrain
- Under-foot conditions
- Slope

The shape of the terrain dictates the potential deflection and clearance. Deflection, and optimum drag sizes, will be greater on concave slopes. Flat or convex slopes afford little deflection and can significantly reduce the optimum drag size.

Broken and steep terrain will affect tree breakage and the ease with which the breaker-outs can safely move over the cutover. Under-foot conditions, such as soil wetness, undergrowth, and slash levels, will also affect the breaker-outs.

Landing location

The landing location dictates the extraction direction, average haul distance, and the available deflection.

Haul distance is the distance that the stems are extracted from the cutover to the landing. The longer the haul distance, the longer it takes for inhaul and outhaul. Also, the the optimal drag size will be lower for longer spans, as rope tensions are closer to the SWL when unloaded.

Haul distance is usually reported as the average for the entire setting or compartment.

Landing locations should ideally provide an optimal haul distance and allow for adequate deflection. This may not always be possible because other factors (such as roading, available space, waste management, and the density of landings) may result in a less desirable position.

Felling pattern and damage

Tree breakage is a function of tree size and felling quality. Trees usually break at 2/3 their total height. In smaller piece-size, the stem material beyond the first break is unlikely to be of merchantable size. Therefore, it is often left in the cutover.

In larger piece-size, the size of the broken pieces increases and they often require extraction. This means that there may be 800 pieces to extract from a hectare with only 500 trees on it. This can slow extraction, as more cycles may be required to extract all merchantable timber.

The stocking rate will affect the number of stems available at any given hook-on point. It also affects the tree size and branch habit.

The felling operation should present stems for efficient extraction. Butt extraction reduces stem breakage and can improve access for the breaker-outs.

Felling breakage should be minimised to reduce the number of short merchantable pieces that need to be extracted. These pieces contribute little to the extracted volume but take considerable time and cost to extract.

Landing size and layout

The landing size and layout need to be matched to the extraction system and woodflow. If the landing is too small or poorly laid-out, interference between the different phases can occur. This may result in operational delays (waiting) or may increase hazards for landing workers.

The landing needs to be big enough to allow the following:

- Separate working zones for each landing activity
- All stems to be landed safely
- Adequate area for parking vehicles off the main carriageway and away from landing activities
- Adequate storage, and smoko or rest areas

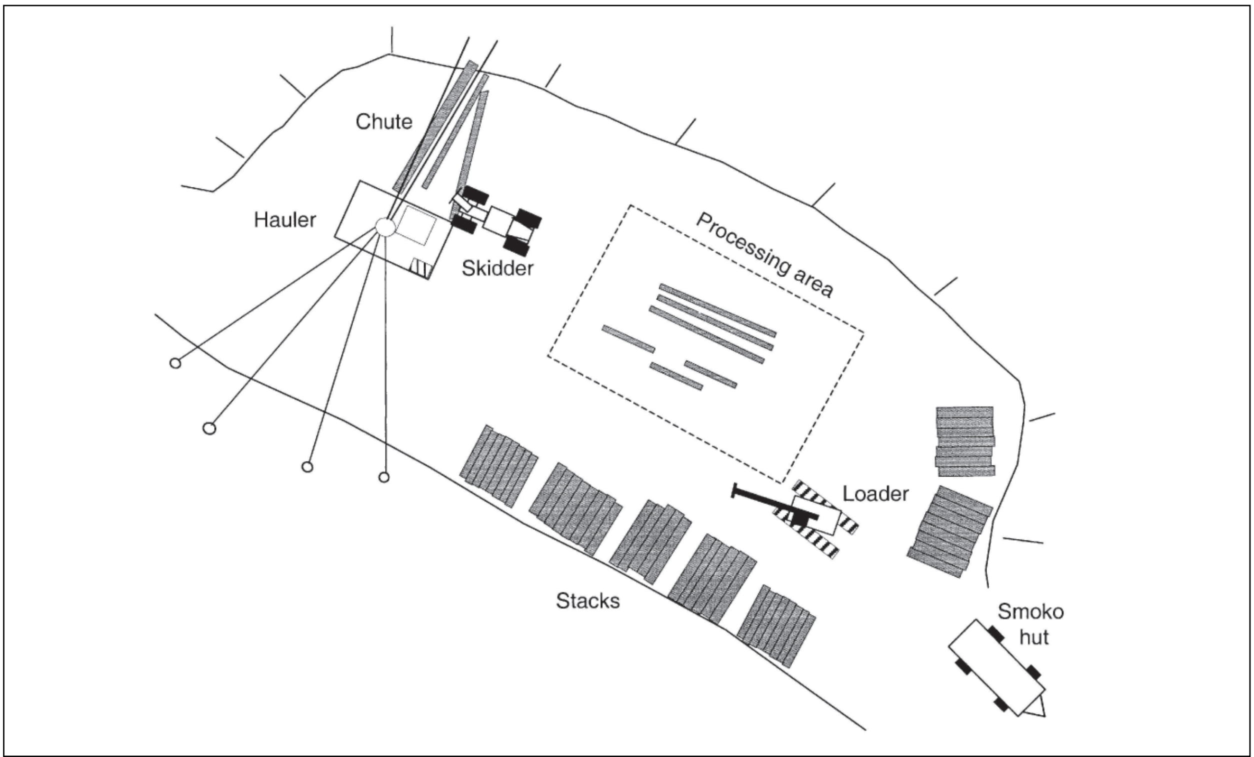
Landings are normally separated into different work areas.

In cable operations, areas should (where appropriate) be defined for the:

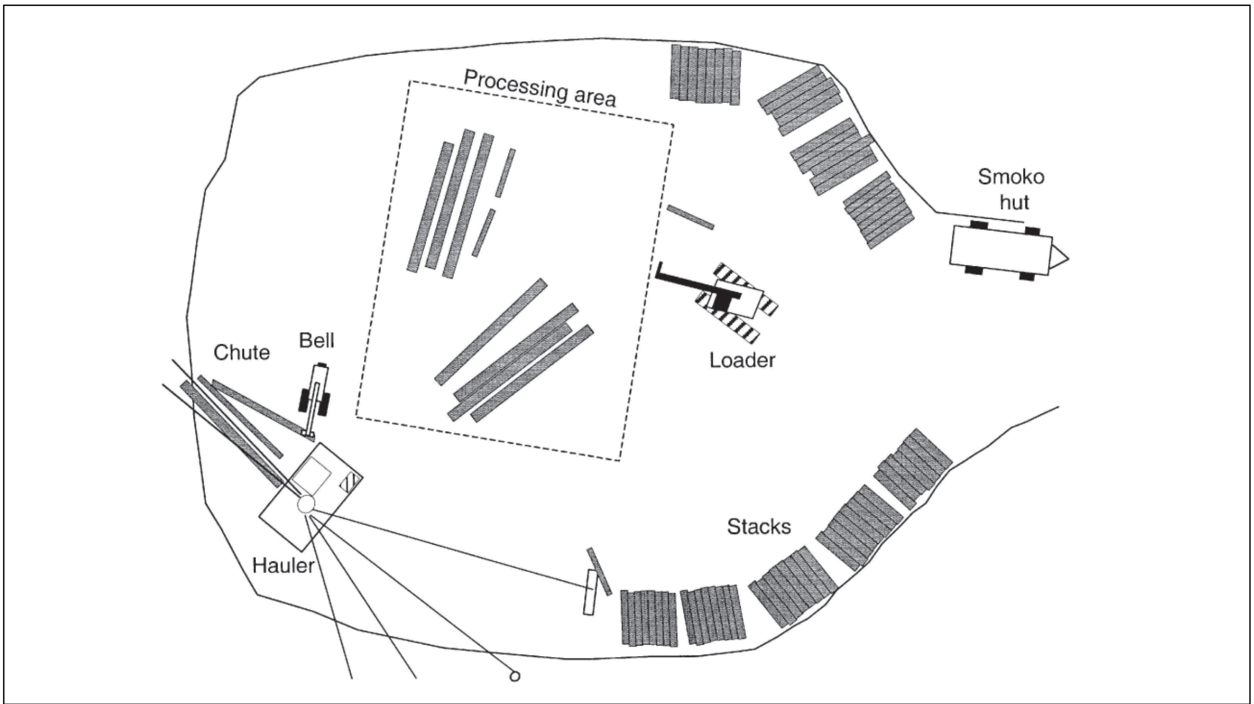
- Hauler position
- Processing activities
- Loading activities
- Saw/machine maintenance
- Waste disposal
- Chute in front of the hauler for landing the drags
- Log stacks
- Smoko facilities
- Fuel storage

Two examples of landing layouts are shown - the roadside landing, and the spur road landing.

Further details of landing design are presented in the **Best Practice Guideline for Road and Landing Construction**



Examples of layouts for a roadside landing (above) and a spur road landing (below)



System and machine capacity

The cable system and machine capabilities are linked.

The number of working drums on the hauler and/or the availability of carriages will dictate the cable systems that can be used.

The tower height, power rating, rope size, and line speed will influence productivity.

The type of tailhold will affect lineshift times. A mobile tailhold should provide faster lineshifts and increase the productivity.

See following sections on **Haulers** (page 27), **Carriages** (page 37), and **Cable Logging Systems** (page 43) for more details.

Crew skill and motivation

A logging system cannot operate efficiently without a skilled and motivated crew. Also important is effective communication between crew members.

These factors combine to ensure that the different phases of the operation integrate with no unnecessary interference or down-time. Communication is also a key component of operational planning. The entire crew must be aware of what is expected of them, and responsibilities and tasks must be clearly assigned.

Where crew skills, motivation, and/or communication are not matched to the job, the productivity (and safety) of the operation will suffer.

Mechanical reliability

Mechanical reliability can affect the production performance of an operation by reducing machine availability. Machine reliability is affected by:

- The age and general condition of the machine (hauler, mobile tailhold, loader, etc.)
- The care showed by the machine operator(s) in looking after the machine(s).
- How much preventative maintenance is done

If the hauler limits production, any downtime will reduce daily production. The flow-on effect may be an imbalance in the operation, and the under-utilisation of other machines and workers.

Regulatory constraints

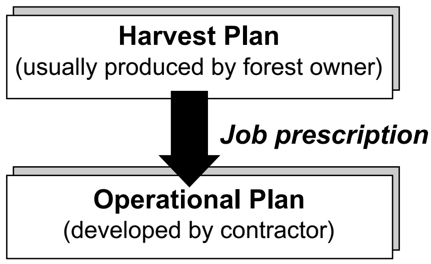
Regulatory contraints may be based on safety and environmental concerns. The Health and Safety in Employment Act 1992, Resource Management Act 1991, and the Historic Places Act 1980 may all have a bearing on the way a logging operation is planned and carried out. Any constraints are imposed for protection reasons and must be complied with - this may affect the production rate of the operation.

Planning issues

There are two main phases of planning for cable logging operations.

- Harvest planning
- Operational planning

These planning phases have different aims and involve different degrees of detail.



Information that was considered in the harvest planning process is communicated to the contractor in the job prescription. This allows the contractor to plan his/her operation.

Harvest planning

The forest owner usually develops the harvest plan. They are developed 1-5 years prior to the harvesting operation.

They may provide the following information:

- Stand details (including piece size, volume per hectare, and inventory data)
- Setting boundaries and harvest volumes (often by product type)
- Road lines
- Location of landings
- Likely extraction directions
- Average haul distance
- Suitable machine types (but not necessarily the actual machines to be used)
- Environmentally sensitive area (including historic and archaeological sites)
- Permanent or temporary waterways

Harvest plans are developed to ensure that the proposed activity is feasible and meets specific resource, scheduling and cost objectives of the forest owner. They may have to be submitted to a District and/or Regional Council to show how a block is to be harvested.

Environmental considerations

Environmental issues are considered during the harvest planning process. Planners select systems that avoid or minimise adverse impacts in the site. In doing so, they consider the potential effects of operations on onsite and offsite values.

They have to consider:

- Environmentally sensitive, cultural, and historic sites
- Location of roads, tracks, and landings
- Controlling water runoff
- Fuel and oil storage
- Seasonal weather limitations
- Visual impacts
- Trees bordering sensitive areas, such as streams or cultural sites
- Potential for site disturbance
- Waste disposal
- Physical resources
- Effects on neighbouring properties

The logging operation will need to comply with environmental standards defined by the forest owner, and local and regional authorities under the Resource Management Act.

The resulting plan should also meet all of the safety, cost, production, quality, and environmental objectives of the company.

To ensure that the plan is acted on, the plan is communicated to supervisors and contractor. This is usually done via the job prescription.

Job prescription

The job prescription is a written instruction from the forest owner to the logging contractor. It details the requirements for the logging operation, and specifies standards for quality (such as product mix, stump heights, and cutover waste) and enviromental impact.

It may contain the following information:

- Species
- Production target (tonnes, m^3, or stems per day)
- Enviromentally sensitive areas
- Known hazards associated with the area to be logged
- Terrain and soil type
- Attachments may include:
  - Stand data report or plot details (e.g., stocking, piece size, and percentage log qualities)
  - Resource Consent
  - Harvest planning map
  - Monitoring report or post-operations checklist (e.g., forest still standing shown on map, earthworks, high-risk environmental issues, log stocks, roading, and re-establishment)
  - Historic Places Consent
- Type of operation
- Main access roads
- Resource Consent No. (if applicable)
- Allowable residual tree damage (in production thinning operations)
- Post-operation clean-up requirements

It is important that all members of the crew are briefed on the prescription, especially parts applying to felling and extraction.

Operational planning

The operational plan is a day-to-day plan developed by the logging contractor or foreman. It has much more detail than a harvest plan in relation to machines and timing. It is based on the specific working patterns of the crew.

The landings and roads specified in the harvest plan are in place when the logging crew arrives. The operational plan must work within the constraints imposed by the harvest plan.

The operational plan will include information on:

- How the block will be worked, including -
  - The starting point for felling
  - Use of landings
  - Direction of lineshifts
  - Felling direction
  - Rigging systems to be used
  - Matching machines and workers to tasks
- The layout of the landing, including -
  - Hauler position(s)
  - Processing areas
  - Location of stacks
  - Warning sign location
  - Guyline anchor requirements
  - Safe areas
  - Truck loading area
  - Processing waste location

Work area safety

Warning signs

Rules

- Signs warning of work in progress shall be displayed when work is on or near public or private roads or adjacent to boundaries.
- Planning of appropriate warning methods shall be prepared as part of hazard management.
- Permanent signs shall comply with the **Manual of Traffic Signs and Marking**, published by **Transit New Zealand/LTSA**.
- Temporary traffic control signs shall comply with **the Code of Practice for Temporary Traffic Management, Transit, 26 November 2004, or subsequent updates.**
- Temporary signs shall be removed or covered when no longer valid or when work has ceased.
- Where there is a road control authority, formal authorisation shall be obtained and compliance made with conditions set by the authority before any signs warning of operations are placed and work commences.

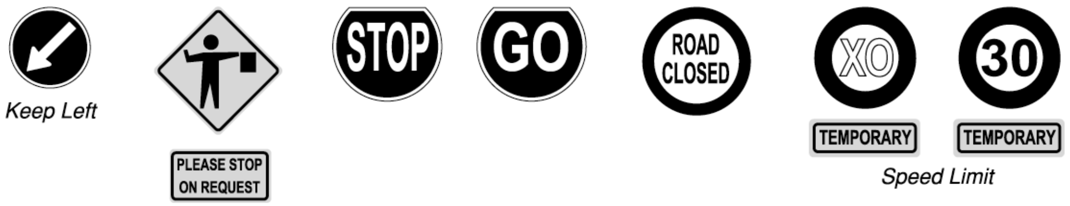
Note that Transit juristiction covers all private forest roads that can be accessed by the public. If a road cannot be accessed by the public, the forest owners are considered the road control authority, and their policies apply.

Acceptable signs

According to the transit code, the following signs may be used.

- **Advance warning signs**

- **Direction and protection signs**



- **End of works/operation signs**

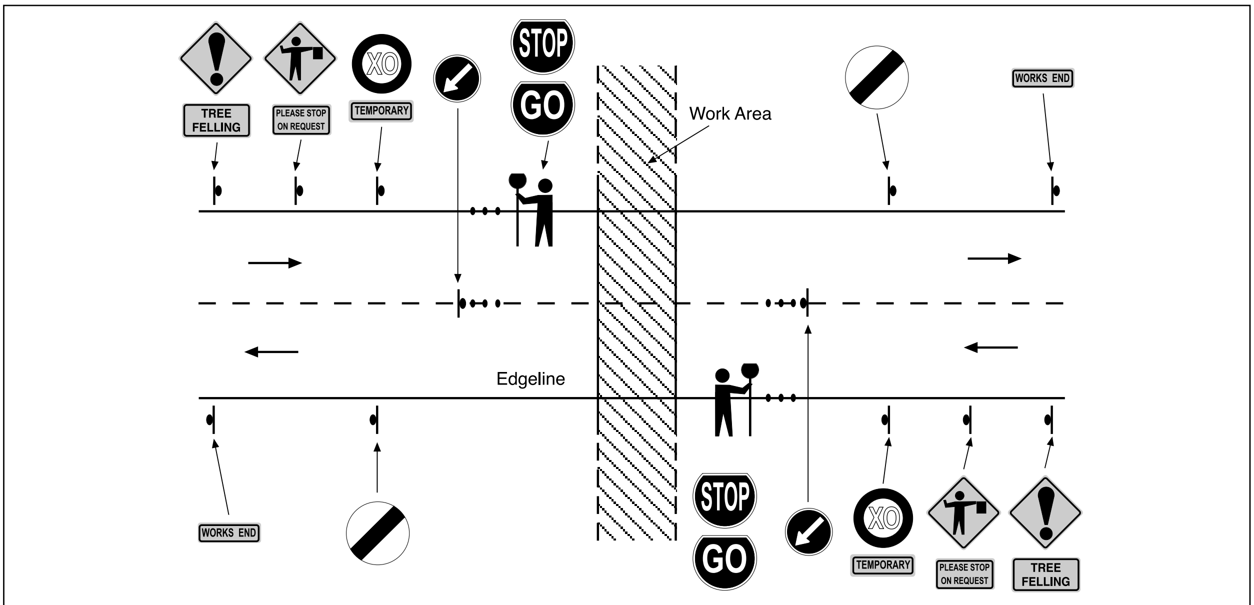
Placement of signs

Tree felling operations within two tree lengths of road must have warning signs.

Transit NZ requirements for sign placement relate to average annual vehicle usage. The following guidelines relate to traffic control on Level 1 roads - these are roads that carry less than 10 000 vehicles per day.

- The distances between the advance warning sign and the edge of the operational area vary with traffic speed.
- The diagram that follows gives an example of the required signs and placement. Road closure is less than 5 minutes at any one time. For full details refer to the Transit NZ Code.

Traffic speed	Distance from advance sign to hazard
50 km/h	75 m
70 km/h	105 m
100 km/h	150 m



Entering an operational area

Every person entering an operation area shall:

- Notify the supervisor or foreman before entering the operational area
- Only enter the area when acknowledged or signalled to do so
- Attract the attention of the faller before approaching within two tree-lengths
- Exercise care when approaching workers engaged in any operation
- Wear the appropriate personal protective equipment

Communication

Effective communication between members of the logging crew is crucial for safe and efficient operation.

Crew members may communicate using:

- Audible signals (tooter signals)
- Radio communication
- Hand signals
- Direct communication

The crew should be aware of the following:

- Audible signals must be clearly heard by all workers in the vicinity of any rope that is about to be moved.
- Should communication become inaudible or not clearly understood, all hauling shall cease until the system is fully restored.
- The standard signals (see below) shall be used.
- Signal systems should be posted in the hauler.
- Radios and tooters are to be tested daily before operations commence.
- Only one breaker-out shall give signals when strops are set. However, any worker may give the emergency signal.
- Hauler operators shall not move ropes if the signal is unclear. If in doubt, repeat the signals as understood and wait for confirmation.
- An audible signal shall always be sounded before any rope is moved.
- Voice communication should be limited to unusual or difficult hauling situations, or for emergency use.
- A check should be made of other tooter frequencies working nearby to ensure there is no interferrence.

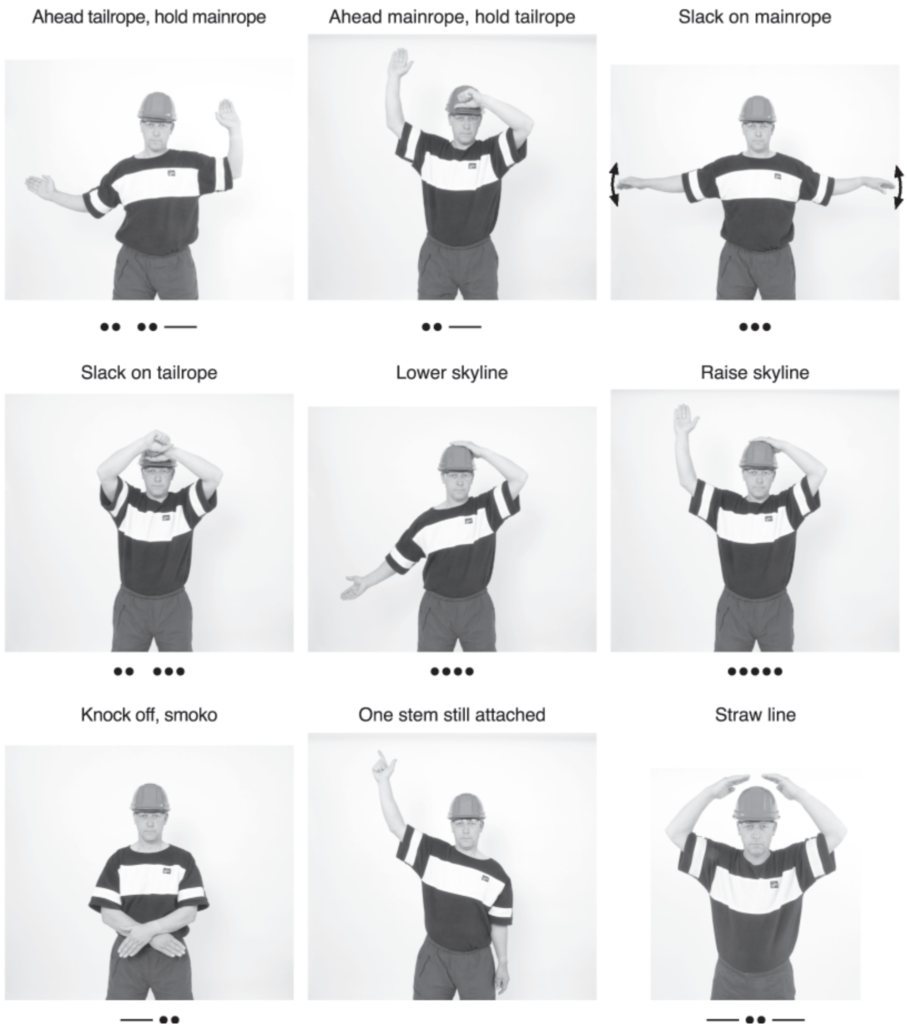
Clear communication between the breaker-outs and the hauler operator is important when directing rope movements, and the application of power during break-out and inhaul.

If instructions are not fully understood, the breaker-outs, hauler operator, and other landing workers face significant hazards associated with unexpected rope movement and rope/anchor failure.

Where audible siganls are used, the following standard signals shall be adopted (corresponding hand signals are also shown.

Standard signals figures

In addition to these signals, others are used to direct other rope movements and responses. These may vary between crews. This increases the risk of new workers (from other crews) mistaking the meaning of a signal. For this reason, additional audible and hand signals are recommended (see below).



Training and supervision

Cable logging is a hazardous extraction method, with workers exposed to loaded ropes and adverse terrain. Workers need to be skilled or under training in the particular tasks they are doing.

In addition, the Approved Code of Practice for Safety and Health in Forest Operations requires that a competent person supervise workers who are new to the operation or task. Regardless of their training status, new workers should not be allowed to work unsupervised until they have demonstrated that they are unlikely to harm themselves or others.

All experienced workers should be under a documented training programme. They should be aiming to pass the relevant NZQA units that apply to the cable logging tasks being undertaken.

Workers involved in cable logging (particularly, breaking-out) need to be fit, active, alert, properly trained or supervised, and appropriately equipped.

Knowledge of hazards

As part of the supervision and training programme, workers need to be **shown** the hazards they will face on the job and the controls to avoid being harmed by those hazards.

Before starting any new block, all workers must be involved in identifying any significant hazards **on the site** and the way those hazards will be controlled. There must be documented evidence on site listing the hazards and controls, and showing that all operators have been run through the hazards and controls.

The two main hazard categories are health hazards and operational hazards.

Health hazards

Cable logging is a physically and mentally demanding job. Your safety and the safety of those around you will be affected if you are not fit and healthy.

To maintain performance levels and prevent accidents through fatigue, ensure that you:

- Take adequate rest breaks
- Maintain an adequate level of hydration and diet
- Keep physically fit
- Get adequate sleep
- Do not let drugs or alcohol impair your judgement.

Health hazards

Hazard	Control
Fatigue (mental and physical)	• Build short frequent rest breaks into your work routine. • Take at least two evenly spaced 30 minute rest breaks during the working day.
Lack of sleep, tiredness	• Ensure that you have at least 5 hours continuous sleep every day • Use power-naps (short sleeps of 20-30 minutes duration).
Early starts	• Learn to go to bed earlier to replace the sleep you lose in the morning. • Your body needs time to adjust to changes in sleep patterns. When first beginning early starts in spring/summer or after the Christmas holidays, recognise that you may remain tired until your body adjusts. • Also, allow time for your body to adjust once you back to late starts.
Alcohol abuse	• Avoid drinking alcohol at least 24 hours before carrying out any hard physical work.
Poor nutrition (most accidents occur between 9 and 11 a.m. when you are tired and running low on energy, so stop and have a smoko break)	• Start each day with a high carbohydrate breakfast like porridge, cereal, toast, bananas, pasta, or potatoes. • Eat high protein foods like lean meat, chicken, eggs, milk, and cheese at night. • Eat at the start of a break, and rest to allow digestion. • Always eat a high carbohydrate snack straight after work.
Exposure to sun	• Wear sun block (SP30+). • Wear a light shirt rather than a singlet on hot days. • Install a neck flap on your helmet. • Wear tinted UV protective eyewear. • Carry out regular health checks of moles, freckles, etc.
Drugs	• Avoid all non-prescription drugs as they seriously affect both your mental and your physical ability to work. • Inform the boss if you are on any medication that may affect your work. Stay home if necessary. • Before receiving any medication, tell your doctor what you do for a living. • If you are on long-term medication for a serious health complaint inform the boss or crew of your condition in case you are involved in an emergency at work.
Hypothermia/chills	• Polypropylene clothing (thermal underwear) is excellent for cold, wet weather.

Health hazards (cont...)

Hazard	Control
Hypothermia/chills (cont...)	• If necessary, also wear a warm hat or balaclava. • Put a hat and warm clothes on when you stop for a break. • Have wet weather clothing handy for when working outside the cab.
Lack of hygiene/infection	• Clean and dress any cuts or scratches received on the job as soon as possible and keep them covered. • Make sure the first aid kit is kept fully stocked. • Carry water and soap on the job to wash hands before smokos. • Bath or shower every night. • Eat a balanced diet to keep your body healthy. • Wear clean clothes against the skin every day.
Occupational Overuse Syndrome (OOS)	• Use the correct techniques when operating machine or other equipment. • If operating a machine, adjust the seat (and controls) to suit you. • Ensure all equipment is well maintained and working effectively. • Use pre-work warm up and stretching techniques throughout the day. • Perform other tasks (off the machine) that will exercise different muscle groups. • Have regular medical examinations if you suspect a problem.
Dehydration/heat exhaustion	• Regularly drink fluids at a rate of 0.5 litres per hour and up to 1 litre per hour in hot conditions. • Drink before you feel thirsty. • Do not drink fluids, like soft drinks and cordials, that have more than 8% carbohydrate content. • Drink high carbohydrate drinks after work to replace energy levels. • Drink plenty of water at night to recharge the body. • Drink a couple of glasses of water before leaving for work.

Operational hazards

Based on accident statistics, breaking out, skid work, and felling are the most hazardous tasks within a cable logging operation. Operational hazards and control measures relating to tree felling are presented in **Best Practice Guidelines for Tree Felling**.

Presented below are operational hazards relating to cable extraction and processing. These have been grouped as follows:

- General operating hazards
- Layout and lineshift hazards
- Landing the drag and unhooking
- Mobile tailhold hazards
- Breaking out hazards
- Elevated support hazards

Operational hazards

General operational hazard	Control
Ineffective personal protective equipment (PPE)	• Do not perform any operation if your PPE is ineffective. • Clean dirty hi-vis garments and oil-soaked protective legwear. • Replace any worn, damaged or expired PPE. • Routinely check the condition of your PPE.
Incorrect signals	• Ensure you use accepted audible and hand signals. • Ensure the signalling system is functioning correctly. • Ensure that everyone using these signals is aware of them.
Standing in dangerous positions	• Do not stand within two tree-lengths of a felling operation. • Do not stand within one tree-length of a drag being broken out. • Do not stand downhill of a drag being broken-out. • Do not stand directly downhill of the landing while the drag is being landed or unhooked. • Do not stand in the bight of a rope. • Do not stand beneath a loaded or moving rope. • Do not stand in front of the hauler when the drag is being landed. • Do not stand beneath the landing where loader operators dump slash. • Do not stand on an anchor stump or mobile tailhold when the working ropes are loaded. • Do not stand beneath a load-bearing guyline during break-out and unhook.

•

Operational hazards (cont...)

General operational hazard	Control
Overloading	• Do not hook on drags that will overload the system. • Unhook stems if necessary if the drag is too heavy. • Ensure the skyline bandbrake is calibrated to slip at the SWL of the skyline, after each adjustment of the bandbrake. • Alternatively, use a rope tension monitor to ensure that the system is not overloaded. • Intentionally make the bandbrake slip at the beginning of each day. • Ensure the SWL of all rope and rigging equipment is at least the same as the SWL of the working rope. Be aware that different rope constructions may increase or decrease rope strength. • Avoid sudden movements in the ropes, particularly when breaking-out.
Unexpected stem movement	• Do not approach stems that you suspect of being unstable. • Hook on stems that are stable - as these are broken-out they should move remaining unstable stems. • Keep at least one tree-length away from the stems that are being broken-out. • Always stand in a position where you can move if necessary, and have an escape route planned should evasive action be required. • Watch for stems that are not part of the drag moving during break-out. • Watch for stems on the landing being moved by incoming drags.
Unplanned rope or rigging movement	• Ensure the rigging has stopped moving before approaching. • When lowering the rigging, signal the hauler operator to stop when the strops hit the ground. • Watch for “bounce” in the ropes that could raise or lower the carriage or rigging.
Tower or machine instability	• Ensure the tower is correctly guyed to resist the applied forces. • Regularly (at least daily) check the condition of the guyline and tailhold anchors. • Ensure the hauler is located on stable and level ground. • Ensure that the breaking strength of the ropes, rigging, and anchors is matched to the breaking strength of the working ropes. • Do not overload the cable system. • Regularly check the guylines and tackle for damage or deterioration - check every time the tower is lowered.

Operational hazards (cont...)

General operational Hazard	Control
Anchor failure	• Ensure the anchor layout is correct to support the tower and working ropes. • Ensure that one or two anchors behind the hauler are not taking the entire load, unless it is a 2-guyline machine. • If using stump anchors: ¤ Ensure they are correctly notched and rigged. ¤ Use only fresh and sound stumps (less than 6 months old) ¤ Check the condition of the stumps at the beginning of each run, looking for signs of movement. ¤ If in doubt about the strength of a single stump, rig a multiple stump anchor, or use an alternative anchoring method. • If using deadman anchors: ¤ Use one or two large logs, at least 5 m long. ¤ Ensure the trench is at least 4 m deep, with an intact front wall. ¤ Ensure the deadman is correctly installed (see page 74) ¤ Paint the strop where it exits the ground. Check for movement of the deadman at the beginning of each run. • If using a mobile tailhold: ¤ Ensure the attachment of the working rope is solid. ¤ Ensure the tailhold is secured from moving forward when loaded (angled towards the load, blade or bucket buried, and stropped to a stump if necessary).
Rope/rigging wear or failure	• Avoid shock loading. • Replace worn or damaged ropes and rigging. • Check the condition of the working ropes/rigging each day. • Ensure that ropes and sheave sizes are matched. • Ensure rope/rigging strength is matched to the task.
Unprotected moving machine parts	• Shut the machine down before carrying out maintenance checks or repairs on moving parts. • Install protective guarding to isolate hazards.
Terrain	• Move carefully across the cutover to avoid losing your footing. • Take the safest route. • Wear spiked boots for added traction, unless in rocky terrain. • Wear safety protective footwear that provides good ankle support (chainsaw-resistant gumboots are less suitable on steep terrain than lace-up boots). • Ensure you have secure footing when working on a steep slope.

Operational hazards (cont...)

General operational hazard	Control
Terrain (cont...)	• On rocky sites, avoid dislodging rocks that may fall into the path of co-workers.
Damage to machine	• Do not operate a damaged machine that may be hazardous. • Check for damage to wire rope. • Watch for failure of machine controls (e.g., air or fluid leaks). • Be aware of block failure. • Avoid tower failure by following manufacturers' rigging instructions. • Be aware of loader movements around the guylines. • Avoid over-spooling (birdsnesting) on the drums. • Ensure that the machine access is always clear and in good condition.
Adverse weather	• Wind, rain, and snow can adversely affect cable operations. This is particularly so for breaker-outs and fallers - stop work if conditions become hazardous.
Injury from machine maintenance	• Take care when greasing the sheaves and fairlead swivels in the tower. • Avoid skin irritation from contact with fuel and oil. • Use your tools correctly to avoid hand injury.
Vibration from machine	• Avoid sudden impacts while operating a machine. • Reduce the time your back is exposed to vibration by getting off the machine at least once every hour. • Work smarter - move larger loads at slower speeds. • Make sure the seat is adjusted properly. • Do exercises while seated to even-out pressure on your spinal discs. • Control breathing and relax muscles. • Keep a good posture. • Keep fit - strengthen abdominal muscles.
Noise	• Use hearing protection if noise level is above 85dB. • Reduce noise exposure while in a machine by keeping doors and windows shut while working.

Mobile tailhold hazard	Control
Unexpected rope, shackle, or block movement	• Do not stand in the bight of a rope. • Stand clear of rigging when loaded or during a lineshift. • Ensure all ropes and rigging have stopped moving before approaching them.

Operational hazards (cont...)

Mobile tailhold hazard	Control
Tower failure. Machine toppling into working area	• All towers must be rigged and operated in accordance with the manufacturer's recommendations. • Ensure the tower is adequately guyed to resist the applied forces. • Ensure the hauler is located on stable and level ground. • Ensure that the strength of the ropes, rigging and anchors are matched to the breaking strength of the working ropes. • Do not overload the cable system.
Movement of the tailhold	• Do not stand directly in front of, or on the tailhold when loaded. • Watch for the anchored rope suddenly going slack - this may indicate that the tailhold has moved. • Ensure the tailhold is adequately secured to avoid movement.
Loss of control during shifting	• Mobile tailhold machines should only be operated by experienced operators, or under strict supervision - the weight of the attached rope(s) can make the machine unstable. • Ensure there is no load on the tailhold when manoeuvring. • Wear the seat belt while you are operating the machine.
Binds or bights	• Watch for binds when tensioning the ropes. • A rope may be able to be lifted over an obstruction by hand. Ensure the rope is completely lowered to the ground before attempting. • Watch for sprags - wear leather gloves. • Only stand on the safe side of the rope - DO NOT stand in the bight. • If attempting to clear an obstacle by tightlining, go ahead on the rope slowly, and constantly assess the situation. • If using a chainsaw to clear the obstruction, ensure you wear the required PPE and are either skilled or under the supervision of a competent person.
Communication failure	• If audible (including radio) communication fails, move to a safe position and use hand signals. • Do not act until signalled to. • Use other workers to assist.
Inappropriate footwear	• If you wear spiked boots, the chance of slipping or losing control of the foot pedals is higher than if the boots are not spiked. • Have non-slip steps and pedal covers fitted.
Unstable soil	• Only operate the tailhold in a stable position.
Falling carriage	• Do not stand beneath a loaded rope.

Operational hazards (cont...)

Layout and lineshift hazard	Control
Carrying heavy loads	• Avoid carrying heavy loads manually. If necessary, use the recommended lifting and carrying stance. • Carry loose rigging in a pack to leave your hands free for balance. • Rest frequently when carrying heavy loads. • Take the safest route (not always the shortest). • Avoid climbing over obstacles.
Handling wire rope	• Avoid hand injuries from sprags by wearing gloves. • Remove sprags with side cutters. • Ensure your footing is stable before pulling rope. • Do not stand in the bight on a rope.
Chainsaw use (when preparing anchors or clearing obstructions)	• Wear the appropriate PPE. • Saws should only be used by experienced/trained workers, or under supervision of a competent person. • Ensure correct chainsaw technique is used **(see Best Practice Guidelines for Chainsaw Use)**.
Rope failure	• Because of its lighter weight, strawline can move further than other ropes when it fails. Be aware of this when the strawline is loaded. Stand in a safe position. • Lay out the strawline in as straight a line as is possible. • Avoid excessive weight on the strawline. • Ensure all joiners are correctly done up and capable of passing any blocks.
Block, strop, or anchor failure	• Inspect blocks and strops before using them. Look for damage or wear - replace if necessary. • Do not stand in front of a loaded anchor (in the bight of the rope). • Keep blocks clear of debris.
Flying debris	• Watch for flying debris when tightening. • Have the hauler operator tension the rope slowly.
Binds or bights	• Watch for binds when tensioning the ropes. • A rope may be able to be lifted over an obstruction by hand. Ensure the rope is completely lowered to the ground before attempting. • Watch for sprags - wear leather gloves. • Only stand on the safe side of the rope - DO NOT stand in the bight.

Operational hazards (cont...)

Breaking-out hazard	Control
Terrain and obstructions	• Move carefully across the cutover • Take the safest route when walking in to or out of the hook-on area. • Wear spiked boots for added traction if soil type permits. • Make sure you are wearing adequate footwear with good ankle support. • Ensure secure footing on steep slopes. • On rocky sites, avoid dislodging rocks that may fall into the path of co-workers.
The bight	• You **must not** enter a bight **unless** there are extra safety precautions in place to avoid injury should an anchor (tailhold, tail block, or corner block) fail. Precautions may include an extra block suitably located on the tail rope, or a high stump, or standing tree.
Heavy undergrowth	• Hook on stems in the order that provides the best access. • Wear protective eyewear to reduce the risk of an eye injury unless the wearing of them creates added hazards.
Wire rope and rigging	• Do not approach a moving rope or rigging. Wait for it to stop moving. • Let the strops hit the ground before signalling the operator to stop lowering the rigging (this avoids getting hit by swinging choker or chain hooks). • When waiting for slack, keep to the side of the rigging and watch the lowering process. • Use gloves when handling wire rope. • Cut sprags from strops using side-cutters.
Flying debris	• Signal the hauler operator to raise the rigging slowly during break-out and tightlining. • Assess the risk of debris movement if ropes are fouled beneath debris (broken heads, stem waste etc). • Stand in a safe position, at least one tree-length from the break-out position, unless protected by a physical barrier or terrain feature.
Overhead hazards (elevated ropes, rigging, drag)	• Do not stand under loaded ropes. • Do not approach rigging until it has stopped moving
Other machinery and operations	• Remain two tree-lengths from any felling operations, or further where there is any risk of sliding logs. • Only enter the work area of another machine when signalled to by the machine operator.

Operational hazards (cont...)

Breaking-out hazard	Control
Anchor failure	• Do not stand directly below or on an anchor when it is loaded.
Overloading	• Reduce the drag size by hooking fewer stems and/or pieces. • Instruct the hauler operator to lower the skyline (increase deflection). • Always try to hook-on the top stems first, and watch for binds or tail-locking. • Unhook stems if necessary if the drag is too heavy.
Incorrect signals	• Use standard and recommended signals (see pages 12-13) • If the wrong signal is given, signal "Stop" immediately.
Runaway stems from landing slash or slovens rolling off landing	• Select a safe position to stand, which is at least one tree-length to the side of the skyline **and not** directly downslope of the chute. • Ensure the hauler operator and/or operator(s) of machines clearing the chute or landing are aware of your presence below the landing. • Always watch the drag until it is safely landed or under the control of the hauler operator.
A fouled drag	• Do not signal to increase the pull as rigging or anchor failure may result. • Signal "Stop" to the hauler operator. • Assess the situation. Instruct the hauler operator to lower the working rope or move the drag away from the landing using the tailrope (if present) - This may be sufficient to avoid the obstacle on the inhaul. • It may be necessary to unhook a stem to reduce drag weight. This **must** only be done if there is no risk of the stem/drag moving during the unhook. Approach the drag from the uphill side.
Dislodged rocks, stems, or debris	• Carefully watch break-out and inhaul from a safe position. • Be aware of material dislodged at the tailhold end of the span (if standing on the back face, you may be looking at the drag unaware of the hazards behind you).

Operational hazards (cont...)

Elevated support hazard	Control
Equipment failure	• Ensure all climbing and rigging equipment is in sound order before using it. Replace if necessary.
Spiking yourself with the boot irons	• Only put the irons on when you are about to climb the tree.
Unstable climbing and working positon up the tree	• Tree work should be carried out by a skilled worker, or under the close supervision of a competent person. • Ensure all climbing equipment is safe and used correctly (have the harness positioned below your waist). • Use the correct climbing technique. • Ensure the climbing spurs are positively engaged before climbing.
Turning upside down in the harness	• Tree climbing requires two people - both capable of climbing. • Ensure there are two sets of climbing equipment - one as a spare.
Falling objects	• The faller should assess hazards within the tree before leaving it as a support tree. • When rigging the tree, the second person on the ground should observe the fall of the top from a safe position behind the tree. • Wear the safety helmet when climbing - you may need a chin strap. • The second person (on the ground) must stand in a safe position where the activity up the tree can be clearly seen and to the side of the intended direction of fall.
Abrasions to hands	• Wear gloves to protect your hands when moving the climbing rope (they must still allow you to adjust the climbing rope adequately).
Chainsaw work	• Wear the required PPE. • Pre-warm the saw on the ground. • If starting the saw up the tree, ensure the chain brake is activated, hold the saw with a straight arm, and use short sharp pulls. • Use the correct cutting tecniques. Use wedges where appropriate (**see Best Practice Guidelines for Tree Felling** for further details). • Use compression and tension cuts when trimming heavy branches. • Do not cut in front or to the left of your body - adjust your position. • Do not use the saw above shoulder height.

Operational hazards (cont...)

Elevated support hazard	Control
Chainsaw work (cont...)	• Complete the felling cuts from a position on the side of the tree (not directly in front or behind the intended direction of fall). • When not required, activate the chain brake and lower the chainsaw on its rope so that it is below the level of your feet.
Tree movement as the top falls	• When the top begins to fall, activate the chain brake and lower the saw on its rope. • Brace for possible tree movement. Place one hand against the tree to avoid hitting it with your face.
Tree splitting	• Use a safety chain with chain hook (or similar). • Wrap the chain around the tree below where you plan to cut it.

Personal protective equipment (PPE)

The Approved Code of Practice for Safety and Health in Forest Operations requires workers in cable logging operations to have and use the following PPE:

- Hi-vis helmet
- Hi-vis garment
- Safety footwear
- Protective eyewear (unless the wearing of eyewear causes a greater hazard, must be worn when cutting wire rope).

In addition, the following may be required:

- Gloves for handling wire rope and rigging. Heavy cotton gloves are preferred ahead of leather because any puncture wounds are less severe
- Hearing protection when near machines or chainsaws
- Chainsaw protective legwear if using a chainsaw
- Water bottle
- A means of emergency communication
- Small first aid kit.

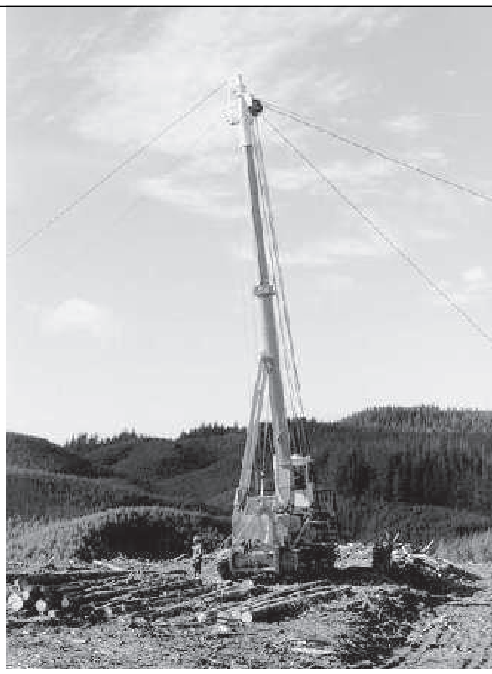
Further information on PPE standards and care is provided in the **Best Practice Guidelines for Personal Protective Equipment**.

Haulers

Types of haulers

Hauler types can be categorised as follows:

- **Haulers**
  - **Mobile**
    - **Integral fixed tower**
      - Steel tube or steel lattice work
      - Either vertical or leaning
    - **Swing yarder**
      - Steel lattice work
      - Excavator type yarder
  - **Stationary**
    - **Independent**
      - Steel tower/spar (tube or lattice)
      - Wooden tower/ spar



Integral fixed-tower hauler

Most **mobile haulers** are self-contained units comprising:

- Carrier (tracked or wheeled)
- Winch unit
- Steel tower integrally mounted on the chasis
- Tower raising (and telescoping) mechanisms
- Blocks, sheaves, and shackles.

The two main types of mobile hauler in New Zealand are the integral fixed-tower haulers and swing yarders.

Swing yarder

Stationary haulers are no longer common. Typically, these units comprise:

- An independent tower/spar
- A single or double drum winch unit
- Sledge carrier.

Stationary hauler with separate wooden spar

Mobile haulers

Integral fixed-tower hauler

- Integral fixed-towers operate either vertically, or lean forward at at angle of up to 8º.
- Some are hinged or telescoping to give two operating heights and reduce their length for transport.
- During operation, the tower base is supported by either the frame of the carrier, or directly by the ground.

Fixed-tower

This type of tower is one piece and can be the mid-mounted leaning type or front-mounted vertical. The height of the tower varies with hauler make and model.

Make	Tower height (m)
Madill 071	15
Madill 009	27
Berger C23	24

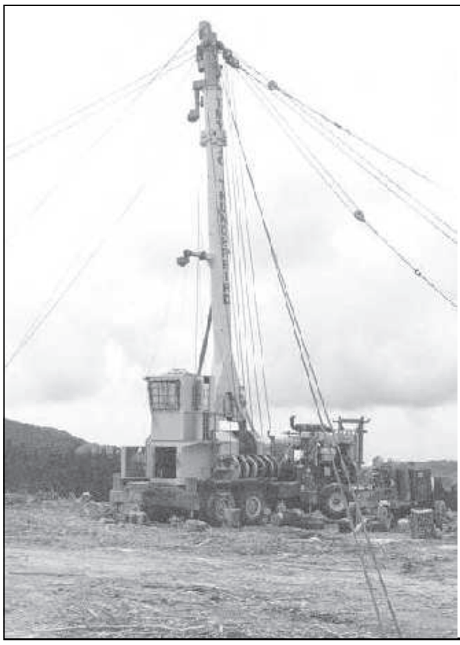
Madill 071

Madill 009

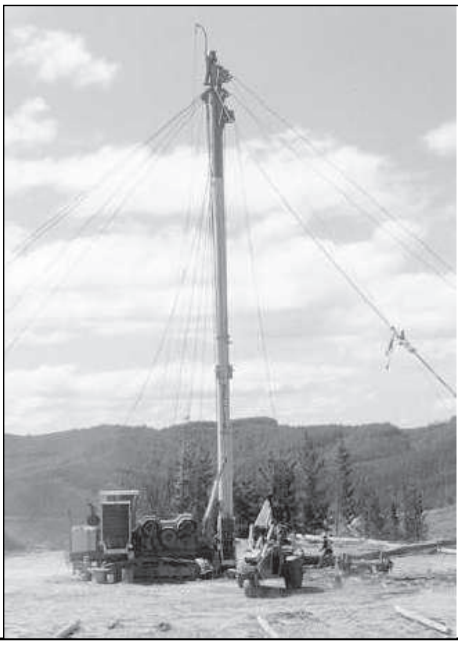
Telescoping

This type of tower has a hydraulic ram, or multi-sheaved cable system, inside the tower that extends to telescope the tower, or retracts to lower the tower. This enables the tower to be operated at two different heights depending on the circumstances. This can allow easier guying on small or steep landings if tower height is not critical. It also allows for easier shifting between settings or blocks.

Make	Tower height (m)
Thunderbird TMY 70	15-21
Madill	15-21
Bellis BE 85	18-26
Berger MR3	18-30



Thunderbird TMY 70



Bellis BE85

Integral swing yarder

Typical features of swing yarders include:

- An interlocked winch-drum drive
- A self-propelled rubber-tyred or tracked carrier
- A separate guy-tower.

Swing yarders are generally heavier and more expensive than conventional haulers of similar tower height, engine power, and rope capacity.

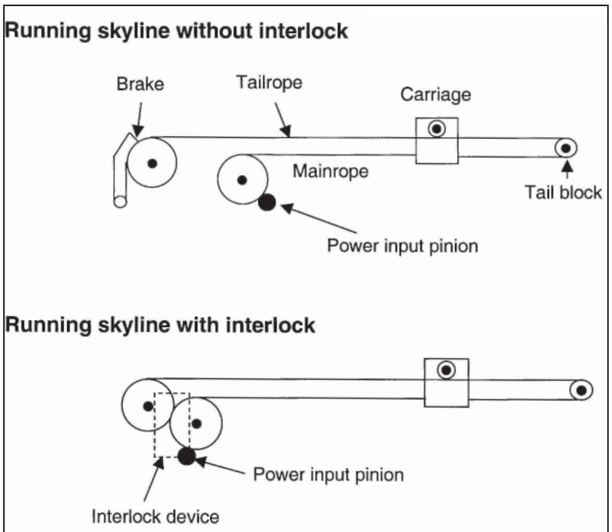
Integral swing yarder (Thunderbird 355)

Interlock

Most swing yarders have an interlock mechanism between the tailrope drum and the mainrope drum.

The interlock allows energy, normally lost as heat, to be regenerated to the shaft or shafts driving the in-winding drum(s) through a slipping clutch or planetary gear system.

The degree of interlocking must be infinitely adjustable to account for variations in rope tensions and the changing diameter of the drums. Some machines have interlock at both inhaul and outhaul while other machines have interlock for inhaul only.



Interlock system

Lattice Boom

This type of tower is associated mainly with swing yarders, although they can be found on smaller integral towers and small European haulers. The lattice design allows for a reduction in tower weight, by as much as 10:1, without compromising the towers bending strength.

Make	Tower height (m)
Thunderbird TSY 6355	18
Thunderbird TSY 50	15
Madill 123	18

Excavator Yarders

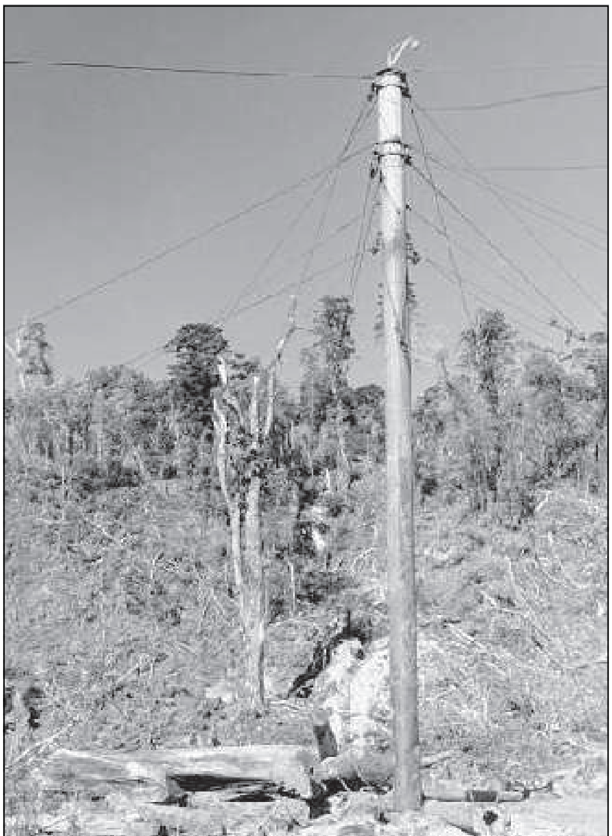
Excavators can be equipped with hydraulic winches and a fairlead set-up to be used as a hauling machine.

Typical features include:

- Two drums, mainrope, and tailrope
- Tailrope can also be used as a skyline for shot gunning
- Strawline drum
- Mounted fairleads on dipper arm or boom
- Guylines for extended dipper arm.

Excavator yarder

Gantner hauler



Independent spar

Stationary Haulers

Gantner/Wyssen conventional haulers

These haulers are common in European countries and are used predominantly in longspan cable operations. A standing skyline is rigged and a carriage is mounted on it. The hauler then operates the carriage.

Typical features include:

- Sled-mounted drum and engine
- One mainrope drum with 1200 m of cable
- Air brake to control the carriage and drag as it travels downhill
- Drum brake to control the winch drum
- Headspar is rigged via a standing tree or an independent steel tower.

Independent tower/spar

Independent towers are separate from the hauler winch unit. They take considerable time and personnel to stand and rig up.

Independent towers can also be of steel construction and of tube or lattice design.

Using an independent wooden tower/spar allows a separate crew to rig it up on the landing in advance.

Suitable trees to use as wooden spars are:

- Douglas-fir
- Eucalypts.

Note: Raising and rigging an independent spar is a complex operation. Experience and skill are required to carry it out safely and efficiently. Generally, a purchase system is used to provide lift. All guyline placements and block attachments are made in advance.

Hauler features

There are many makes and models of haulers and swing yarders in use. The choice as to which particular machine to use will be influenced by the following features:

Key feature	What to consider
Winch/ropes	• Number of working drums • Rope capacity (length) • Rope strength (diameter, type)
Tower	• Tower type and height • Guyline configuration of tower to be used • Allowable lead angles. **Comment:** Hauler lead angles will determine guyline and machine shifts on each landing, and therefore the guyline anchor requirements
Carrier type	• Mobility if needing to shift often
Engine power	• Adequate to power all the drums

Winch unit

Winch options

The features of the hauler winch determine the available rigging systems.

These options …	… depend on these hauler features
Types of cable systems which can be run	• The number of working drums (excluding strawline drum) • Type of brakes fitted to working drums • Method of power transmission to the winch drum set • The location of these drums within the winch unit (drum configuration)
Maximum haul distance	• Amount of rope on the working drums • Line speed
Payload capabilities of the hauler	• Strength of the working ropes • Engine output (kilowatts) • Tower height

Transmission systems

Power transmission systems found on haulers include:

Type	Explanation
Conventional	Mechanical drive-train, with drums controlled by clutches and brakes
Interlocked	Mechanical drive-train, where drums interlock and are controlled by a variable-power transmission system
Hydrostatic	Hydraulic drive-train, where drums are controlled by varying the hydraulic pressures and flow applied to each drum

Engine

Drive-trains cannot operate without a power source. Two- or four-stroke diesel engines are the most common engine. These supersede petrol due to increased efficiency, low-end torque, and reliability.

Engines vary in power rating. Larger haulers, with heavier ropes and taller towers, require more power to operate efficiently.

Power ratings of haulers used in New Zealand varied a great deal more when cable thinning operations were common. Today however, the range in power ratings is generally between 200 and 350 kilowatts.

Power-train

The following key components serve the primary function of transferring the power from the engine to the wire ropes.

- Engine
- Chain drive/gear drive
- Winch drums
- Transmission
- Drive shafts and gears
- Torque converter

The operation of a typical hauler power-train is as follows:

- A power-shift or automatic transmission and torque converter, mounted directly on the engine, leading to a –
- Chain or gear drive, which connects to –
- An intermediate shaft, which in turn drives the drum shaft through spur or bevel gears. Clutches and brakes are directly adjacent to each drum.

The chain drive, torque converter, and gears are necessary to reduce the speed of drive from some 2000 rpm at the engine, to around 100 rpm at the drums.

Torque converter

The functions of the torque converter are to:

- Utilise engine power, enabling faster cycle times
- Automatically select torque multiplication to provide maximum line pull and speed
- Remove shock loading between the winches and the engine.

Some machines have a direct drive from the torque converter to the drum set, while others use a multi-speed transmission, which incorporates a torque converter.

Note: *If a torque converter is continually overloaded, it will overheat and eventually fail*.

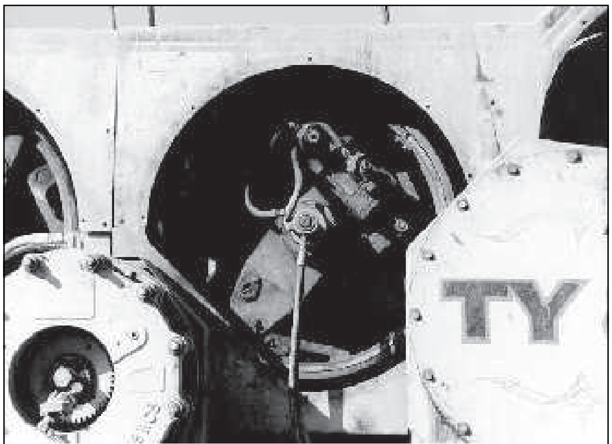
Drums

Drums

A winch drum is made up of two components, a flange and a barrel.

The flanges confine the rope within the length of the barrel. If drums are narrow and deep, there is a considerable loss of line pull and increase in line speed as the drum fills up. Wide shallow drums minimise the change in line speed and line pull as lines wind and unwind.

The number of winch drums dictates the cable systems that can be used.



Clutch

Clutches

Power is transmitted to the drums through clutches. These may be operated:

- Mechanically
- Hydraulically
- Pneumatically (air-operated).

The three most common types are:

- Cone-type
- Disc- or plate-type (multiple-plate-type for strawline drum)
- Internally expanding band-type (most common in medium to large haulers).

Drum brakes

Drum brakes are either band- or disc-type. Disk brakes can either be:

- Water-cooled
- Air-cooled.

Dynamic brakes (commonly called friction brakes)

Water-cooled brakes are air-actuated and designed to work as tensioners on the moving ropes. This prevents the drum from over-running (creating a birdsnest), and allows for smooth spooling.

A set amount of air pressure is applied to the drum during normal service (braking torque is proportional to air pressure).

The brakes have one or more friction disks that act upon a water-cooled reaction plate. Water is circulated through the water jackets. The cooling water dissipates heat caused by dynamic braking.

Static brakes

These are designed to hold the drum when it is not moving (like park brakes).

There are two types of band-brake:

(1) Service brake (air actuated):

- Used during normal operation
- Braking torque increases as air pressure increases
- On skyline machines, the air pressure that is applied determines the torque at which the brake will slip (e.g., SWL of the skyline).

(2) Night brakes (spring-activated/maxis):

- Applied when not working or when the operator leaves the controls
- If the air system fails these brakes are automatically applied (safely).

Stabilisers

Hydraulic stabilisers are required on rubber-tyre-mounted haulers.

The primary functions of stabilisers are:

- Levelling the hauler to provide positive stability
- Allows the working ropes to spool evenly on the drums.

At the base of the stabiliser ram is a heavy plate referred to as a lily pad. The lily pad is a large-diameter plate that serves to spread the weight over a larger area. This prevents the stabilisers from sinking down into the ground and destabilising the machine. In most instances, heavy boards or logs are put under the lily pads to help transfer weight even further.

Stabiliser

Towers

Tower height

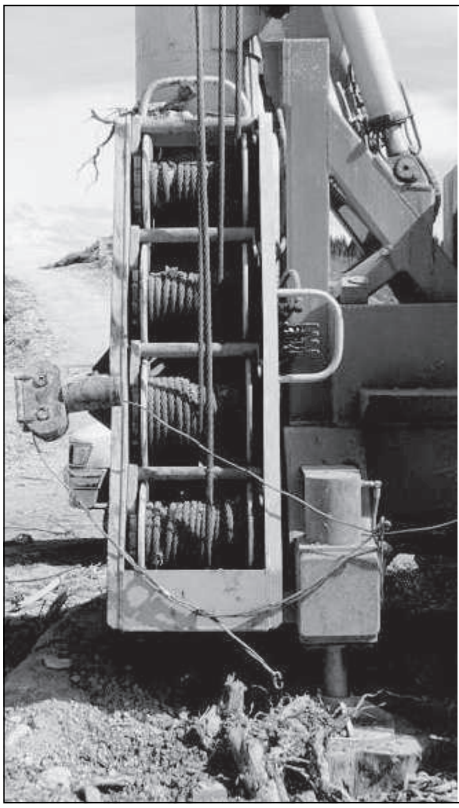
Tower height will influence:

- Available deflection/clearance along the extraction corridor
- Distance from tower to guyline anchors
- Highway transportation.
- Rigging options required for a given extraction corridor
- Landing size

Tower bases

Most tower bases are connected to the frame/carrier of the hauler. Some towers have been designed to be independent of the hauler during extraction operations. For example, the Berger Tele-tower is independent of its carrier and mounted in a ball and socket base. The ball and socket base eliminates stresses in the tower and carrier frame during inhaul.

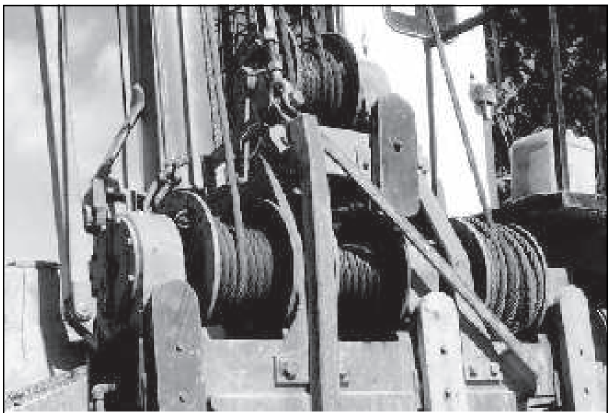
Guyline drums



Guyline drums mounted to the base of the tower

Guyline drums

Guyline drums house the guylines. They are mounted to the hauler in a variety of ways. On swing yarders and machines with leaning towers, the guy drums are usually mounted behind the tower. On vertical towers, the guy drums are usually mounted near the base of the tower.



Guyline drums mounted to the back of the tower

Fairlead

Fairleads

Fairleads are mounted on the top of the tower to permit a change in direction of a running line, as well as preventing the running line from jumping out of the sheave.

Carriers

Mobile haulers are self-propelled or require towing. Carriers are mounted on either rubber tyres or tracks.

Rubber-tyred (self-propelled)

Advantages:

- Fast to move long distances
- Some can use public roads
- The most mobile option
- Small skidder-mounted type can negotiate rough grades.

Disadvantages:

- High purchase cost
- Extra components for carrier drive-train
- Extra weight
- Generally require well-formed, suitable grades.

Rubber-tyred self-propelled carrier

Rubber-tyred (trailer-mounted)

Advantages:

- Cheap to construct
- Light to transport
- Fast to move long distances
- Some can use public roads.

Disadvantages:

- Larger fifth-wheel trailer-mounted haulers require a log truck or tractor unit to move them.

Rubber-tyred (trailer-mounted) carrier

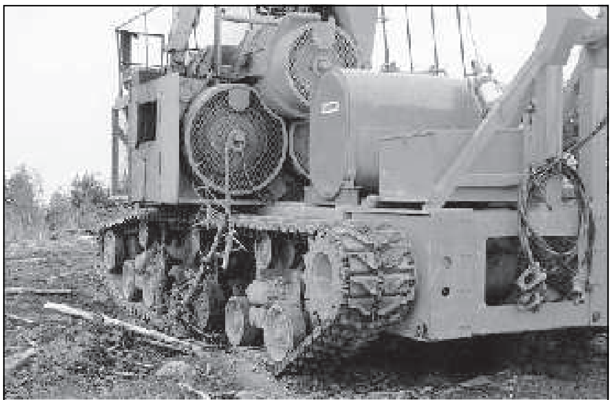
Track-mounted (self-propelled)

Advantages:

- Can manage steep/rough grade
- Stable on soft ground
- Very manoeuvrable
- Tank-type carriers can absorb some landing irregularities
- Excavator-type carriers are more robust mechanically.

Disadvantages:

- Tank-based carriers require extra care during shifts
- Limited self-propelled travel distance.



Track-mounted carrier

Sled-mounted (single drum)

Advantages:

- Small unit, easy to transport
- Can pull itself along by tying the winch rope to an anchor point, then engaging the winch to inhaul.

Disadvantages:

- Not a true mobile winch, requires a flat-bed truck to move from one setting to another
- Slow when propelling itself.

Sled-mounted Gantner hauler

Cab

Most haulers provide a cab to house the operator and controls. The hauler operator is seated in an elevated position allowing a clear view of the drums, ropes and the landing area.

Cab designs require attention to access, controls, and visibility.

Access

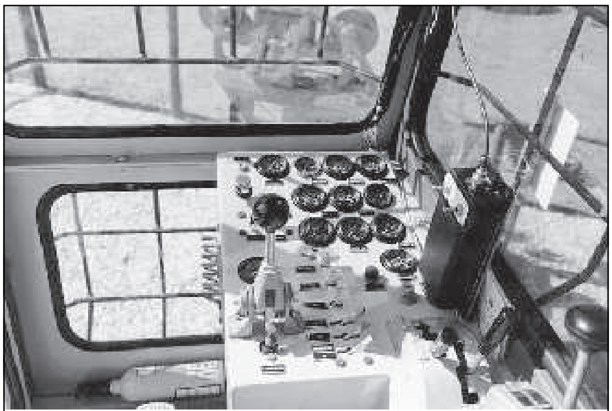
Either vertical ladder or easy staircase.

Controls

Modern controls are either dashboard type or split dash (modern swing yarders). Late model hauler cabs have all the luxury requirements, like air conditioning, heater, sound proofing, etc.

Visibility

Visibility is a major requirement. The operator must be able to see working components of the hauler so that immediate action can be taken in the event of a mishap. Being elevated increases safety, as it offers a wider field of vision so that the operator is aware when workers or machinery are entering the work zone.



Dashboard type

Split-dash type

Cab-less haulers

Some small haulers and Gantner/Wyssen-type winches have no cab. The controls are operated by standing beside the winch unit, or on a console with an umbilical cord attached to the hauler. This allows the operator to operate the machine from several metres away.

Some small winch units are remote-controlled, enabling the operator to be involved in other parts of the logging operation as well as operating the winch unit.

Accessories

Technological improvements have allowed cable loggers to use various types of equipment to improve the safety standards and operational efficiencies. The following is a list of modern accessories available to cable operations.

Accessory	Description
Tension monitor	Used as a safety and production device to monitor safe working tensions in skylines or guylines. Tension information can be utilised to help optimise drag sizes. There are two main types — cable deflection and sheave pin deflection.
Communication systems	Advances in radio designs have meant better communication between workers, improving safety and production.
Self-releasing chokers	Mechanical and electronic self-releasing chokers are available to reduce cycle times. They are usually slower to set than conventional chokers. However, the reduction in unhook time compensates for this.

Carriages

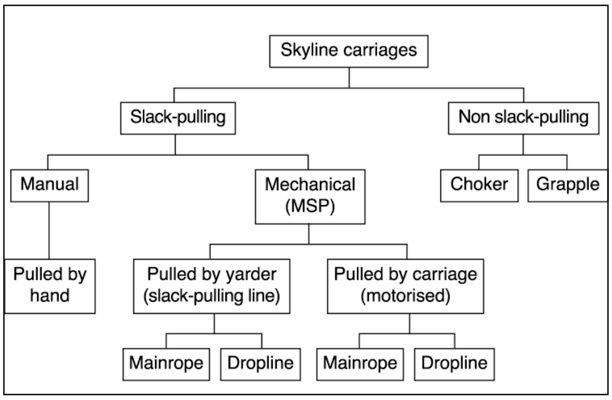
Types of carriages

A carriage is a load-bearing device that travels on sheaves along the skyline or tailrope.

Some carriages, like the basic carriages, haven't changed from when they were first used in skyline operations.

However, the need to pull wood from fewer skyline positions led to the development of mechanical slackpulling (MSP) carriages. These have since been refined and superseded by the motorised versions that are available today.

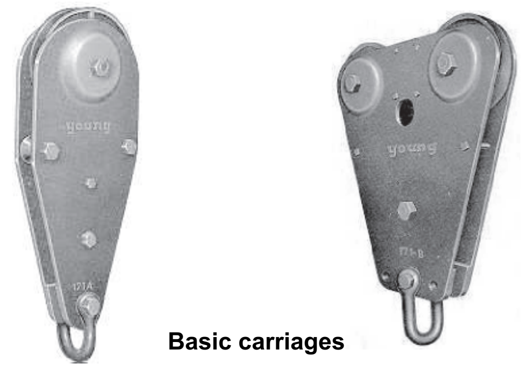
Carriages can be categorised as per diagram at right.



Basic carriages

Basic carriages comprise two side plates housing one or more sheaves.

One- and two-sheave carriages can be used for skyline systems such as Northbend, slackline, and running skyline systems. With the addition of a third sheave, the carriage can be used for Southbend and Block-in-the-bight systems.



Basic carriages

Shotgun carriages

Basic carriages can be used in the shotgun system if of suitable weight. However, specially designed shotgun carriages have been developed to improve carriage performance.

These carriages are more streamlined than basic carriages, with a lower centre of gravity to minimise the risk of the carriage up-ending. Additional steel plates or lead-filled compartments may be attached to gain more momentum during the outhaul. Strops are attached directly to the carriage.

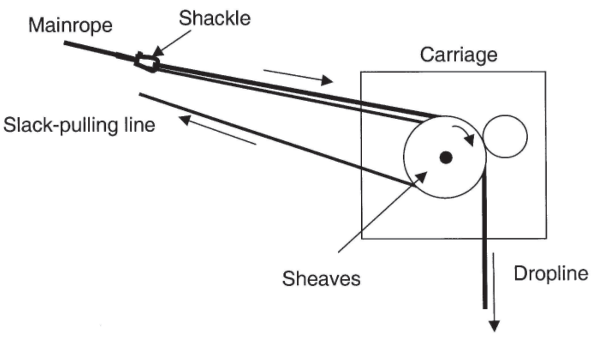
Shotgun carriage

Slack-pulling carriages

The two main types of types of slack-pulling carriages are as follows:

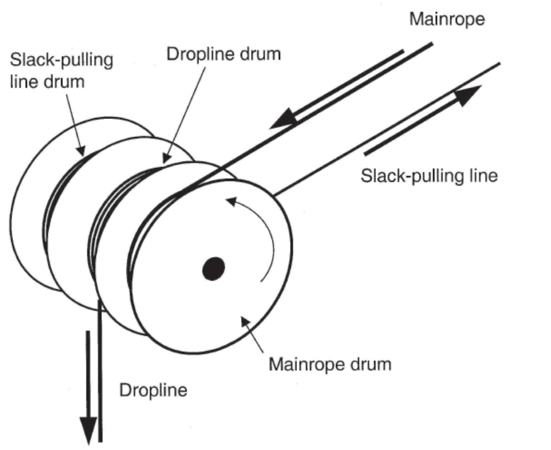
- Manual
- Mechanical slack-pulling (MSP)
  - Mainrope pulled by the hauler
  - Carriage dropline operated by hauler
  - Mainrope pulled by motorised carriage
  - Dropline operated by motorised carriage

They all provide mainrope or dropline slack to the breaker-outs which can eliminate the need for lowering the skyline. By pulling slack either side of the skyline position, wider corridors can be extracted, reducing the number of lineshifts needed.

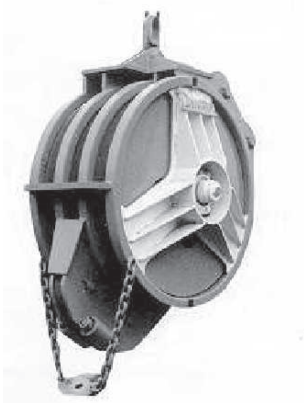


MSP carriage reeving

A Danebo MSP carriage



Dropline carriage drums



A Danebo dropline carriage

Manual slack-pulling carriages

These carriages must be operated with light mainrope (e.g., 12 mm) so that it can be pulled manually. Alternatively, where the chord slope exceeds 20% heavier ropes can be fed by gravity.

They work best on relatively even slopes, where mainrope slack is pulled downhill of the carriage. In broken terrain, the mainrope may sag into the gullies and the belly can be too heavy to pull out.

Usually a heavy hook is attached to the end of the mainrope to get the strops down to the breaker-outs.

MSP carriages - Mainrope pulled by the hauler

These carriages contain two internal sheaves connected to a common shaft. The slack-pulling line is under-wound through one of these sheaves. It is then connected to the mainrope using a shackle or shay swivel. When the slack-pulling line is pulled, the mainrope or dropline is fed through the carriage over the second sheave. Reversing the process raises the drag to the carriage.

The length of slack that can be pulled depends on where the shackle or swivel is connected.

The carriage travels on the skyline or tailrope on a single rider block or skyline "truck". During carriage outhaul, the slack-pulling line and mainrope are released. Once positioned, the carriage is held in place using the tailrope or skyline stop.

MSP carriages - Carriage dropline operated by the hauler

This carriage has three drums, one each containing mainrope, dropline, and slack-pulling line. The mainrope is over-wound on one drum, while the slack-pulling line is under-wound on another. Between these two drums is the third containing the dropline that is over-wound. By pulling on the slack-pulling line and releasing the mainrope, the dropline is lowered. Reversing the process lifts the strops back to the carriage.

These carriages require a skyline-capable hauler, with four working drums. The lateral hauling capacity of these carriages allows for wide haul roads and fewer lineshifts than a non-slack-pulling carriage.

MSP carriages - Mainrope pulled by motorised carriage

The motorised MSP carriage comprises skyline and mainrope clamps and a set of motorised slack-pulling sheaves.

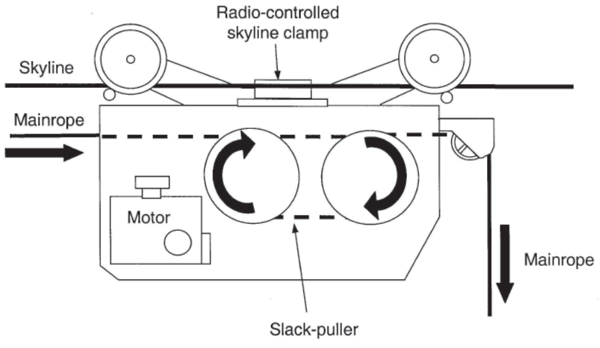
In use, the mainrope is clamped during outhaul. The carriage is either pulled out by the tailrope or by gravity-return (no tailrope). Once the carriage is positioned it is clamped to the skyline. The mainrope clamp is released and the carriage pulls the mainrope off the hauler drum and lowers it to the ground. The mainrope drum on the hauler powers break-out and inhaul. The skyline clamp remains activated until the drag is lifted to the carriage. The mainrope clamp is then activated, the skyline clamp released, and the carriage is inhauled by the mainrope.

The ability to clamp the carriage to the skyline enables the break-out angle to be controlled. The length of the mainrope, and the distance from the carriage to the hauler dictates the lateral hauling distance. The tailrope may be connected to the carriage or to the butt-rigging, which can assist the pulling of mainrope slack uphill of the carriage.

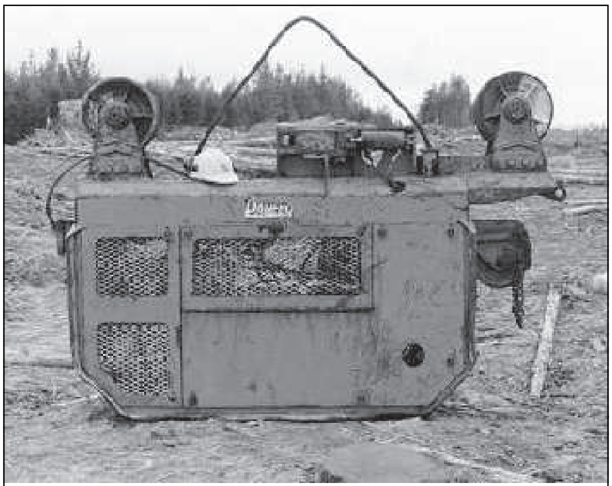
Motorised MSP carriages can be fitted with single-sided skyline sheaves, which allows the carriage to pass an intermediate support jack.

Skyline and mainrope wear may be accelerated through clamp use.

Motorised MSP carriages are expensive and sophisticated. They are not suited to rough use and can suffer significant damage when dropped.



Motorised carriage components



Danebo motorised carriage

MSP carriages — Dropline powered by the motorised carriage

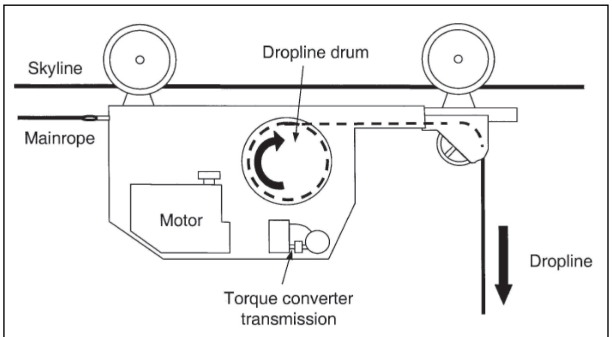
These carriages are commonly termed skycar carriages. They travel on a skyline and have their own radio-controlled motorised dropline (up to 300 m in length).

The dropline is operated by the breaker-outs during lowering of the rigging, hook-on and break-out. The hauler operator takes control of carriage operation when it is near or at the landing.

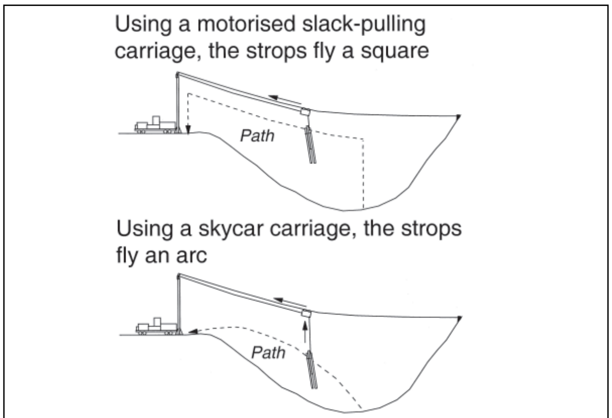
The dropline is of smaller diameter than the mainrope. This makes rope handling easier than for mainrope systems and can contribute to quick hook-on times. The motor is large enough to power slack and inhaul the drag to the carriage.

The dropline can be operated while the carriage is moving on the skyline. This allows the strops to fly an arc rather than a square, as with the other types of MSP carriage (where either the skyline or mainrope clamp must be engaged at all times). This results in quick cycle times.

Skycar carriages can be used on haulers with two or three working drums (limited to gravity-return on a 2-drum hauler). Where gravity-return is being used, two groups of breaker-outs can be used to pre-strop drags from different portions of the span. The strops are connected to the end of the dropline using a bull (butt) hook.

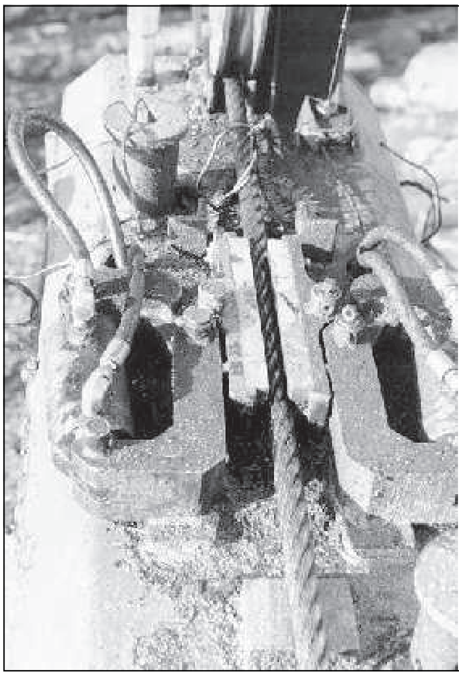


Skycar carriage components

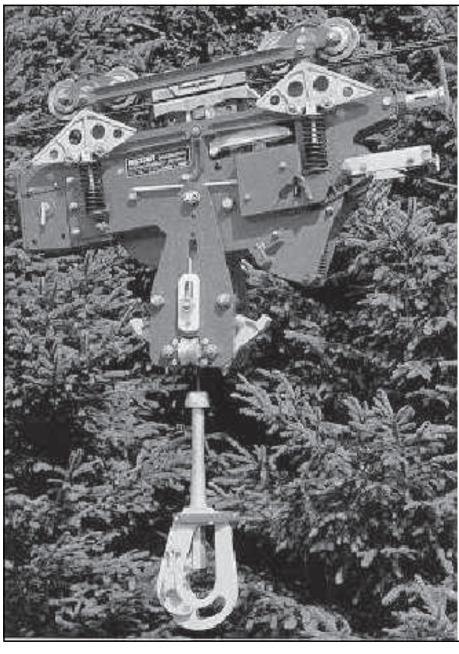


Strop flight paths

A Bowman skycar carriage



A skyline clamp



A Wyssen clamping carriage

Some skycar carriages are fitted with a skyline clamp. These are most often used to hold the carriage in position in uphill cable thinning operations.

Skycar carriages suit terrain with good deflection (8–10%). With carriage weight up to six tonnes, optimum payloads can be significantly reduced if less deflection is available. They are suited to deep gullies, where considerable time is spent lowering the rigging to the breaker-outs. To avoid damaging the dropline drum, the rigging can be lowered into deep gullies by lowering the skyline while lowering the dropline.

Although not designed for bridling, butt-rigging and the tailrope can be connected to the dropline for lateral hauling.

Motorised MSP carriages are expensive and sophisticated. They are not suited to ground contact and may require additional preventative maintenance to ensure trouble-free operation.

Clamping carriages

Many of the carriages previously mentioned can be fitted with a skyline clamp. This holds the carriage in position during lowering of the rigging, hook-on, and break-out. This allows better control over break-out direction and enables drags to be pulled directly to the carriage. The use of a clamp may eliminate the need for a tailrope when uphill logging.

It is important to recognise that clamping the carriage can cause unequal skyline tensions on either side of the clamp. If not recognised, the skyline can fail through overloading as the clamp is released (*see* **Clamping Carriage Position and Skyline Tensions**, page 52).

There are three types of clamp:

The **time trigger** works when the carriage is halted for a pre-determined time, the skyline clamp is engaged and the fall-block lowered. A small pump, driven by a friction sheave in a hydraulic accumulator, generates the hydraulic pressure required to activate the clamp. When the fall-block is returned to its holder on the carriage, the skyline clamp is released and the carriage is free to travel.

The **carriage reverse trigger** is similar to the time trigger, except the carriage is made to travel a pre-determined distance (commonly 1–4 m) past the intended clamping point. A mechanical winding device triggers the hydraulic clamp after it has reversed the necessary distance and the fall-block is released.

The **radio-controlled** carriage has a small internal friction roller, driven from the skyline. This generates oil pressure that is stored in hydraulic accumulators. The radio-control swaps the valve setting, which means either the skyline or the mainrope is clamped.

Self-propelled carriages

There are two types of system in which self-propelled carriages are used.

In the first system, the carriage requires only a standing skyline to operate. The skyline is spooled around a powered double roller. The carriage powers itself along the skyline. This reduces the skyline's working life.

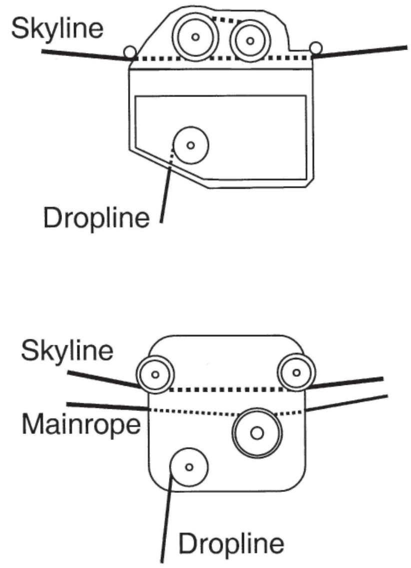
The second system requires a skyline and a mainrope. The carriage is suspended from the skyline like a conventional system. It drives itself on the mainrope in the same fashion as the system above. With this method, a smaller diameter mainrope is used which reduces damage from the rollers.

Grapple carriages

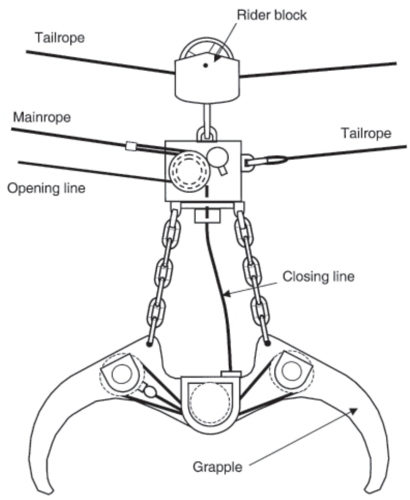
A grapple carriage comprises hinged jaws operated by the mainrope and opening line (same as the slackpulling line used for MSP carriages). They require three operating ropes to function, and are usually used in swing yarder operations.

Because of the position of the chains on the grapple jaws, the grapple falls open when the mainrope is slackened and the opening line tensioned. Once positioned on a stem, reversing the process closes the grapple.

The grapple carriage is heavily built, weighing approximately 1 tonne, to withstand the rigours of operation. The short-length of closing line can wear quickly and may need replacement every 1 or 2 days.



Two types of self-propelled carriages: skyline only (top) and skyline + mainrope (bottom)



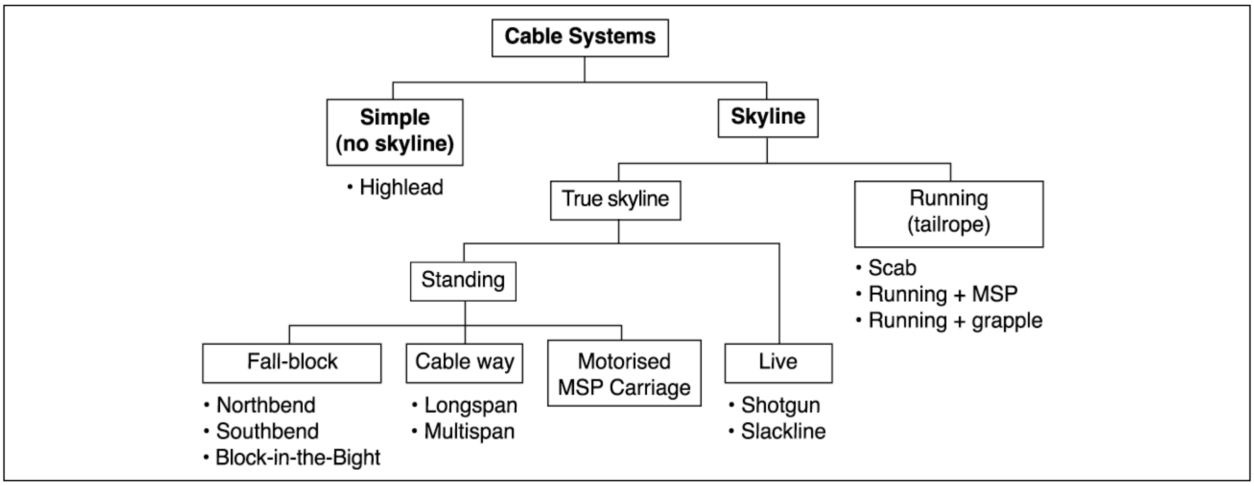
Grapple carriage components

Johnson grapple carriage

Cable logging systems

Types of system

Cable systems can be categorised as follows:

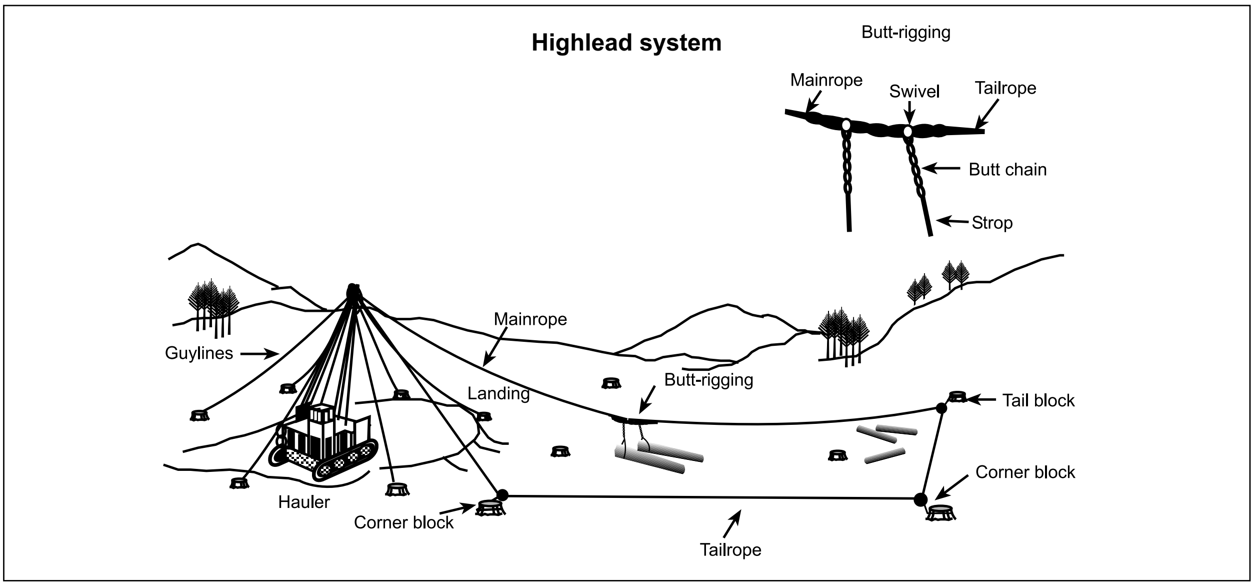


Highlead system

The highlead system is the most simple cable system. It requires a two-drum hauler rigged with a mainrope and tailrope. Strops are connected to the butt-rigging.

The highlead system provides the least amount of drag suspension of any system. Partial suspension can be achieved by *tightlining*, where the tailrope brake is applied during inhaul. This is not an ideal way to achieve suspension, as considerable hauler power is required to overcome the braking. Also, there is a risk of over-heating the tailrope brake.

Generally, the drag is ground lead. Ideally this requires a clear line of sight from the drag to the top of the tower. If there is an intermediate ridge, the highlead system tends to try to pull through the ridge. This can result in a fouled drag and/or increased soil disturbance. Many of the older two-drum haulers have high-powered motors to help overcome this.



The highlead system is suitable for:

- Logging uphill, level, or moderate downhill slopes
- Short haul distances
- Sites with even or rounded slopes that reduce the chance of the drag fouling during inhaul
- Sites with resilient soils.

The width of the extraction corridor depends on the length of the strops attached to the butt-rigging

Advantages:

- Quick to rig and effect lineshifts
- Relatively inexpensive two-drum hauler can be used
- Can be used for uphill and downhill extraction.
- Some degree of drag suspension is achievable
- System can be quickly changed to Scab skyline by the addition of a rider block

Disadvantages:

- Relatively high power input required
- Extraction corridor width limited by length of the strops
- Larger strops (often chains) and rigging are required to withstand shock loads
- Effective haul distance limited by ground shape
- Drag suspension is limited by pulling and braking power
- Soil damage during downhill hauling can direct water runoff to one point at the landing.

Standing skyline systems

There are three main types of standing skyline system:

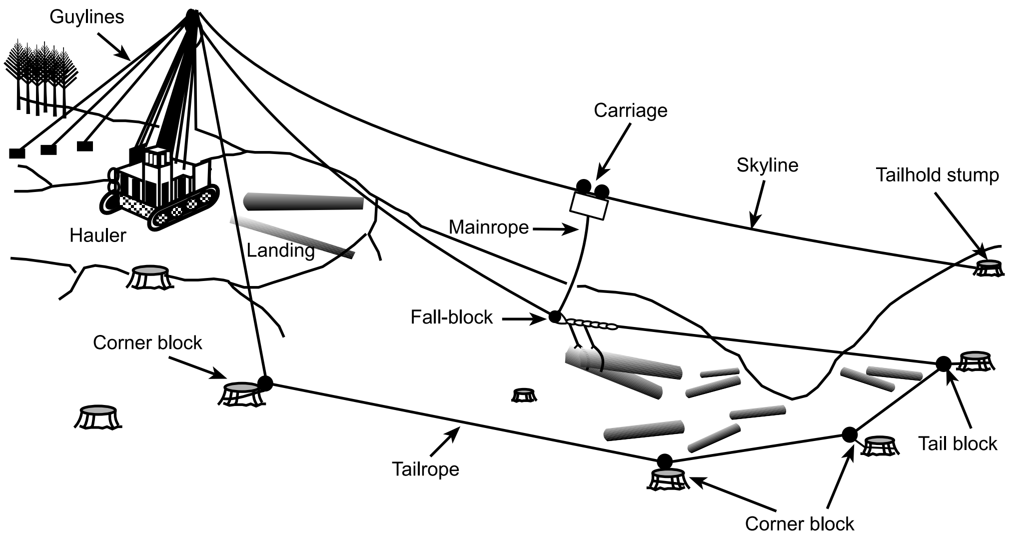
- Fall-block systems
    - Northbend
    - Southbend
    - Block-in-the-bight.
- Cable way systems
- Motorised slack-pulling carriage systems.

Northbend

This is the most simple fall-block system. The mainrope goes through the fall-block from the tower, and then up to the carriage (often a 1- or 2-sheave basic carriage).

Lift is generated by the purchase on the fall-block. As the mainrope is pulled in, the fall-block swings up and towards the hauler. It is often difficult to get the fall-block right up to the carriage without overly-braking the tailrope drum.

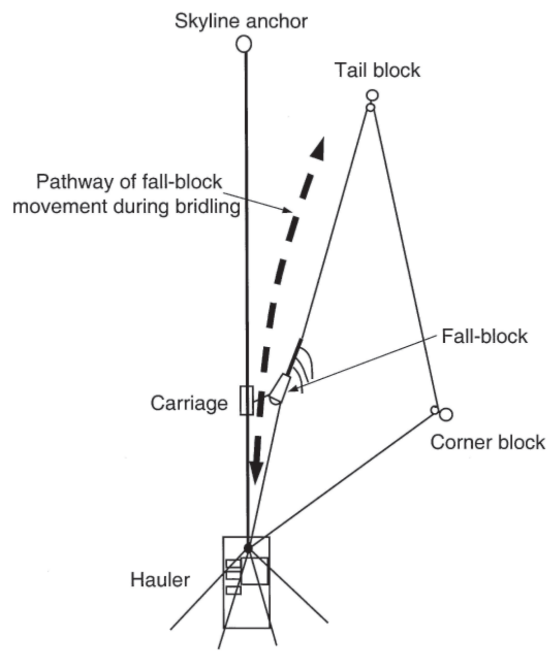
The reverse occurs when lowering the fall-block. The fall-block falls through an arc towards the tailhold.



Northbend system

This can make spotting the rigging more difficult (the carriage must be stopped some distance before the proposed hook-on point).

The width of the extraction corridor depends on the position of the tail block relative to the skyline. Placing the tail block to one side of the skyline (*bridling*) allows the fall-block to be pulled out sideways from beneath the skyline during outhaul. This allows the extraction corridors to be wider (particularly at the back-end of the corridor) and reduces the number of lineshifts. Bridling can also be used to access trees that are located behind an obstruction and not in clear view of the hauler.



Fall-block movement when bridling

Generally, the northbend system is suitable for:

- Clearfell, and transporting logs in a 2-staging system
- Partial/full suspension of the drag
- Bridling.
- Logging uphill, on level ground, and over long haul distances
- Providing good control of the drag movement

Advantages:

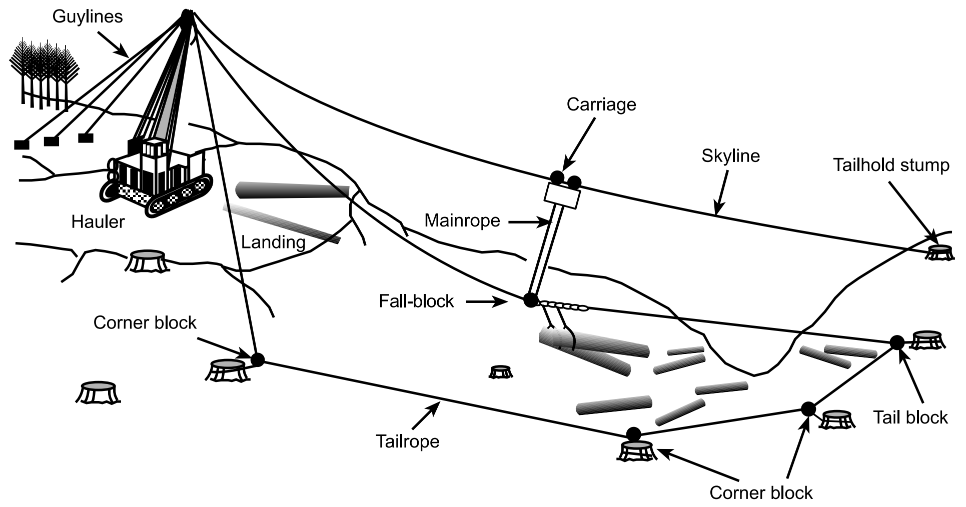
- Partial/total suspension of drag is possible, reducing log damage and soil disturbance
- Results in less rope wear than the other fall-block systems (they have an extra sheave)
- Bridling is possible (which may reduce the number of skyline shifts per unit volume extracted)
- Greater control over drag movement.

Disadvantages:

- One of the slowest systems in terms of cycle time:
  - Can be difficult for breaker-outs to spot butt rigging
  - Often slow to unhook drag at landing
  - Takes time to rig up and to shift tailholds and block anchors.
- Can result in a significant bight area, hence increased hazards
- It is easy to overload the skyline as the fall-block forms a block purchase
- The fall-block and carriage tends to move away from the tower when the drag is lowered at the landing. This can result in the drag sliding off the front of the landing. This can be avoided by allowing adequate space in front of the hauler, or attaching a tagline to the carriage to hold the carriage during lowering of the fall-block.
- Good deflection (8–10%) is required to extract large loads without overloading

Southbend

The southbend is similar to the northbend. However, the mainrope passes through a sheave on the carriage and is connected to the fall-block. This provides greater upward lift on the drag during break-out and initial inhaul.



Southbend system

As with the northbend system, the width of the extraction corridor can be increased by bridling.

The southbend system is generally suited to:

- Clearfell
- Providing good control of the drag movement
- Logging uphill/moderate downhill slopes, and over long haul distances
- Partial/full suspension of the drag
- Bridling

Advantages:

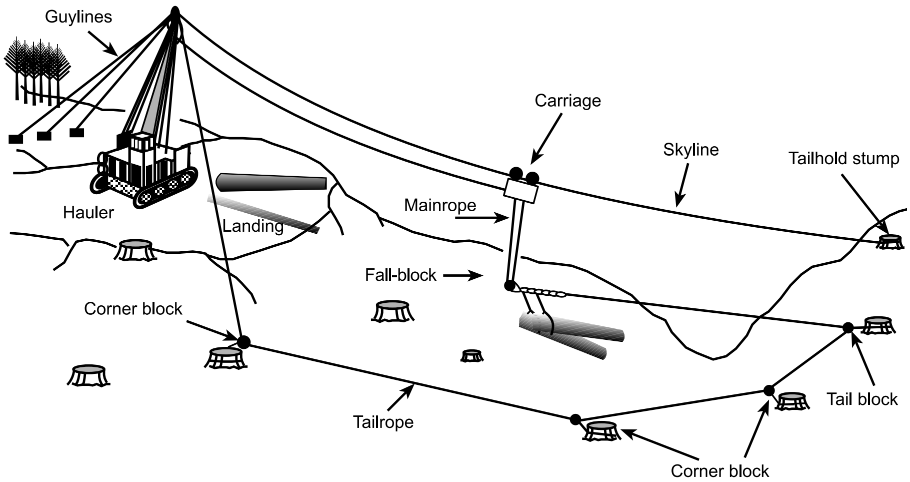
- Partial/total suspension of drag is possible, reducing stem breakage and soil disturbance
- Bridling is possible
- Compared to northbend system:
  - Extra block purchase provides more vertical lift to the drag
  - Less tail-rope tension is needed to generate lift
  - It is easier for breaker-outs to spot butt-rigging as it tends to come down more vertical
  - It is easier to keep the load within the hauling radius.
- Greater control over drag movement, particularly at break-out

Disadvantages:

- One of the slower systems in terms of cycle time
- Compared to northbend system:
  - Increased skyline tension during breaking-out means it is easier to overload the skyline.
  - However, mainrope tension is reduced.
  - Mainrope may wrap between fall-block and carriage
  - Slower raising and lowering of rigging for break-out and at the landing
  - More mainrope is needed for extra purchases
  - Increased mainrope wear due to extra sheave
  - A heavier fall-block is needed to get the rigging to drop
  - Increased rigging time.
- Good deflection (8–10%) is required to extract large loads without overloading.
- Up to 10% deflection required

Block-in-the-bight

This system differs from the northbend and southbend systems. The mainrope passes through a sheave on the skyline carriage, before passing through the fall-block and connecting back to the carriage.



Block-in-the-bight system

The block-in-the-bight systems works well when vertical lift is required (e.g., out of a steep gully).

This system is suited to bridling, particularly when the drag must be pulled from behind an obstacle during break-out and initial inhaul.

The block-in-the-bight system is generally suited to:

- Clearfell
- Logging uphill or downhill slopes, and over long haul distances
- Providing good control of the drag movement
- Partial/full suspension of the drag
- Landings where it is difficult to slack strops without the drag slipping off the landing

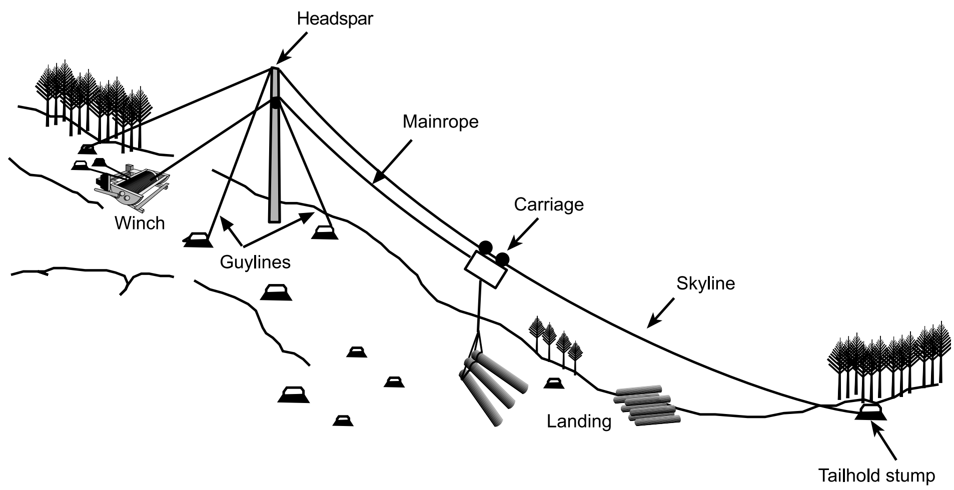
Advantages:

- Partial/total suspension of drag is possible, reducing stem breakage and soil disturbance
- Best system for bridling:
  - Fall-block travels more at right angles to skyline
  - Easy to get slack in strops on landing.
  - Less hang-ups as mainrope goes directly from the hauler to carriage
- Greater control over drag movement
- Compared to northbend system:
  - Extra block purchase provides more vertical lift to the drag
  - It is easier for breaker-outs to spot butt-rigging.
  - Less tailrope tension is needed to generate lift
- Low binding/abrasion of mainrope on terrain minimises site degradation

Disadvantages:

- Takes time to rig up and to shift tailholds and block anchors.
- Compared to northbend system:
  - Increased skyline tension during breaking-out means it is easier to overload the skyline. However, mainrope tension is reduced.
  - Mainrope may wrap between tower carriage (around skyline), and fall-block/carriage
  - Can get excessive twisting of the mainrope between the fall-block and carriage when bridling long distances
  - More mainrope is needed for extra purchases
  - Increased mainrope wear due to extra sheave
  - A heavier fall-block is needed to get the rigging to drop
  - Slow raising and lowering of rigging for break-out and at the landing.
- Good deflection (8–10%) is required to extract large loads without overloading.

Longspan and multispan cableways



Longspan cableway system

European longspan or multispan cableway systems use a standing skyline to extract stems or transport logs from steep inaccessible slopes. They are two-line systems that depend on gravity for operation. The mainrope winch is located at the top of the span, whether hauling uphill or downhill. The winch is designed to pull itself up the hill with its mainrope.

The skyline is separate from the winch unit. The skyline is elevated using a block (or shoe) in a headspar and tailspar. The skyline is anchored at both ends, and is not easily adjusted.

If a multispan system is used, an intermediate support tree is rigged with a support jack, which allows the carriage to pass the support.

The mainrope may pass over a block in the headspar before connecting to carriage. Alternatively, it may be connected directly to the carriage.

A manual slack-pulling carriage is often used. Typically such a carriage has a self-energised skyline clamp, and is fitted with 2-4 skyline sheaves. These sheaves are open-sided to pass over intermediate support jacks if required.

The mainrope is automatically released when the carriage is clamped. This lowers the terminal hook and allows the breaker-outs to pull slack.

Over long spans, a squirrel block may be attached to the mainrope to keep the belly out of the mainrope and facilitate easier manual slack-pulling.

These systems are used predominantly for downhill operations over long distances (600-1200 m). The winch unspools the mainrope as the load travels downhill using gravity. The downhill speed is controlled by the winch air brake.

Full suspension is required over most of the span for downhill operations, although it is common to see the load make ground contact at critical points.

If a multispan skyline system is used, the hauler must slow down the load with the air brake to cross intermediate supports safely.

When hauling uphill, the hauler pulls the load against gravity and without need of the air brake. The drum brake on the winch is sufficient to control the carriage velocity during gravity outhaul.

Advantages:

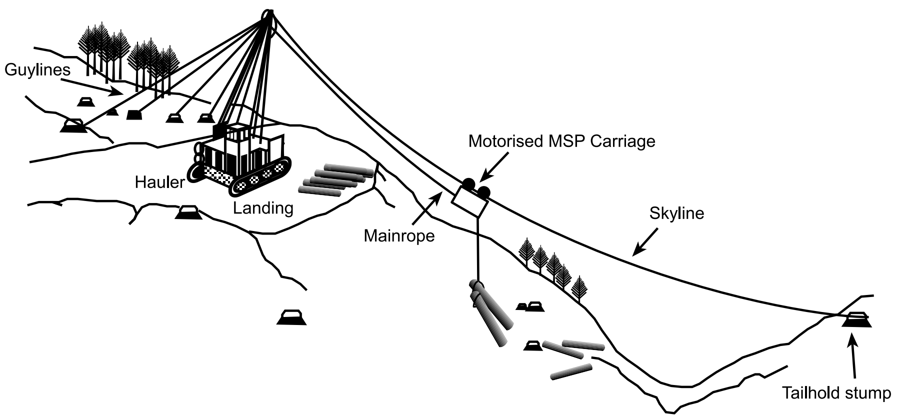
- Reduced need for roads and landings as the winch unit can pull itself up to the top of the span
- Full suspension reduces site disturbance
- Lower initial investment than larger self-propelled, integral haulers
- Smaller crew size, ranging between two and six people.

Disadvantages

- Production rates are much lower than typical hauler systems (generally less than 100 tonnes per day)
  - Longer set-up time due to rigging practices; new skyline roads can take up to 5 days to rig, and involve the whole crew
  - Not suited to stem-length logging because of increased ground contact and slower downhill travel — works best in log-length operations
  - Difficult to pull slack over long distances
  - It can be difficult to assess the skyline tensions as the operator cannot “feel” the skyline response
  - Complex carriage with many moving parts and not resilient to dropping or rough treatment.

Standing skyline with motorised slack-pulling carriage (MSP)

A standing skyline system may be used with a motorised MSP carriage or a skycar carriage. In both cases, the carriage travels on the skyline. If rigged, the tailrope can be fitted to the back of the carriage, or to the trailing end of the butt-rigging for bridling.



Standing skyline system

When uphill logging, outhaul can be achieved by gravity-return. This eliminates the need for the tailrope to be rigged.

The strops are lowered to the ground by pulling the mainrope off the hauler (motorised MSP) or lowering the dropline (skycar).

Lowering or raising the skyline during the cycle is not required for these carriages. However, adjusting the skyline height while activating the MSP carriage can increase lowering and raising speeds. This can also reduce the stress on the internal dropline drum within a skycar.

Advantages:

- The use of gravity return means:
  - ¤ A tailrope is not required if the chord slope exceeds 20%
  - ¤ Pre-stropping can be used.
  - ¤ There is no tailrope bight, which makes it safer for the breaker-outs
- Slack-pulling capacity allows wider corridors to be pulled
- Full or partial suspension is achievable
- The skyline can be located in the best position to maximise deflection. The drags are then pulled to the skyline
- The angle of break-out can be controlled, particularly if using a clamping MSP carriage
- Less soil disturbance as drag is lifted up to the carriage
- Reduced stem breakage during break-out
- The drag can be dropped vertically on to the landing, without the carriage moving away from the hauler
- Skyline height can be altered during the cycle to increase efficiency
- Can be used effectively for clearfell and production thinning operations.

Disadvantages:

- The skyline anchor must be of adequate strength to withstand a greater period or volume of use
- Uneven skyline tensions either side of a clamping carriage can result in over-loading and premature failure of the skyline
- Motorised MSP and skycar carriages are expensive and sophisticated. Rough treatment (including ground contact) can result in mechanical failure, with associated down-time.

Live skyline systems

Live skyline systems require the skyline to be lowered and raised for each cycle. The skyline is lowered to lower the strops to the breaker-outs. The skyline is later raised to provide lift to the drag during break-out and inhaul.

Shotgun system

The term "shotgun" is often mis-used to refer to gravity return systems using a slack-pulling carriage. These are in fact gravity-return, standing skyline systems.

The shotgun system requires a two-drum hauler, fitted with a skyline and mainrope. The mainrope and strops are attached directly to the carriage.

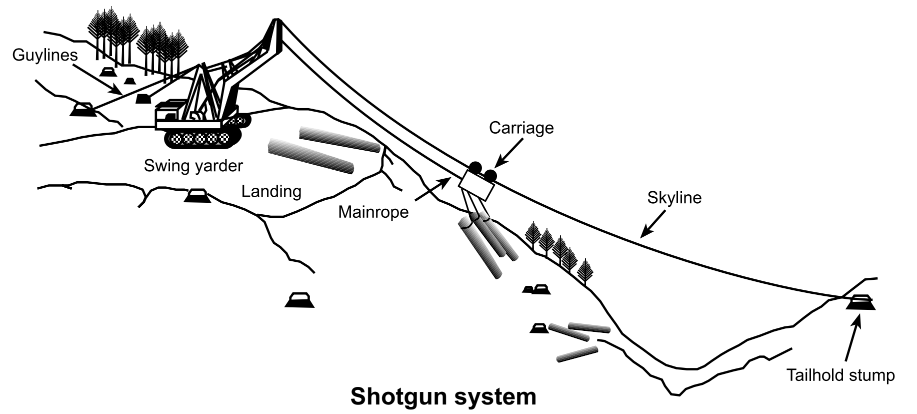
The mainrope drum brake controls carriage outhaul.

Lowering the skyline lowers the strops to the ground. The length of the strops limits the corridor width, and results in more lineshifts than most other skyline systems. This may be avoided by using a dutchman block to pull a bight in the skyline during outhaul.

Breaking-out of the drag is achieved through raising the skyline and inhauling the mainrope.

The shotgun system is generally suited to:

- Clearfell extraction from the front face (below the landing)
- On level/downhill slopes.
- Situations where deflection is less than 8% and a chord slope greater than 20%



Shotgun system

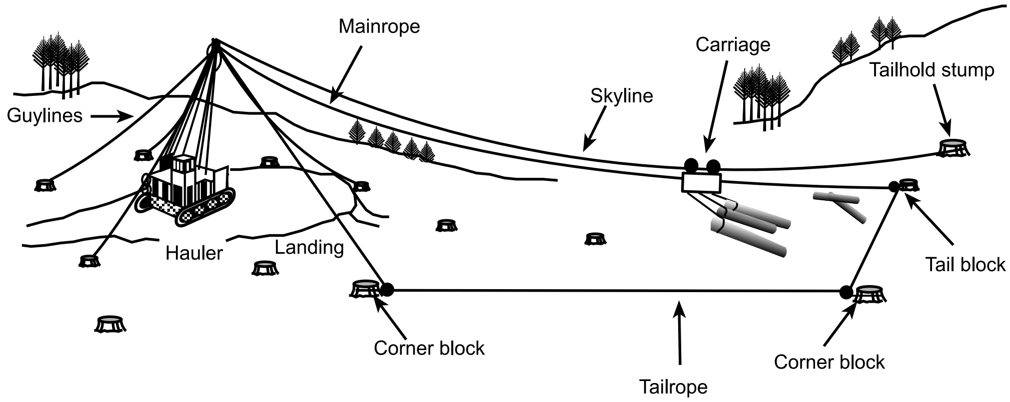
Advantages:

- Fast to rig up (can be quickly interchanged with the slackline system)
- Partial/total suspension of drag is possible
- Gravity outhaul promotes:
  - Fast cycle times
  - Reduced fuel consumption.
- A tailrope is not required. Having no tailrope bight reduces hazards for the breaker-outs

Disadvantages:

- Gravity return restricts use to uphill hauling
- Chord slopes greater than 20% (11°) are required for this system to work at its best
- Extraction corridor width may be restricted
- Can be difficult to hold the carriage past mid-span on a convex slope

Slackline system



Slackline system

The slackline system is similar to the shotgun system but requires an additional hauler drum containing tailrope. The tailrope is connected directly to the rear of the carriage.

A lighter (two-sheave basic) carriage can be used, as outhaul is achieved by pulling in the tailrope.

This slackline system works well for downhill and cross-slope hauling, where there is inadequate clearance to use a fall-block system.

The strop length limits the corridor width. A slightly wider corridor may be created using a dutchman block, as for the shotgun system. Alternatively, the tail block may be located to one side of the skyline.

Advantages:

- Can be quickly interchanged with the shotgun system (if a tailrope is available)
- Can be used where clearance is limited
- Less tension in tailrope as skyline supports both carriage and drag
- Good control over drag movement, especially for downhill hauling
- Partial/total suspension of drag is possible
- Easy for breaker-outs to spot carriage and strops.

Disadvantages:

- Large hauler usually required
- Limited capacity for lateral hauling, resulting in frequent line shifts
- Good deflection required to achieve large optimum payload
- Compared to northbend system:
  - slow raising and lowering of rigging for break-out and at landing.

Running skyline systems

In the running skyline system, the carriage or rider block travels on, and is supported by the tailrope.

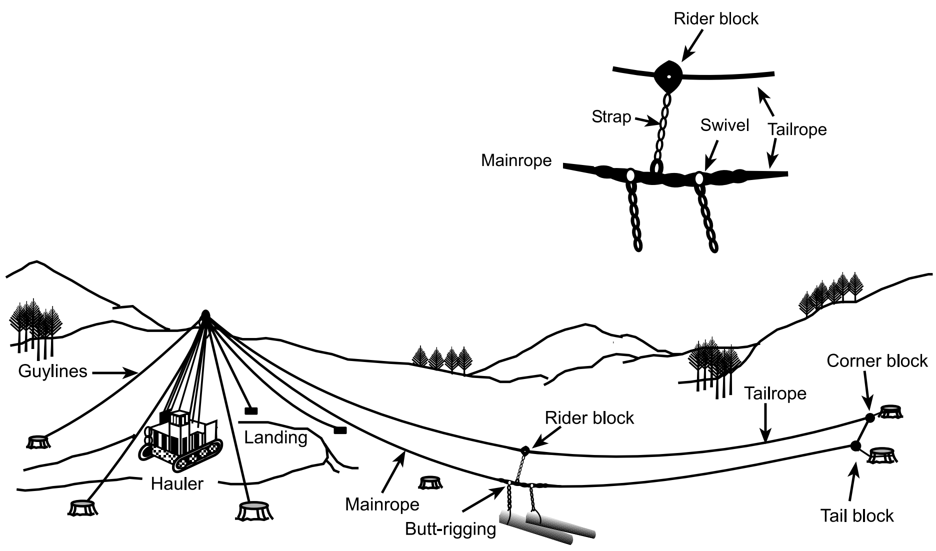
Scab skyline

The scab skyline requires two hauler drums, fitted with mainrope and tailrope.

The mainrope is connected to the leading end of the butt-rigging. The tailrope is connected to the trailing end. A rider block is connected to the butt-rigging, and rides on the tailrope between the tower and corner block. The rider block is separated from the butt-rigging using a spreader chain. The strops are attached to the butt-rigging.

The hauler may or may not be fitted with interlocking drums. If there is no interlock, lift is provided by braking the tailrope against the mainrope. The use of an interlock system provides the following benefits:

- More fuel/energy efficiency
- Less rope and brake wear



Scab skyline system

This system is suited to:

- Logging uphill, level, or downhill slopes
- Situations that need good control of drag movement, particularly when downhill hauling.
- Clearfell extraction over short/medium distances
- Partial suspension of the drag

Advantages:

- Simple and inexpensive rigging
- Can be quickly interchanged with the highlead system
- Two ropes support the load
- Partial suspension of drag is possible
- Compared to highlead:
  - Greater control over drag movement prevents tailrope overrun when hauling downhill
  - Larger payloads can be carried
  - More fuel efficient
  - Less stem breakage during break-out and inhaul
  - Less tensions on the ropes for the same payload
  - Can reduce ground disturbance.

Disadvantages:

- Hauler must have heavy-duty air or water-cooled drum brakes to brake the tailrope if drums are not interlocked
- Increased rope wear caused by abrasive line wrap
- Extraction corridor width is limited by strop lengths, leading to frequent line shifts
- A good deflection (8–10%) is required for large optimum loads.

Running skyline systems with a MSP carriage

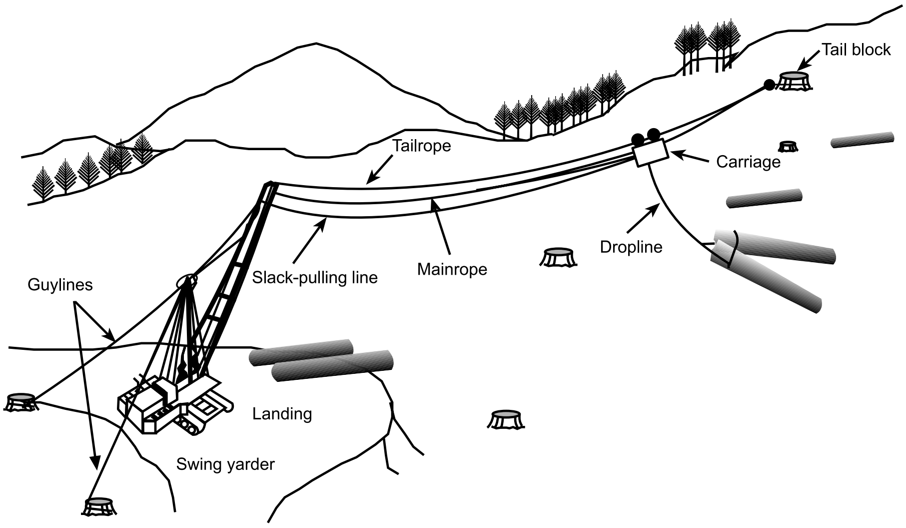
These systems work best on haulers with interlocked winch drum sets (generally swing yarders).

The tailrope is rigged through at least one corner block and a tail block, before connecting to the back of the MSP carriage.

The rigging of the mainrope will differ slightly according to the type of MSP carriage used. They all have in common the fact that they are operated by the hauler slack-pulling line. The carriage types include those that pull mainrope slack off the hauler, and those which have an internal dropline drum.

The extraction corridor width is determined by:

- The length of the mainrope or dropline between the point where the slack-pulling line is attached and the strops *or*
- The length of dropline on the carriage drum.



Running skyline with MSP carriage

Generally, this system suits:

- Landings with limited room in front of the hauler (drags are lowered vertically)
- Partial/full suspension of the drag
- Situations that need good control of drag movement
- Logging uphill, level, or downhill slopes, over short/medium distances
- Clearfell and production thinning operations

Advantages:

- Relatively safe system:
  - There is only a small tailrope bight area
  - Strops can be pre-set safely.
- Short tower, and fast hauler/swing yarder shifts as towers need three (not eight) guylines
- Light rigging can be used (with interlock)
- Lateral hauling is possible
- Partial/total suspension of drag is possible.

Disadvantages:

- Large (more expensive) hauler/swing yarder usually required
- Increased rope wear caused by:
  - Abrasive line wrap
  - Twisting of the dropline and slack-pulling line.
  - Rider block wear on the tailrope
- A good deflection (8–10%) is required for large optimum loads

Running skyline with a mechanical grapple

As with the MSP system, this system works best on haulers with interlocked winch drum sets (generally a swing yarder). The hauler must have three working drums fitted with a tailrope, mainrope, and opening line.

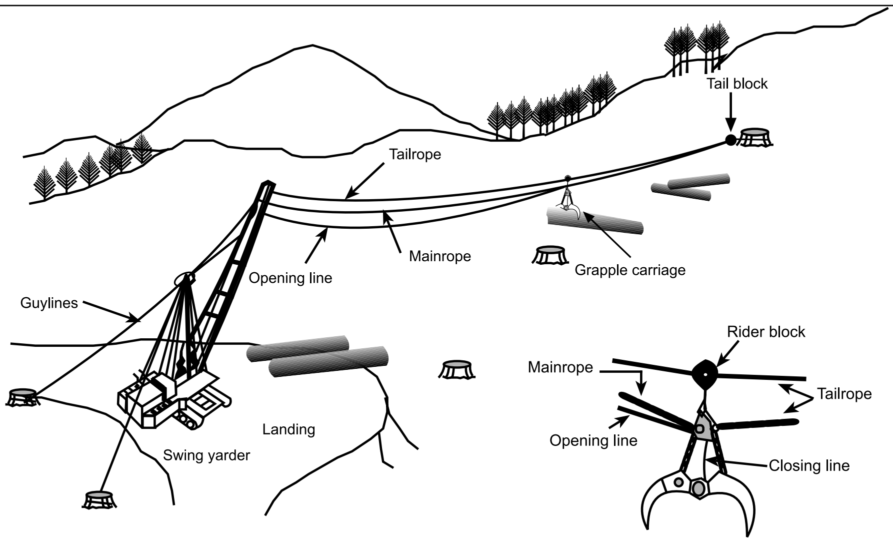
A rider block is attached to the top of the grapple by a short section of chain and shackle. The rider block travels on the tailrope and provides lift for the grapple.

By pulling the mainrope and slackening the opening line, the grapple closes on the drag. The drag is inhauled by pulling in on the mainrope and opening, while releasing the tailrope. The grapple is able to fall open by pulling in on the opening line and releasing the mainrope.

The opening line and short section of closing line are joined to the end of the mainrope using a 3-way Dee.

The extraction corridor width is limited to the width of the open grapple jaws. Grapple logging works best with swing yarders, as:

- They are mobile and quick to shift
- They can throw the grapple out to either side to reach stems (although this reduces productivity).



Running skyline with mechanical grapple

Generally this system suits:

- Clearfell logging any slope over short/medium distances (up to 300 m)
- Concave slopes where the hauler operator's vision is unrestricted. A spotter can be used to guide the grapple movement where the hauler operator can not see the drag
- Operations working in large piece size timber, where high productivity can be achieved by extracting one stem at a time.
- Interlocked swing yarders with a mobile tailhold machine (excavator or tractor)
- Situations where landing space is limited. A swing yarder is capable of turning the stems away from the chute to allow easier chute clearance
- Partial/full suspension of the drag

Advantages:

- A safer system:
  - No breaker-outs required (unless using a strop attached to the carriage)
  - If needed, the spotter can stand well clear.
  - There is only a small tailrope bight area
- Light rigging can be used with an interlocked drum set
- Two ropes support the load rather than one
- High production when properly planned and executed.
- Can be used for night logging, if lights are attached to the hauler
- Partial/total suspension of drag is possible
- Swing yarders can extract to smaller landings or the roadside.

Disadvantages:

- Requires:
  - Extensive planning to realise full potential of system
  - A high level of operator and spotter skills
- Large (more expensive) hauler required (generally a swing yarder).
- This system tends to break trees when head pulling.
- Increased rope wear caused by
  - Abrasive line wrap
  - Rider block wear on the tailrope
  - High utilisation (the ropes are moving all the time)
  - The grapple sheaves.
- Production is very dependent on:
  - Piece size
  - Efficient removal of drags from chute area
  - Shape of the terrain (grapple clearance). A strop can be attached to the carriage if grapple clearance is too low. However, this substantially reduces productivity.

Wire ropes and rigging

Wire rope basics

Strength and ductility

The two key characteristics of wire rope used for logging are:

- Strength - the ability to withstand tension without breaking
- Ductility - the ability to deform or bend without damage.

Strength depends on the:

- Grade of the steel used in the wires (wire rope shall not be less than 180 tensile grade)
- Overall diameter of the rope (sum of the cross-sectional areas of all the wires)
- Compactness of the individual wires.

The ability of high tensile steel wire to bend (without damage) depends on its diameter. Obviously, a smaller diameter can be bent through a smaller radius.

So, increasing the rope strength (by increasing the diameter) reduces the rope's ductility.

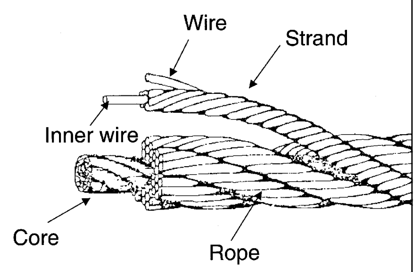
To retain the ability to bend without damage, wire rope is made up of many smaller wires.

Describing wire rope

All wire rope currently used in logging consists of a central core, surrounded by six strands.

Wire rope is described by its:

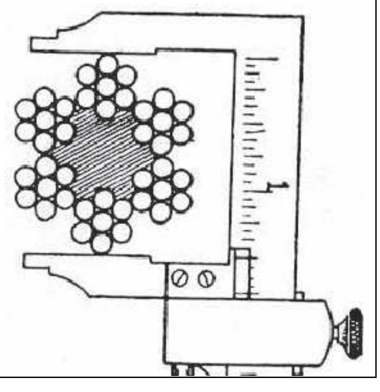
- Diameter
- Rope core
- Configuration.



Rope components

Diameter

A rope's diameter is the size of the circle enclosing its outermost wires. Diameter is measured in millimetres using callipers or special wire rope gauges.



The correct way to measure rope diameter

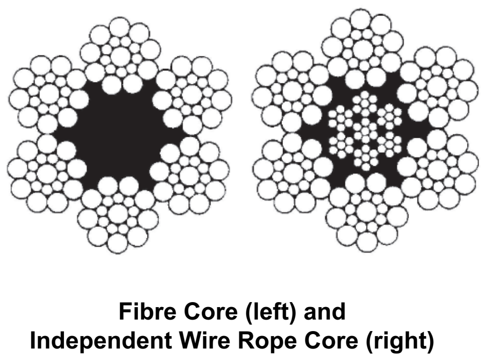
Rope Core

The rope core has three functions.

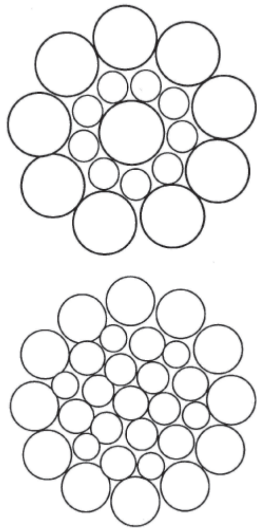
- Provides a foundation for the strands so that they may work past each other without interference as the rope is bent
- Offers resistance to the rope crushing in on itself
- Acts as a reservoir for rope lubricant.

There are two types of core:

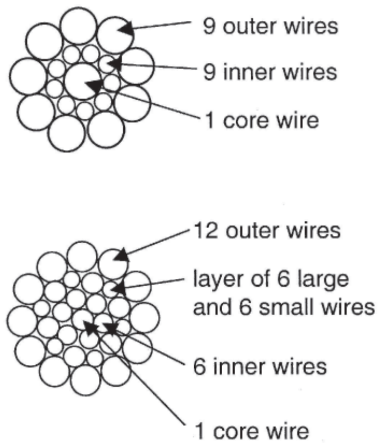
- Fibre Core (FC) made of sisal or synthetic fibre
- Independent Wire Rope Core (IWRC). Usually comprises six strands and a core, each comprising seven wires (i.e., 7x7 construction). IWRC gives a rope higher strength and crush resistance, and should be used on all logging ropes (except strawline).



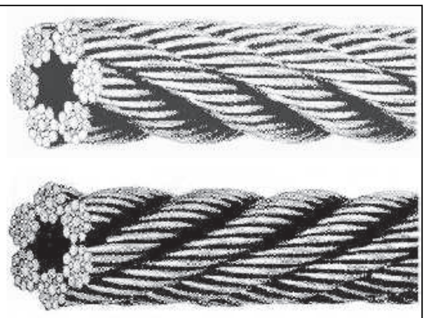
Fibre Core (left) and Independent Wire Rope Core (right)



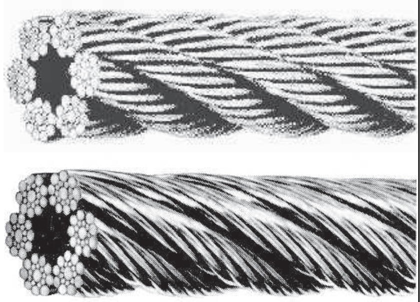
6x19 (top) and 6x31 (bottom)



9/9/1/ (top) and 12/6 + 6/6/1 (bottom)



Right-hand lay (top) and Left-hand lay (bottom)



Right-hand Ordinary lay (top) and Right-hand Lang Lay (bottom)

Configuration

Wire rope configuration is described by the number of:

- Strands per rope
- Wires per strand.

Examples:

6x19 - the rope has 6 strands, with each strand having 19 wires

6x31 - the rope has 6 strands, with each strand having 31 wires.

Strands

A strand is described by the number of wires, from the outside layer to the inside.

Examples:

9/9/1 comprises -	9 outer wires
	layer of 9 inside wires
	1 core wire.
12/6 + 6/6/1 comprises -	12 outer wires
	layer of 6 larger wires and 6 smaller "filler" wires
	layer of 6 wires
	1 core wire

Lay

Lay refers to the direction in which strands are laid in the rope.

Lay is described as being:

- Right- or left-hand lay, which refers to the direction the strands turn about the core
- Ordinary or Lang lay, which refers to the direction of the wires relative to the strands.

In right-hand lay rope, the strands go to the right, like the threads on an ordinary right-hand screw. This is the most common lay direction.

Lay direction affects the way in which the rope spools on the drum. Note that there are a few installations that require left-hand lay ropes.

In Ordinary lay rope, the strands are wrapped in one direction and the wires in each strand in the opposite direction. Lang lay rope has the strands and wires wound in the same direction.

The following table compares the strengths (✔) and weaknesses (**x**) of Ordinary and Lang lay ropes:

Characteristic	Ordinary lay	Lang lay
Ease of handling	✔	x
Tendency to unlay	✔	x
Potential for drum crushing	✔	x
Resistance to distortion	✔	x
	lays offset each other	
Flexibility of rope	x	✔
Resistance to abrasion	x	✔ more of each wire is exposed to the drum

The **pitch** of the lay is the distance along the rope needed for one wire/strand to complete one full turn around the core. This is further described as strand and rope lay:

- Strand lay is the pitch of the wires in the strands
- Rope lay is the pitch of the strands in the rope.

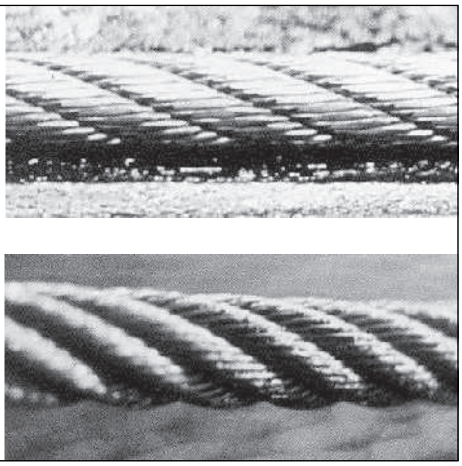
Swaging

Swaging involves hammering the wires and stands closer together to form a denser and stronger rope. Swaged rope has the appearance of an evenly worn rope.

The advantages and disadvantages of swagging are shown in the following table:

Advantages	Disadvantages
• Higher breaking strength than non-swaged rope of the same diameter • More resistant to abrasion • More resistant to crushing	• Less resistant to bending fatigue • Can be more difficult to splice • May have nicks in outer wires in each strand where they are pressed against the core. These may cause potential weak spots and prevent the wires from sliding against each other.

Double-swaged rope (e.g., Powerpac 2000) has strands swaged before being wound on to the core to form the rope. The rope is then swaged again. This results in even denser packing of the wires.



Swaged (top) and unswaged (bottom)

Load limits for ropes

When loaded, the behaviour of wire rope changes:

- At low loadings, the rope temporarily stretches. When the load is released the rope springs back to its original size.
- As the loadings increase, the rope stretches but does not spring back again. This results in permanent stretching of the rope though metal fatigue. This is said to be beyond the elastic limit.

In forestry operations, ropes are rated by their breaking strength (expressed in tonnes). Operationally, ropes should only be loaded up to their **Safe Working Load (SWL)**, which is 1/3 the breaking strength.

Term	Percentage of breaking strength (BS)	Comment
Safe working load (SWL)	33%	Obtained by dividing the BS by the factor of safety of 3. The SWL provides a margin of safety against gradual weakening of ropes through wear or age.
Endurance limit	50%	If rope tensions regularly exceed the endurance limit, the life of the rope is shortened through fatigue.
Elastic limit	60–65%	Exceeding the elastic limit permanently stretches the rope, leading to a reduction in breaking strength.

Wire ropes in cable operations are often subjected to sudden (shock) or dynamic loads. These loads may exceed the SWL for a split-second, and can eventually lead to the rapid fatigue of a rope.

Repeated shock loading may cause:

- Rope fatigue
- Core displacement
- Drum crushing
- Early rope failure

Shock or dynamic loads may occur if:

- Excessive tension is applied to break-out a drag
- Rapid application of power to a working rope allows it to "whip" (oscillate)
- The drag hits an obstacle during inhaul
- A falling tree or moving machine contacts a tensioned rope (includes guylines).

Causes of rope damage

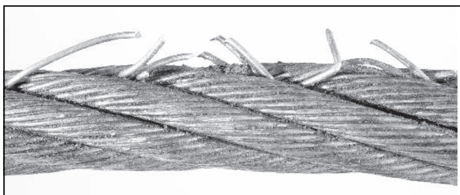
Type of damage	Cause
Corrosion	• Lack of lubrication
Crushing	• Loose spooling or crossing over on the drum
Bending fatigue	• Using sheaves and drums of too small a diameter • Reverse bending (when rope passes over a sheave, then switches sharply in the opposite direction) **Note**: Effects of reverse bends can be minimised by: ¤ Using flexible rope construction ¤ Using larger sheaves ¤ Spacing sheaves as far apart as possible.
Excessive abrasion	• Rope rubbing on rocks, stumps, steel or hard objects • Sheaves that are corrugated or have pinching grooves • Frozen or seized sheaves (intense frictional heat is created)
Premature failure	• Using the wrong rope • Frozen sheaves (see above) • Shock loads (e.g., repeated starting/stopping) **Note**: Normal dynamic shocks/overloads encountered in most operations may cause severe unseen damage
Localised wear	• Improper socketing/splicing (leads to uneven strains on strands, causing slack which will work down a rope)

Handling wire rope

Wire rope can be difficult to handle. Workers must be aware of rope characteristics, which may cause them harm when handling.

These include:

Spring - When a rope is moved or bent from its natural lying position it forms a spring as it tries to go back to its original state. This can occur when splicing or coiling rope.


Sprags

Sprags - A sprag is a broken wire protruding from the rope and has the potential to cause injury. Check wire rope strops for sprags and if considered harmful, cut them back with wire cutters (side-cutters).

Kinks - A kink develops by allowing a loop to form in a slackline and then pulling the line tight. Avoid this when uncoiling or coiling ropes as it causes permanent damage to the rope and early fatigue.

Cutting Wire Rope

Rope cutting equipment

Wire ropes or strops at some stage may require cutting to remove a length of worn or damaged rope.

The following are the recommended rope cutting tools:

- Grinder
- Impact cutter
- Long-handled cutter
- Hydraulic cutter.

Safety equipment

The following safety equipment shall be used when cutting wire rope:

- Protective eyewear
- Gloves (preferably heavy cotton).

Transferring rope

Wire rope is sold in reels. This rope must be transferred to the hauler winch drum.

When transferring rope from reel to drum it is important to brake the reel to avoid over-run. Also, the rope should be wound:

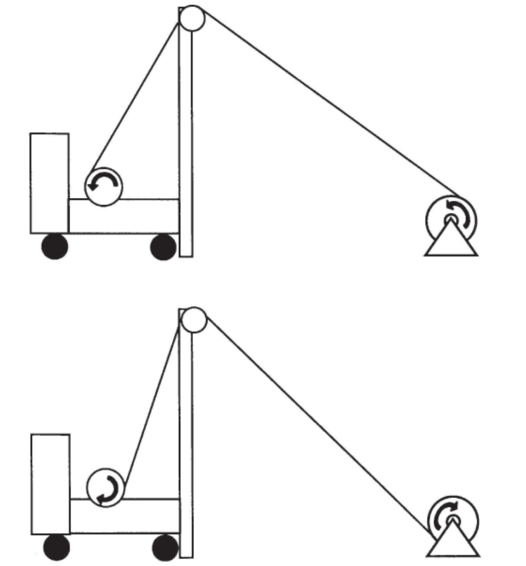
- At the correct tension to ensure even spooling on the drum (this can be done after installation but before use)
- So that it bends in the same direction as when it was stored on the reel. This can be achieved by running it either from the:
    - Top of reel to the top of drum, *or*
    - Bottom of reel to the bottom of drum.

When winding multiple layers of rope on to a working drum, it is essential that each layer winds on evenly and under equal tension. Also, make sure that each additional layer fits snugly with the one below.

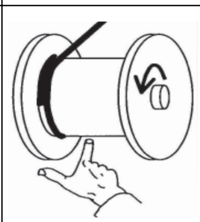
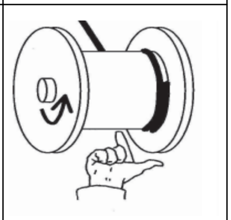
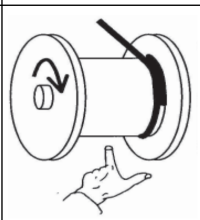
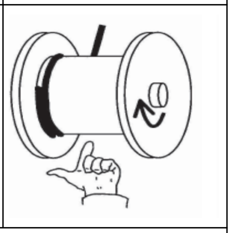
Fleet angles should be kept as small as possible, between 1° and 2° for flat-faced drums and no more than 4° for grooved drums.

Excessive drum wear or poor spooling will result if these tolerances are exceeded.

A simple method for remembering how to wind right-hand lay and left-hand lay ropes on to a drum is shown at right.



Transferring rope from the reel to the hauler drum

	Overwind	Underwind
Right-hand lay		
Left-hand lay		

A simple method for correctly winding left-hand and right-hand lay rope

Rope Lubrication

Wires and strands are lubricated during manufacture to:

- Enable wires and strands to slide easily against each other
- Provide a coating on the metal surfaces and prevent corrosion.

Lubricant will disperse out of the rope over time, particularly if the rope reaches high temperatures. However, with some rope types (especially swaged) it may be very difficult to gain penetration into the rope to replace the lubricant.

What lubricant to use

Special rope lubricant is available, but note that lubricant may attract abrasive particles (dust, sand, scoria, etc.) so that the net effect is more damage than benefit.

Notes:

- Never use used engine oil as it contains many abrasive particles.
- Do not mix lubricant with a solvent (such as diesel) to gain penetration, as this will flush out any original lubrication still in the rope.

When to discard rope

Wire rope has a temporary life expectancy. Whether a line is damaged through poor work practices or just through wear, there comes a time when it needs to be replaced.

The following criteria indicate rope should be discarded:

- Severe surface wear and inter-strand nicking
- Broken wires near fittings
- Broken wires, when over a length of 8 diameters the total number of visible broken wires exceeds 10% of the total number of wires.
- Drum crushing
- Bird caging
- Kinking

For example:

26-mm diameter rope, 6x19 construction
total wires = 6 x 19 = 114
8 diameters = 8 x 26 = 208
10% of 114 = 11.4
If in a length of 208 mm, there are more than 11 visible broken wires, then discard.

Choosing the right rope

It is important to choose rope with appropriate characteristics for the particular logging operation being undertaken. Here is a list of generally preferred characteristics.

Characteristic	Comment
6 strands	• More crush-resistant than 8
Right-hand lay (RH)	• Most hauler rope drums are designed for RH lay
	• More common (and cheaper)
	• Right-hand lay rope cannot be spliced into left-hand lay rope
Ordinary lay (OL)	• More stable than Lang lay (won’t unwind itself)
	• More common (and cheaper)
Independent wire rope core (IWRC):	• Greater crushing resistance than a fibre core
	• Contributes more rope strength than fibre core

Other things to consider when selecting a rope are its:

- Resistance to bending fatigue (better with small outer wires)
- Strength to diameter ratio (a small-diameter rope with the same breaking strength as a large one may provide the same operational performance and allow a greater length to be fitted to the hauler).
- Abrasion resistance (better with large outer wires)
- Crushing resistance

The following sections provide suggestions for matching the rope configuration and type to the purpose.

Skylines

Skylines are typically larger-diameter ropes because they carry substantial loads. Swaged or double swaged rope is now commonly used for skylines.

Purpose	Rope	Reasons
Skyline	Swaged or double-swaged 6x19 (9/9/1)	• Long service life • Relatively small diameter for a given strength means a greater length can be stored on the drum

Note that rope diameter must be considered along with:

- Groove size of sheaves in the tower, carriage, and rider blocks
- Maximum rope strength recommended by the hauler manufacturer
- Strength of guylines and other rigging equipment.

Mainrope

The best rope to use as a mainrope depends on the cable system being used.

Purpose	Rope	Reasons
Highlead mainrope	6x19 Large outer wires Low price	These ropes are subject to rubbing along the ground, particularly in blind lead situations on convex slopes. Abrasion is a much greater factor in rope wear than bending fatigue.
Mainropes with fall-blocks	6x31 Possibly swaged	Fall-block systems subject ropes to a lot of bending - resistance to bending fatigue is a higher priority than abrasion. Use swaged rope if down-sizing to increase available length. For example, when: • There is a large length of skyline • Extra length is needed for bridling.
Shotgun and slackline	Cheapest mainrope	Abrasion and bending fatigue both have a fairly low occurrence in these systems.
Motorised slack-pulling carriages	Swaged rope	Low weight for given strength is important if breaker-outs need to drag mainrope (which also serves as a dropline) across the ground. Swaged rope also offers high resistance to crushing from carriage drive sheaves.

Tailrope

Tailrope tension is relatively low (unless tightlining the drag), so strength is not generally a high priority.

However, both bending fatigue and abrasion may contribute significantly to deterioration and a choice between 6x19 or 6x31 is not obvious. Swaged rope has a longer life in some situations, but it is also more expensive, and the decision will often be based on price.

Notes

- When the tailrope runs through 2 or 3 tailrope blocks, it may not be possible to avoid rope wear through rubbing on stumps, logs, or the ground.
- Running skyline systems keep ropes close together and off the ground for most of the time. Rope wear may here be due to:
  - Line-wrap abrasion
  - Tailrope tension
  - Bending fatigue from rider block and corner/tail blocks.

Strops

Non-swaged 6x31 is an ideal construction for strops. This is because they must be flexible to allow:

- Quick hooking and unhooking
- Kinks to be hammered out.

Strawline

6x19 (12/6/1) is probably the best construction for strawline.

A strawline is not subject to crushing on the drum, and will be used for only a small proportion of the time.

Hemp core offers sufficient strength and is lighter to pull and carry around the setting.

Rope standards

No wire rope can be used in forestry work unless the manufacturer or vendor has certified its breaking strength.

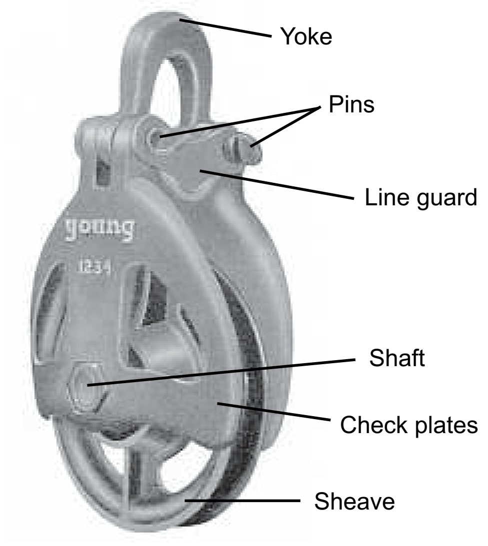
Ropes designed for the purpose of logging should be used for any skyline or running line.

Wire rope used in forestry work shall comply with either *BS/NZS 302: Part 5:1987 - Specifications for ropes for hauling purposes*, or any other standard embodying the same or more stringent criteria.

Purchasing wire rope

When ordering wire rope, the supplier needs to know:

- Length (m)
- Diameter (mm)
- Tensile grade (strength) (180 or 200)
- Construction (e.g., 6x19 RHOL)
- Core (IWRC or FC).



Block components

Blocks

Block basics

A block is a metal case enclosing one or more sheaves to facilitate a change of direction of a rope, or to gain mechanical advantage in transmission of power through a rope.

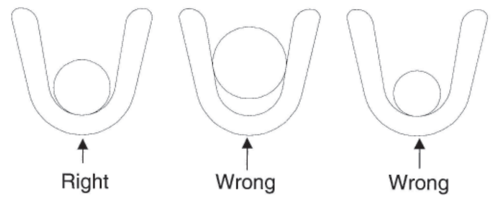
Note: all blocks must be of a design and rating to withstand the loads imposed upon them.

A block is made up of six main components:

- Sheave
- Shaft
- Cheek plates
- Yoke
- Pins
- Line guard.

Things to consider:

- The strength of the block must be greater than or equal to the strength of the rope.
- The diameter of the sheave should be 20 times the rope diameter. This is not always practicable, but if smaller diameters are used rope life may be shortened. Most tail blocks used today have sheave diameters ranging between 30 and 38 cm.
- To increase the number of rigging options more blocks are needed on site.
- The sheave groove should be fitted with the correct size rope. This ensures that the rope is supported over half the rope circumference, thereby reducing rope distortion.



Matching rope diameter to sheave groove size

Open Sheaves

The open sheave (Tommy Moore type) provides only one-sided line support but will allow shackles and connectors to pass through it. However, extensive passing of such equipment will nick and chip the sheaves. The running lines tend to flatten, resulting in shorter life.

Types of Blocks

Bull block

The mainrope lead-block in highlead hauling. Also refers to a large throated block through which rigging can pass.

Bull block

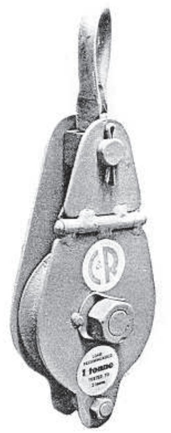
Tailrope block

Tailrope blocks

These are used as tail blocks and corner blocks on the tailrope circuit. In New Zealand, tailrope blocks are carried from stump to stump by the rigger or moved by a mobile tailhold machine.

Pass block

A light block used for hauling blocks and other rigging gear up tailtrees, intermediate support trees, or wooden spars.



Pass block

Fall block

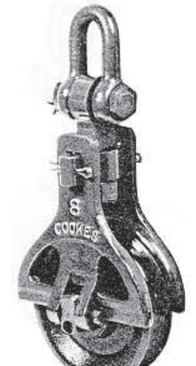
Fall-block

The fall-block is used in the bight of the mainrope with the northbend, southbend and block-in-the-bight systems. The block is balanced so that most of the weight is below the sheave.

Tommy Moore (transfer block)

These blocks have wide throats that allow shackles, splices and other line connectors to pass through.

Tommy Moore



Snatch block

Snatch block

These have a hinged cheek strap which makes it easy to put a bight of rope on a sheave. However, they are not considered as satisfactory as fixed blocks because play within the hinges may allow misalignment and distortion of the block components.

Tailtree block

This is a device with sheaves, used to support or maintain the skyline in an elevated position.

Block maintenance

Blocks should be regularly checked and maintained in sound condition for obvious safety reasons and to reduce line wear.

The following checks should be made:

- Check yokes for wear
- Use proper pins
- Inspect line guards and make sure they are being used
- Use correct size grommet in pin holes
- Check for tightness of sheave and shell
- Grease regularly (either daily or weekly)
- Any faulty equipment should be taken out of service and reported to the foreman/contractor

Shackles

Shackle basics

Shackles are used to join or secure lines. They come in a variety of sizes and shapes, depending on their intended use.

Rules

(1) Shackles with bodies made of high tensile steel or alloy steel and fitted with high tensile pins, may be used for any purpose if:

- **they are fitted with screw pins when used in butt rigging**
- **they have their pins secured from undoing if they cannot be readily checked at anytime during operation (e.g., at the top of the tower).**

(2) Shackles and rigging screws or turnbuckles used in the rigging or guylines shall:

- **be tested and marked with their safe working load.**
- **have a breaking strength at least equal to the rope to which they are rigged.**

Shackles are rated differently. For example, two common ratings are 4:1 and 6:1. A green pin shackle has a 6:1 rating which means its breaking strength is 6 times the safe working load stamped on the shackle.

Safety pin shackle

Flush pin shackle

Shackle types

Safety pin shackle

The threaded pin is additionally secured with a nut and cotter pin or grommet (used on guylines, extensions, and skylines).

Flush pin shackle

Used where shackles go through blocks, carriages, or fairleads.

Guyline sheave shackle

A wide-throated shackle with a pushpin to hold guylines on a tailtree or guylines around a stump.

Screw pin shackle

Used to join the mainrope and tailrope to the butt rigging.

Knock-out pin shackle

This shackle is designed with a long tapered guide point and an adequate knock-out head. Normally used to release a line where there is inadequate slack available. Used on skylines and guylines.

Eye-pin shackle

This is similar to most other shackles except the screw pin has an eye head. Mainly used on guylines and guyline extensions.

Eye-pin shackle

Shackle maintenance

Regular inspection of shackles should be made to identify any faulty parts.

Things to consider when inspecting shackles are:

- Shackles should be tested and marked with their SWL
- The shackle must be discarded if any signs of excessive wear or cracks appear
- Guyline, skyline extension shackles, and the like should be secured with a grommet or cotter pin
- Should have a breaking strength at least equal to the line to which they are rigged
- Screw pin shackles should be tightened securely and checked on a regular basis
- Any faulty equipment should be taken out of service and reported to the foreman/contractor.

Butt-rigging

This rigging assembly consists of a series of shackles, hooks, swivels, and links.

Variations include:

- One, two, three, or four tags may be slung from the butt-rigging, depending on the size of the hauler, and the size of the stems being hauled
- In some cases where small broken material must be recovered along with larger material, two strops may be attached to the third tag instead of one
- Either wire rope or chain strops can be used

Butt-rigging

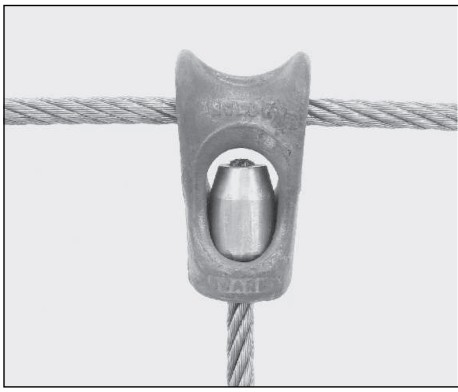
- When the more specialised carriages are employed, butt-rigging may be present in a much-reduced form or dispensed with entirely
- Sometimes, spreader bars are used between tags in place of chain links and shackles.

Swivels

Swivels relieve the torque that builds up in a line, especially as the line wraps on and off the drum. Without a swivel, a large line will create torque in a small line to which it might be attached. This will cause it to twist tight and damage the rope.

Swivels are found between the mainrope and butt-rigging, tailrope and butt-rigging, and butt hook and butt-rigging.

Ball-bearing swivels should not be used.



Choker hook

Sleeve-type hook

Strawline hook

McGovern hook

Chain hook

Hooks

An arrangement of hooks is used in rigging for attaching lines and choking logs. The following hooks are commonly used in cable operations.

Choker hook (bell)

Also known as the Bardon hook, this is the most popular device for choking logs.

Screwy hook

This type of hook can be quickly installed or removed from the choker ropes after the ferrules have been attached.

Sleeve-type hook

Hooks and chokers are free to slide along the skidding line.

Double-ended guyline hook

These are used to join guylines and guyline extensions.

Strawline hook

This is used to join the strawline connector to itself.

McGovern hook/Butt hook

One end is connected to the swivel on the butt-rigging; the ferrule of the strop is placed in the other end. This hook allows for the removal or addition of a strop to the hook.

Buzzard hook

This is used mostly to attach the tailrope to the butt rigging. Its design allows for quick and easy attachment and detachments of the lines.

Chain hook

This is another method used in the choking of logs.

Pelican hook

This is used to hold a line from moving (same principle as a pass chain), but is designed so that the line is released with a blow from a hammer to the finger part of the hook.

Wire rope strop

Strops

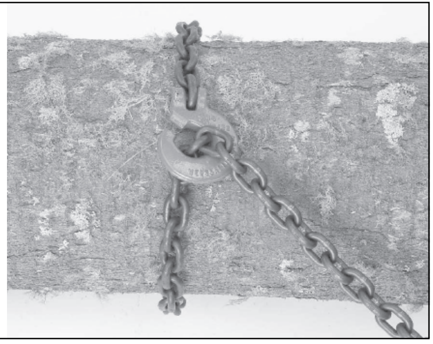
There are two types of strop.

Wire rope strops

- The most common form of attachment.
- They are cheap and easily used.
- Usually fitted with a ferrule and choker hook.
- The breaking strength of a wire rope must be less than the mainrope strength. This ensures that if an overload situation arises, the strop breaks first.
- Diameters and lengths are determined by the system used. For example, lighter strops are often used with skycar carriages where ready slack is available. Longer heavier ropes are used for scab skyline and northbend systems.

Chain strops

- Less common.
- More expensive than wire rope strops.
- May be used where it is more likely that the drag may foul (highlead system).
- Chains are fitted with a chain hook.
- The breaking strength of a chain must be less than the mainrope strength. This ensures that if an overload situation arises, the chain strop breaks first.



Chain strop

Self releasing chokers

Two types of self-releasing chokers are available. They are either mechanically or electronically operated:

- The Gibson Hook is a mechanical self-releasing choker that is best suited to situations where the drag can be suspended during inhaul.
- Electronic choker hooks are also available whereby the choker is released by radio control from the hauler.

Other rigging equipment

Hammer locks

Used to join various parts of the butt rigging and are commonly used to join broken chains.

Cable clamps

Used to join a line back on to itself. They are most often used for rigging tailtree guyline anchors.

A cable clamp needs to be fitted so that the saddle (rounded end) is placed over the main body or live end of the rope.

Hammer lock

Cable clamp

Ferrules

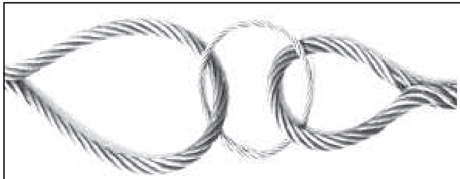
A ferrule is a metal sleeve or collar, fastened to the end of a wire that fits into a hook or socket to secure the wire rope. Ferrules are found in a variety of applications in cable logging. They may be used with choker hooks, guyline hooks, or attaching lines to winch drums. Ferrules can be attached to the wire rope by swaging (pressing), wedging, or babbitting.

- A **swaged ferrule** will attain 80–90% of the rated breaking strength of the rope. It is usually fitted by the rope supplier.
- The **wedge-type ferrule** has spiral grooves on the inside designed to conform to the lay of the rope. The ferrule is driven down over the cut ends of the rope, then the strands are distributed each into its proper recess and the wedge is driven into the recess in the ferrule. Wedge ferrules may work loose if they are whipped or banged around.

Swaged ferrule

Wedge-type ferrule

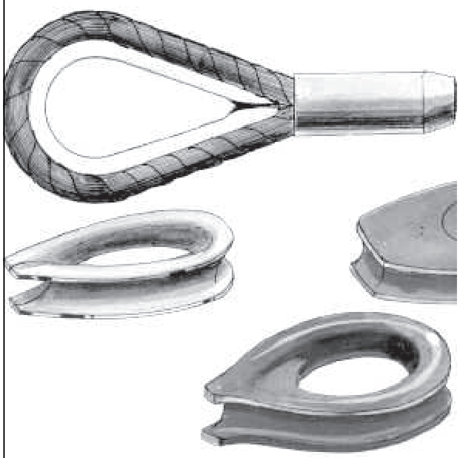
- **Babbitting** is more complicated but considerably more effective. A special type of ferrule with a flared recess is driven down over the rope end. The strands of the rope are separated and then further untwisted so that the rope is pulled up into place and the wires are distributed within it. Melted socket metal is then poured down among the wires and allowed to set.



Grommet

Grommet

The grommet is a strand of line wrapped around the lay of the strands a number of times to form a circle. It is used as a temporary link to connect eye splices, and to secure shackle pins.



Thimbles

Thimbles

Thimbles are a formed or cast steel fitting placed in the eye of a rope to retain the round shape, give support, and protect it from wear on the pin. As thimbles cannot be run through blocks or fairleads, they can be used only on standing lines. Without a thimble, the line will deform and flatten out as it goes around the shackle pin. This deformation weakens the line, with a possibility of failure.

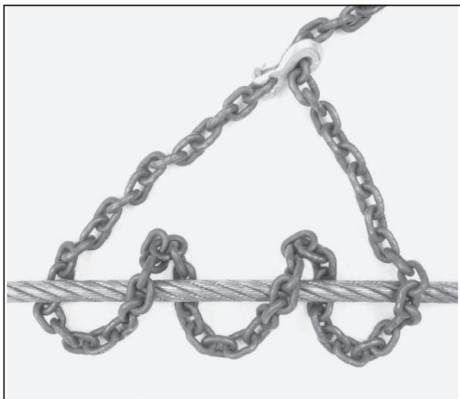
Extensions

These are sometimes required for guylines and skylines when existing lines are too short. The following are some examples of various forms:

- A skyline extension usually has an eye at either end. One eye is tied off on to the anchor and the other end shackled to the skyline.
- Guyline extensions may vary in form, e.g., an eye at either end.
- There may be ferrules at either end with a choker in the middle.
- A ferrule and choker may be at one end, with an eye at the other.

Coil of strawline

Strawline, in most instances, is laid out around a section of, or the perimeter of an area to be logged before the tailrope can be pulled around. This is usually done manually and the easiest way of carrying strawline is in coils. A coil may be up to 80 m or more depending on its diameter. The length of the span and the size of the setting will dictate the number of coils required to fence it in.



Pass chain

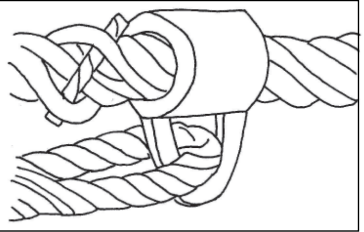
Pass chain

This is a specially designed chain manufactured of low-alloy, T-1 steel. It is used for pulling or securing ropes. Wrapping the chain around the cable a minimum of three times against the direction of pull secures it. The bight of the chain is then threaded back through the hook, and the chain is tightened. Slack will become available in the direction in which the chain is pulled.

Sometimes two chains are required, one to hold a rope from running away while the other is used to pull rope under tension to form slack.

Shay swivel

A shay swivel can be used to attach the slackpulling line to the mainline on a mechanical slack pulling system. A short (15–20 cm) line is spliced into the mainline with a reverse lay, creating a bump for the shay swivel to ride up against so the slackpulling line can pull line off the hauler drum for lateral hauling.



Shay swivel

Sockets and dees

Sockets are fitted to the ends of lines and straps to facilitate connecting lines to each other or to objects such as blocks, or standing rigging. There are:

- Open sockets
- Closed sockets.

Sockets can be:

- Cast
- Swaged
- Wedged

Open sockets are used mostly for standing rigging connections.

Anchors

Anchor basics

The purposes of an anchor are to:

- Secure a guyline or skyline in place to prevent the line from moving
- Provide a secure position to attach a tailrope block(s).

The effectiveness of an anchor is the extent to which it resists movement. The required strength of an anchor depends on size and duration of the pulling force it must resist.

Here are the things to consider:

- Hauler type and size (power rating and rope weights).
- The amount of deflection, which affects the working rope tensions and the optimum payload. If not considered, the working ropes and anchor(s) can be over-loaded.
- The number of drags to be pulled while attached to the anchor. If repeated loading exceeds the elastic limit of the anchor, progressive (slow) failure can occur. The more drags that are pulled, the more loading cycles the anchor must resist.
- Likely payload weights. For a given situation, anchor loadings increase with payload weight.
- Cable system being used. For example, bridling can impose slight sideways forces on the anchor. It will also increase the number of drags that will be pulled from a single set-up. Also, running skyline systems can impose high loadings on an anchor if both the corner and tail block are attached to the same anchor (i.e., mobile tailhold).

Types of anchors

There are four types of anchors used in cable operations:

- Stump anchors
- Mobile anchors
- Earth anchors
- Rock anchors.

Stump anchors

A stump anchor is simply the stump of a felled tree, which has been selected as suitable for use as an anchor.

Stump anchors may be used for:

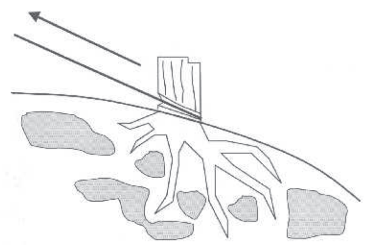
- Hauler guylines
- Skyline anchors
- Anchoring other machines or equipment.
- Tailspar and intermediate support guylines
- Block anchors

Holding power

Many factors affect the holding power of a stump. This makes it near impossible to guess the holding power of an individual stump. Despite this, there are some general rules that apply:

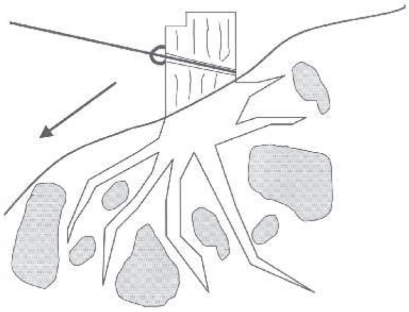
Things that *increase* a stump's holding power

- Being freshly cut (less than 6 months old)
- Deep and firm soils
- Sufficient height of solid wood above the planned notch (e.g., at least 30 cm)
- A larger diameter stump (e.g., a 60-cm-diameter stump may hold approximately four times as much as a 30-cm stump)



Pulling a stump uphill increases the holding power

Do not use old rotting stumps. This 2-year-old stump failed, causing a tower to overturn



Avoid pulling a stump out of the slope

- Attachment of the rope or strop as low as possible on the stump
- Pulling the stump uphill (*see* diagram).

Stumps to avoid

The following stumps should be avoided:

- Stumps which have been damaged or disturbed during road or landing construction.
- Stumps on wet swampy areas. Stump (and soil) strength decreases as a soil gets wetter.
- Stumps located in shallow, loose, or friable soil. In particular, where there is only a thin soil overlying rock
- Stumps that have started to rot. The root systems on stumps over 6 months old have started to rot and their strength may have reduced.
- Stumps that have been previously used as anchors. These may be in a weakened state despite looking sound.
- Stumps of wind-damaged or heavily leaning trees.
- Stumps that have been cut too low to allow adequate holding wood above the attachment point.
- Those that are pulled out of the slope (*see* diagram).

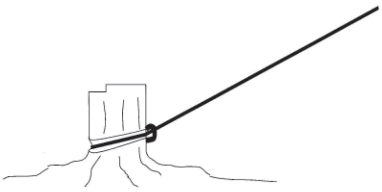
Note: If there is any doubt as to a stump's holding capacity, then either tie back to other stumps, or consider an alternative anchor type.

Types of stump anchor

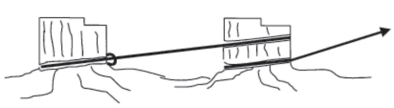
Stumps can be rigged in different ways to increase their resistance to movement.

Single stump

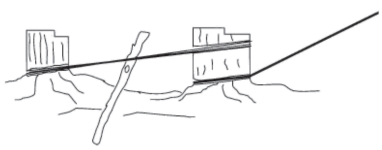
A single stump anchor is the stump of a felled tree. It is the simplest anchor to use, but its holding power is difficult to predict.



Single stump anchor



Wrap-and-go-back stump anchor



Twister stump anchor

Wrap-and-go-back

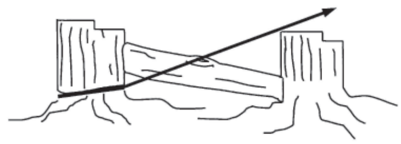
Wrap-and-go-back stump anchors have the load-bearing rope spiralling up around the first stump and tied off to a second. They work best when the two stumps are in lead with the direction of pull. There is little load-sharing advantage in using more than two stumps.

Twister

Twister stump anchors have the load-bearing rope tied off to the front stump. This stump is connected to a second stump beyond the first. The two stumps are connected with loops of strawline, which are then tensioned with a stick. The two stumps should be in lead with the direction of pull, although multiple stumps can also be "twisted" together.

Jill Poke

Jill Poke stump anchors use a rigid brace between two stumps. The load-bearing rope is tied off to the second stump and the brace transfers the load to the front stump. A single Jill Poke brace requires that the two stumps be in lead with the direction of pull, although multiple braces can be used.

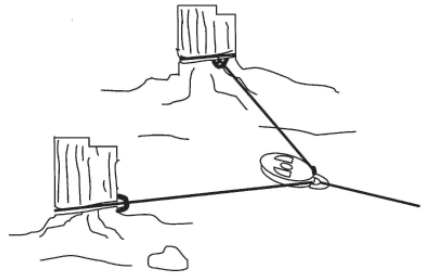


Jill Poke stump

Bridle block

Bridle stump anchors have the load-bearing rope tied off to an equaliser block that "floats" on a strop between two anchor stumps. This distributes the load evenly between the two stumps. The angle between the two legs of the strop should not exceed 120°. Also the anchor stumps do not have to line up with the direction of pull.

Multiple stumps and blocks can be used for greater anchor strength.



Bridle stump anchor

Advantages/disadvantages of stumps

The main advantages and disadvantages of stump anchors are:

Advantages	Disadvantages
• They are cheap compared to earth anchors • Generally available on site • Relatively quick to set up • Do not require earthworks	• Difficult to predict stump holding power • The best stumps may not be in the right place • They must be planned for and selected before felling commences • They deteriorate over time and with use

Earth anchor basics

Earth anchors consist of an object such as a log or a device that is buried, screwed, or pushed into the ground.

They may be used for:

- Hauler guylines
- Tailspar guylines
- To anchor other machines or euipment
- Skyline anchors
- Rope block anchors

Earth anchors are relatively expensive to use. Earthmoving equipment, such as a digger or large pneumatic drill, is required to install them.

Holding power

The holding power of an earth anchor depends on the:

- Volume of soil above and in front of the anchor
- Frontal surface area of the buried anchor.
- Soil strength

It may be necessary to use more than one earth anchor to provide the required holding capacity.

Note: All earth anchors are difficult to realign with changes in direction of pulling force, and have limited ability to withstand lateral pull.

Types of earth anchor

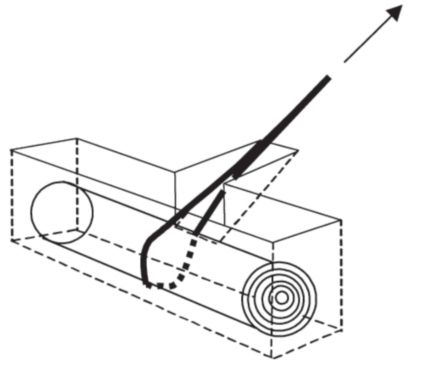
There are different types of earth anchor for different soils and situations. These include:

- Deadman
- Screws
- Pickets
- Tipping plates.

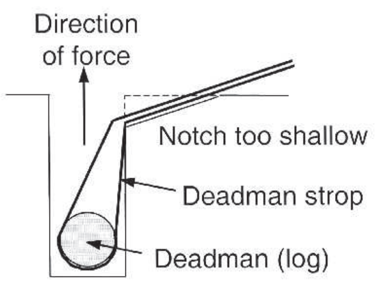
Deadman

Deadman anchors are objects, such as logs, which are buried for use as an anchor. A deadman is the most common type of earth anchor used in New Zealand cable operations. They can be used in most soil types so long as they are not shallow. They are the cheapest and easiest earth anchors to install.

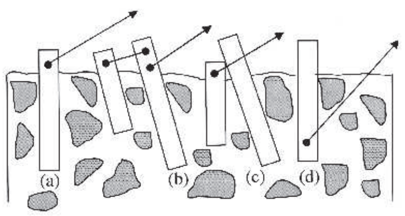
They comprise one or two logs buried in a trench at right angles to the proposed direction of pull. The log(s) have a strop around them to which the loaded rope is shackled. In general, they should only be used where soil is cohesive and dry.



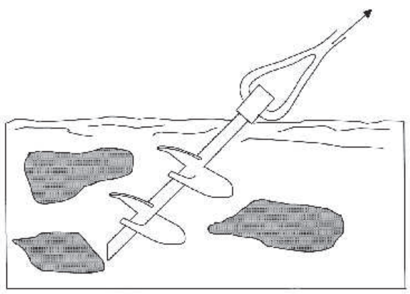
A deadman anchor



A shallow notch can cause the deadman to lift up when loaded



A range of picket installations (a to d)



Screw anchor

Things that ***increase*** the holding power of a deadman:

- The depth of the trench (should be at least 4 m deep)
- Orientating the trench at right angles to the line of pull
- Digging the trench in dry ground
- Using a large-diameter log (e.g., over 50 cm), or two or more logs together if in doubt
- Using freshly cut logs
- Using logs which are more than 5 m long
- Cutting a channel in the front face of the trench to provide a straight line of pull on the deadman strop.

Things that ***decrease*** a deadman's holding power:

- Wet soils
- Inadequate soil volume in front of the anchor; avoid pulling deadman out of a slope
- Having a bight induced in the strop which will tend to lift the deadman out of the trench.

Pickets

Pickets are posts or pegs driven into the ground.

They work best in firm, stony or shallow soils, but have limited holding power and are time-consuming to install.

Screws

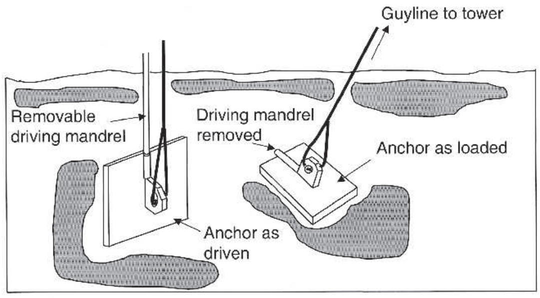
Screw anchors resemble augers.

They are especially suited to heavy soils like clay, though they also work well in sand or gravel. Screw anchors require special equipment to thread them into the soil to a depth specified by the manufacturer.

Tipping plate

Tipping plate anchors require cohesive soils without much rock, and are effective in clay, sand, or gravel.

They are manufactured in a variety of shapes and sizes. Some models require special vibrating installation equipment to force the anchor to a predetermined depth. Certain soil conditions may require some models to have pre-drilled holes with subsequent backfilling or grouting.



Installation of a tipping plate anchor

Advantages/disadvantages of earth anchors

The main advantages and disadvantages of earth anchors.

Advantages	Disadvantages
• Alternatives when stump anchors are not available • Deadman anchors generally have greater holding power than stump anchors • More consistent holding power than stump anchors • Can be positioned in the right place for the desired purpose	• Need specific installation equipment • Access for installation equipment may not be possible • Specific to soil types • Costly to purchase • Costly and time-consuming to set up • Except for pickets, may need elaborate/expensive equipment to recover

Mobile anchor basics

A mobile anchor is any mobile machine suitable for use as an anchor, such as a tractor, skidder, or excavator. They may be used for:

- Hauler guylines
- Tailspar guylines
- Skyline anchors
- Rope block anchors
- To anchor other machines or equipment.

The full cost of using machinery for an anchor includes depreciation and ownership costs.

Holding power

The effectiveness of a mobile anchor depends on its weight and what it is secured with:

- Blade or bucket dug into ground
- Excavator boom or stick used as a brace
- Winch rope or strop connected back to a stump anchor.

Types of mobile anchor

Machinery used as a mobile anchor must be mechanically reliable and have secure attachment points for the rigging intended for them.

Tractors

Tractors are commonly used as mobile anchors in hauler operations. They are used to anchor skylines, tailropes, and, to a lesser extent, load-bearing guylines.

A tractor used to anchor hauler guylines

The following factors influence the holding power of a tractor:

- The weight of the tractor
- The coefficient of traction between the tractor and the ground
- The way in which the loaded rope is attached to the tractor
- The ground slope
- The mass of material (e.g., soil, stumps) in front of blade
- Additional securing of the tractor (e.g., winch rope attached to a stump anchor).

The weight of tractor and the condition of the ground upon which it is situated have a significant effect on the holding power of a tractor. Even a very large tractor parked on flat dry ground will not withstand the forces imposed from medium to large hauler line-loads.

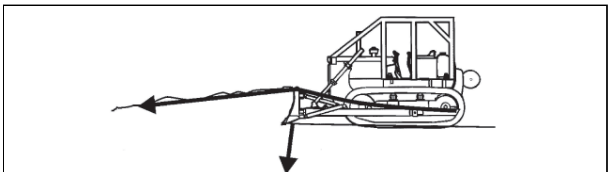
The coefficient of traction between the tractor tracks and the ground depends on the condition of the ground surface. If the ground surface is wet and slippery, as opposed to dry and hard, the tractor's holding power is reduced.

Ground slope - holding power increases if the pull is up slope because the hauler is pulling against both the tractor's coefficient of traction and the slope resistance (gravity). Holding capacity is reduced if pulling the tractor downslope.

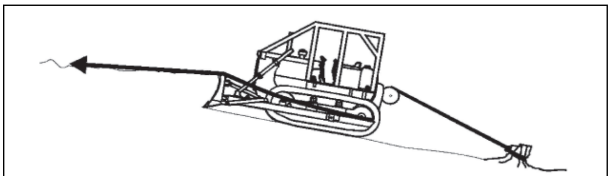
Mass in front of blade - just pushing up a pile of soil has little effect on holding power. The weight of such a pile may only be 1 or 2 tonnes, which is small compared to the rope loadings. Ideally, the soil mass needs to be pushed up against something with extra security, such as a stump.

The attachment method will affect the way in which the blade behaves when it is loaded. The attachment should be over the blade forming a small bight that forces the blade down when loaded. The loaded rope or strop should not be attached directly to the blade as it is not designed to be pulled forward.

Additional securing of the tractor to a correctly notched stump greatly increases the holding power. Such securing should be in addition to correct attachment method.



Attaching the loaded rope so the blade is forced down when loaded



Attaching the winch rope to a stump anchor

Excavators

Excavators can be used to anchor skylines and tailropes in cable logging operations. The method used to attach these load-bearing ropes and the positioning of the excavator can greatly affect its stability. Also, the physical size of an excavator can influence anchor stability — the bigger the excavator the greater the loading required for it to overturn.

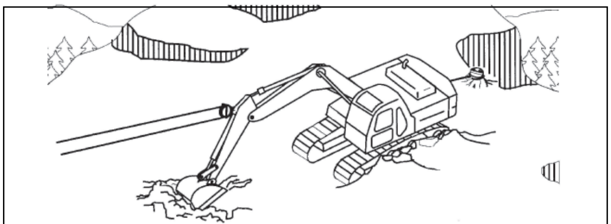
An excavator used to anchor swing yarder guylines

The holding power of an excavator is affected by:

- Rope attachment height
- The angle of the stick
- Track gear orientation.

Attachment height — attaching the working ropes to the bucket only relies on the excavator's weight, coefficient of traction, and the bucket resistance to overcome the sliding effect.

To increase the holding power, the loaded rope(s) should be attached higher up the stick.

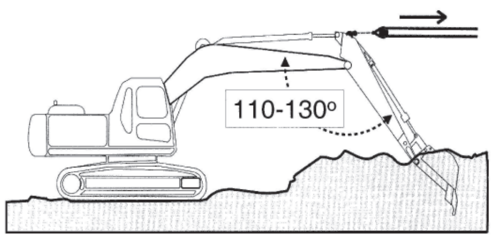


Attach the loaded rope(s) higher up the stick to increase holding power

Providing the boom is in line with the direction of pull, the loaded rope(s) will force the bucket down into the ground. This will reduce the likelihood of the machine sledging forward.

Angle of the stick - the effective length of an excavator anchor (from the bucket to the back of the tracks) has a significant effect on machine stability (providing the excavator does not screw, or slew sideways).

Ideally the angle between the stick and the boom should be approximately 110–130°. This increases the effective length of the machine and increases the proportion of the load that is transferred down the stick. Extending the stick further forward reduces the holding power (and rope height) as less of the load is directed down into the ground.

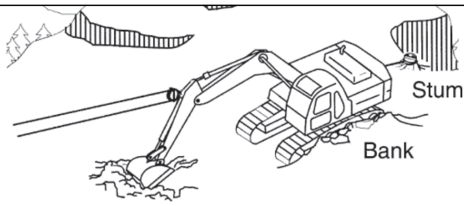


Extending the stick to 110–130° increases machine stability

Track gear orientation - mobile anchors are often sited on undulating or difficult terrain. The operator should always attempt to position the machine as level as possible, although it is unlikely the excavator will always be parked on perfectly flat ground. If not parked sideways, there could be a tendency for the excavator to slide sideways downhill when the applied load approaches the overturning resistance to the excavator.

This sideways movement can be minimised by:

- Orientating the tracks at 90° to the line of pull (as the track frame is generally longer than wider) to increase the effective width of the excavator.
- Positioning the tracks against a bank, to oppose likely sideways movement. This method is more effective when the tracks are oriented parallel with the bank (in line with the direction of pull).
- Attaching a strop from the rear of the undercarriage to a notched stump opposite the line of pull from the working ropes. The strop can be tensioned by driving the excavator forward before positioning the bucket on the ground.



Increasing excavator stability by positioning against a bank or attaching to a stump

Advantages/disadvantages of mobile anchors

The main advantages and disadvantages of mobile anchors are:

Advantages	Disadvantages
• Consistent reliable performance • Faster rope shifts (useful for cable systems with little lateral reach) • Can be used (instead of people) to carry heavy loads, ropes, and rigging on rough/hilly ground) • Self-contained unit, does not need to be rigged at every rope shift • Useful to increase tailhold height	• Access may not be possible • Some soil disturbance is likely • Site conditions, environmental legislation, or codes of practice may restrict use • Initial capital cost and continuing repair/maintenance costs

Rock anchor basics

Rock anchors are either galvanised wire rope lengths or steel pins which are inserted into holes drilled in solid rock and held in place with grout (resin), ferrules, wedges, or other expanding mechanisms.

They may be used for:

- Hauler guylines
- Skylines and rope blocks
- Tailspar guylines
- Other machines or equipment.

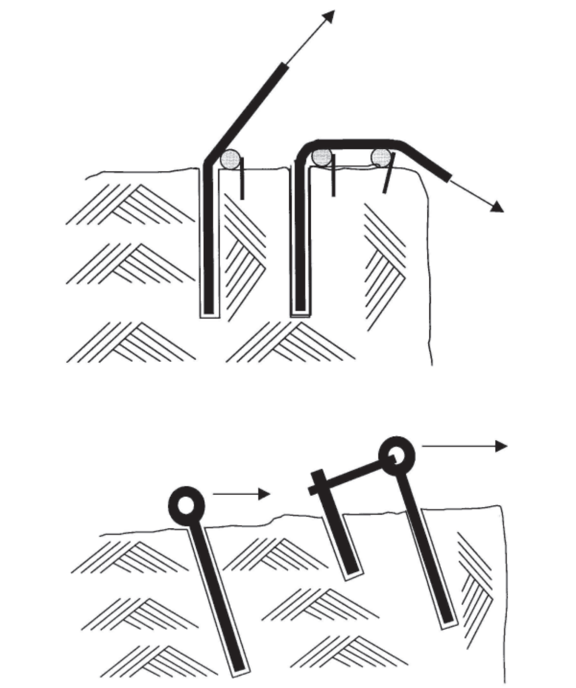
Rock anchors are costly to set up, requiring time, special equipment, training, and planning. They are most often used where high altitude contribues to shallow soil overlying rotten rock, with small, poorly rooted trees, where access by a mobile anchor is not possible.

The holding power of a rock anchor cannot be established without knowledge of local rock types and characteristics. In general, it depends on:

- Length of anchor in the rock
- Hardness/strength of the rock itself.

It may be necessary to use more than one anchor to provide the required holding capacity, and two or more rock anchors are often used together in a bridle arrangement.

Note: Rock anchors cannot be realigned with changes in direction of pulling force, and have limited ability to withstand lateral pull.



Wire rope (top) and steel pin (bottom) anchors

Types of rock anchor

There are two types of rock anchor, both requiring strong non-fractured rock.

Wire rope

Wire rope rock anchors have the load-bearing rope attached to a length of wire rope grouted into a drilled hole.

The anchor rope should be non-lubricated (e.g., galvanised) and the buried end should be moused, wedged, or fitted with a ferrule. This is for grout adhesion, and to ensure a firm hold. Multiple wire rope anchors with bridle blocks can be used.

Steel pin

Steel pin rock anchors have the load-bearing rope attached to a mild steel pin secured in a drilled hole.

The pin can be grouted and/or wedged and the bottom third of the pin should be tapered to get the pin to the required depth. Multiple steel pin anchors with bridle blocks can be used.

Advantages/disadvantages of rock anchors

The main advantages and disadvantages of rock anchors are:

Advantages	Disadvantages
Can be used in areas with: • Unsuitable stumps • High water tables • Weak, shallow soils over hard bedrock	• Access for installation equipment may not be possible • The best rock may not be in the right place • Costly to set up in time • Cannot be recovered • Must be installed by experienced workers.

Before rigging an anchor

Ensure that all rigging equipment is appropriate for the task and that the workers undertaking the tasks are either skilled or under close supervision.

All rigging equipment must be visually checked to ensure it is undamaged and appropriate to the rigging tasks being performed

All strops and extensions shall be of at least equal strength to the attached rope

Shackles shall be labelled with their SWL. This should be at least the same or greater than that of the working rope(s).

Ensure shackle pins have a means of being secured (e.g., grommet).

Spliced eyes must be correctly formed.

All chainsaw equipment must be on site and in working order. Chainsaw operators must be suitably skilled or under close supervision of a competent person. All appropriate personal protective equipment shall be worn. See **Best Practice Guidelines for Chainsaw Use** for further details.

Ensure there is a clear means of communication with the hauler operator. This will be critical when directing rope movements.

How to rig a single stump anchor

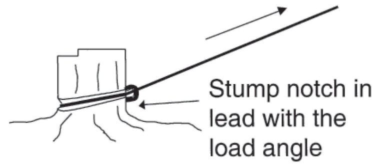
(1) Make sure you are in a comfortable and safe stance. Some of the grooving is done with the bar tip, so be careful.

(2) Clear around the stump before commencing the cuts.

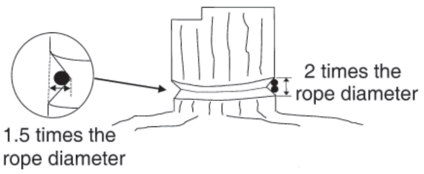
(3) The first cut is made near the front of the stump, so position yourself on the right-hand side of the stump.

Make a guide for your notch by lightly cutting into the bark and guiding the bar towards the back of the stump. (The notch should be in lead with the attached line.) You will find that you will be moving in a clock-wise direction, backwards, around the stump.

The notch should be as low as possible, without cutting any fluting or roots. There should be at least 30 cm of holding wood above the notch.



Keep the notch in lead with the angle of load



Correct cutting of the notch

(4) Groove out that side of the stump. Maintain an open "V"-shaped notch - cutting the notch too sharp will cause the rope to wedge tightly into the notch when the line comes under tension, making it difficult to remove. The depth of the notch should be no more than 1.5 times the diameter of the rope and no greater than twice the diameter of the rope.

(5) Start the other side working from the back of the stump to the front. Make sure the notch lines up with itself.

(6) Wrap the rope around the stump and fit it into the groove

(7) Now, connect attached line to the strop or extension using a shackle (remember, pin through the eye). Secure the shackle pin.

(8) Tighten the attached line gradually. Use a maul to knock out the slack and to help house the line properly (**do not use your hands**).

How to rig a wrap-and-go-back stump anchor

(1) The front stump has a spiral notch cut in it. This creates a spacer so that the rope doesn't rub on itself.

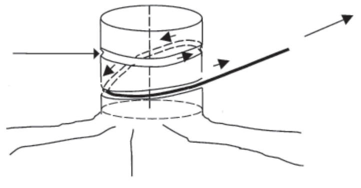
(2) The rear stump is notched in the same fashion as a single stump

(3) Choke one end of the strop or extension around the rear stump

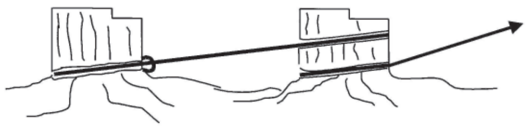
(4) Now guide the strop or extension around the front stump. The line should enter the spiral at the top and exit at the bottom.

(5) Make sure you remove as much slack from the line as practicable before tightening up the line

(6) Make sure the strop or extension is kept in lead with the tower



Wrap the strop or extension around the front stump



Ensure the strop or extension is in lead with the tower

How to rig a twister stump anchor

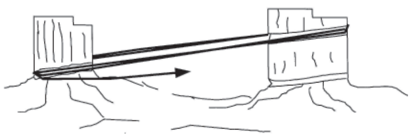
(1) Select two high stumps that are in lead with the tower. The front stump is tied to the back stump with strawline, and the strop or extension is choked to the front stump. Notches are cut to accommodate the two ropes.

(2) The strawline must be above the load line on the front stump, and as low as practicable on the back stump.

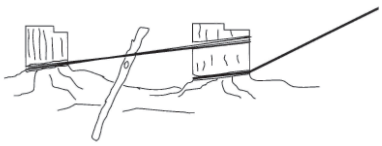
(3) Wrap the strawline around the stumps a number of times (8-mm strawline requires five wraps to achieve the same breaking strength as a 26-mm strop or extension).

(4) Use a sturdy stick or sapling of sufficient strength and diameter for a twister stick. Twist the lines until firm, and securely lock the twister stick. Do not over-tension the strawline.

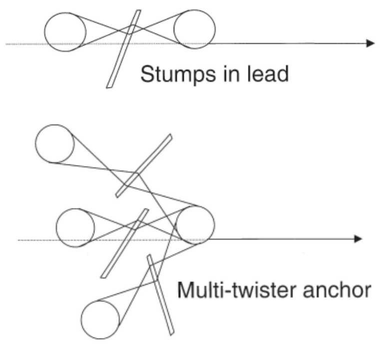
(5) If there is still doubt about the security of the anchors, twist more stumps together. Ensure that the stumps are kept in lead with the direction of pull.



Wrap the strawline around the stumps the correct number of times



Use a sturdy twister stick. Do not over-tighten.



Ensure the main load-bearing stumps are in lead with the tower

How to rig a jill poke stump anchor

(1) Select a suitable secondary stump in front of and in lead with the anchor stump.

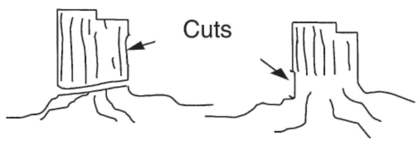
(2) Cut a flat vertical surface on each stump facing the other. Position the cuts so that when the guyline is tightened it doesn't knock the brace out of position.

Notch the back stump for the extension or guyline.

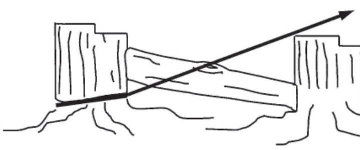
(3) Cut a suitable log slightly longer than the distance between the two faces.

(4) Drive the log into position between the stumps.

(5) Attach the extension or guyline to the back stump.



Make the cuts for the log



Attach and tension the extension or guyline

How to rig a bridle block stump anchor

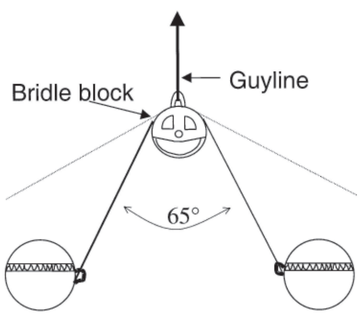
(1) Select the bridle line to withstand the load imposed.

Select two adequate stumps; the distance between them should be such that when the bridle block is in place and tensioned the angle does not exceed 120°. If the angle is greater than 120°, there will be greater pull on the bridle than the original pull; the less angle the better.

(2) Notch the stumps.

(3) Shackle the strap to the stumps, making sure that the shackles are on the inside of the stump.

(4) Attach the bridle block to the strap.



Ensure the angle between the two sides of the strop is less than 120°

(5) Attach the guyline to the yoke of the equaliser block and tension the line. Check that the angle is less than 120°. You may require a longer strap to achieve an adequate angle.

How to rig a deadman anchor

Equipment

You will require the following equipment to install a deadman anchor:

- An excavator to dig the trench
- A deadman strop of adequate strength and length. The strop must be at least equal in breaking strength to the attached rope.
- Log(s) of sufficient size to anchor to. Typically, these should be greater than 50 cm diameter and 5 m long.

Rigging procedure

The following example is the most widely used procedure.

(1) The excavator digs a trench long enough to fit the log(s) and at least 4 m deep. The trench must be at right angles to the line of pull and the walls must be vertical if it is to be effective.

(2) The excavator cuts a notch angled at right angles to the main trench. This is done to prevent vertical pull when tension comes on the guyline.

(3) The strop is laid in the trench with ends of the strop projecting on either side of the trench.

(4) The excavator places the first log in the trench.

(5) If only one log is being used, proceed to Step 8.

(6) Bring the two ends of the strop together on the opposite side of the trench from the hauler.

(7) The excavator places the second log in the trench.

(8) The strop ends are pulled together on the hauler side of the trench.

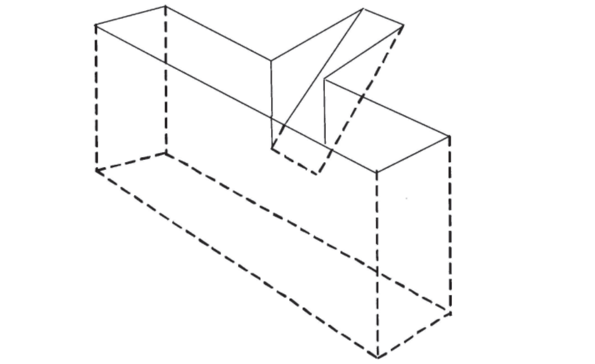
(9) Back fill the trench to about half way, but make sure the strop ends are not buried.

(10) Bring the strop ends together. Now thread a chain through the eyes and clip the hook back on to the chain. Shackle the other end of the chain to the excavator bucket and pull up tight. This will even up the strop ends.

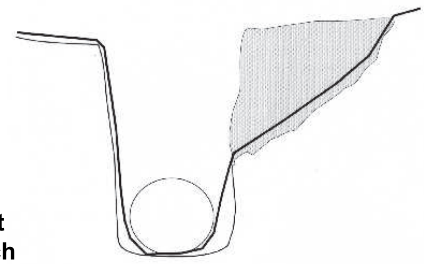
(11) Back fill the rest of the trench and intermittently pack down the fill with the excavator bucket.

(12) Spray paint the strop ends so that they are easy to locate when it is time to join them to the guylines.

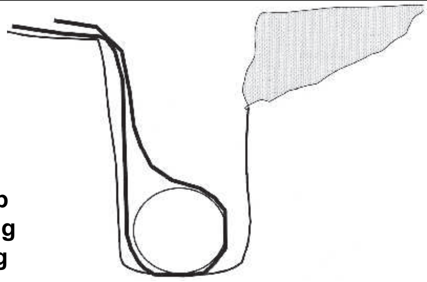
(13) Spray paint the strop where it exits the ground. This is used to monitor deadman movement during the operation.



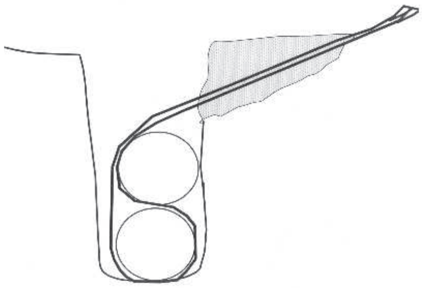
Install a small notch in the front face of the trench



Install the first log in the trench



Move the strop before installing the second log



Pull the strop ends together

How to anchor a tractor

Rigging a tractor anchor

It is important that the tractor is anchored in such a way that it does not pull free. The following steps provide a guide to safe tractor anchoring.

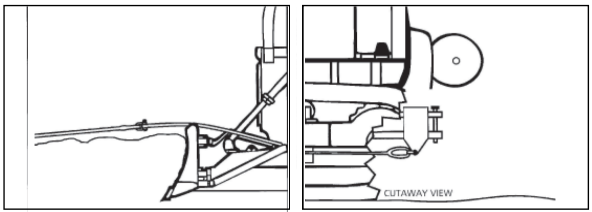
(1) Select a positive area to maximise the grade resistance (e.g., being pulled uphill, into the slope).

(2) Position the tractor so that the blade is facing towards and at right angles to the line of pull.

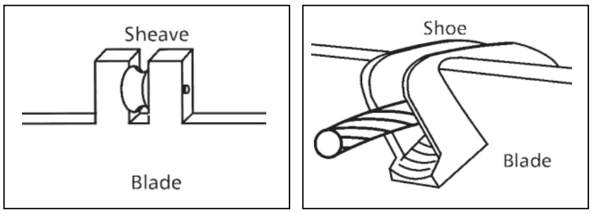
(3) Blade up a mound of soil to at least half the depth of the blade, and preferably behind a mass of stump roots as well, when practicable. Force the blade down into solid ground. Engage the park brake.

(4) Attach an extension to the tractor drawbar attachment to induce a straight bight. The extension should be cut to length so that the eye is just in front of the blade.

The blade should have a hard-faced sheave or shoe fitted to it where the extension passes over, this will prevent the rope from wearing



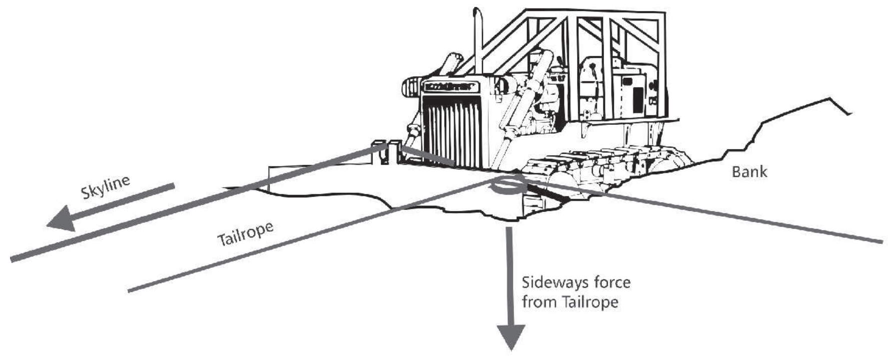
Recommended attachment of the extension to the tractor



Recommended blade attachments to reduce rope wear

(5) Attach the skyline to the extension using an appropriately rated shackle. Secure the shackle pin.

(6) If there is lateral force induced from the working ropes, position the tractor in a trench, or against a bank to prevent the tractor from twisting sideways.



Position the tractor to withstand any sideways forces

(7) If you are in doubt about the tractor's anchorage capacity, tie the winch rope back on to a notched stump as well.

(8) Once the tractor is in position, get off before signalling to the hauler operator to tightline.

(9) Once the ropes are on their new line, make a final check of the tractor and rope positions,, and tractor security, before signalling the hauler operator that the operation can restart.

Shifting the tractor

Points to consider when shifting the tractor:

- Have direct communication with the hauler operator (e.g., radio)
- When it is necessary to tension the working ropes during a line shift, ensure the blade is square to the line of pull
- Wear the seat belt
- Retreat to a safe position clear of the machine before tensioning the working ropes
- Have the hauler operator wind in excess slack from the ropes regularly to avoid large bights developing in the ropes

How to anchor an excavator

Rigging an excavator anchor

It is important for the safety of workers and well being of machinery that the excavator is well anchored, the following steps provide a safe and effective guide to anchoring excavators.

(1) Make sure the controls' neutraliser is engaged.

(2) The excavator is positioned on level ground (when practicable).

(3) The working ropes are attached.

(4) The stick is positioned in the range 110° to 130° to ensure there is a downward force proportionate to the forward force being applied.

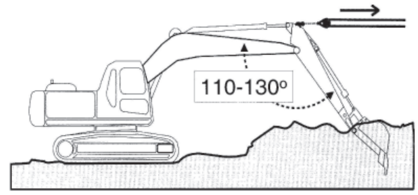
(5) The boom is oriented parallel to the skyline (load-line) except when drags are being pulled laterally to the skyline when the boom can be positioned to one side to compensate for the lateral forces imposed on the excavator.

(6) Prevent the base of the excavator moving sideways when under load from the working ropes. For example:

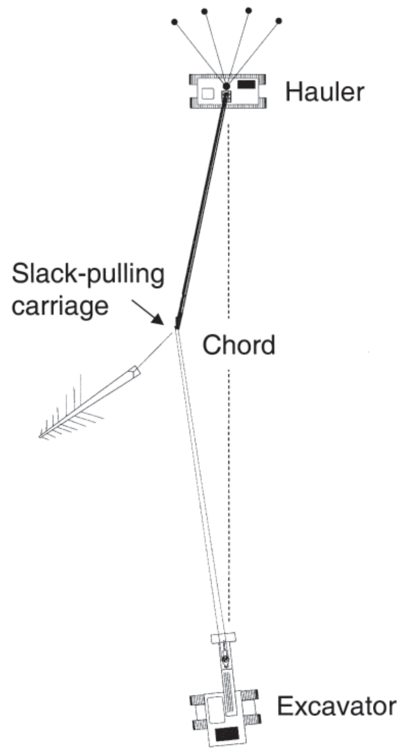
- Track gear is oriented at 90° to the boom, or
- Tracks parked hard-up against a bank, and/or
- A strop is tied between the back of the excavator base and the stump.

(7) Once the excavator is in position, get off before signalling to the hauler operator to tightline.

(8) Once the ropes are on their new line, make a final check of the excavator and rope orientations, excavator security before signalling the hauler operator that the operation can restart.



Recommended stick position



Angle the boom to compensate for any sideways forces

Shifting the excavator

Points to consider when shifting the excavator:

- Have a direct communication system with the hauler operator.
- Wear the seatbelt.
- When it is necessary to tension the working ropes during a line-shift, ensure the boom is oriented in-line with the working ropes. Do not tension the working ropes to the degree where you do not have total control.
- Have enough height in the ropes to clear any obstacles.
- Retreat to a safe position clear of the excavator before the working ropes are fully tensioned.

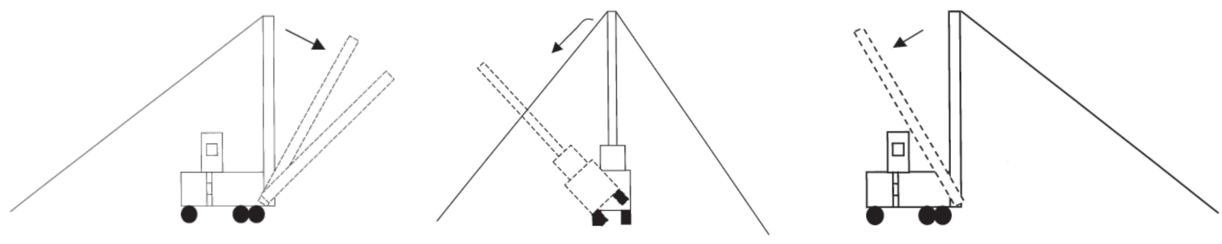
Guylines

Reasons for guylines

Guylines are required to keep the hauler tower or spar upright by apposing the forces transferred through the ropes.

The guylines on a hauler provide three types of support:

- Resistance to the tower toppling forward
- Lateral support for the tower
- On some towers "snap" guys or front guys are required to prevent the tower from toppling backwards should one of the working ropes break.

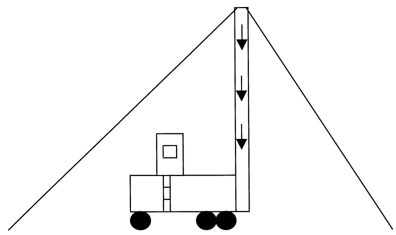


Guylines support the tower

Forces on a tower

Each guyline (and usually each of the working ropes) exerts a downward force on the tower.

The higher the tension in the guylines, the greater the compression in the tower. Compression increases with any given load as the guyline angles steepen.



Tower compression

Examples:

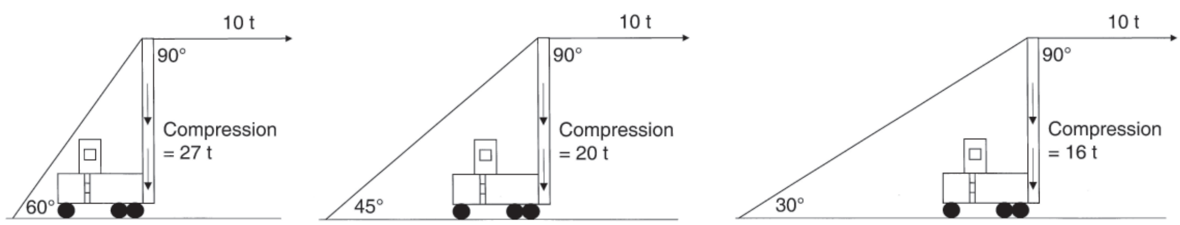
If a guyline is angled at 60° from horizontal, with the skyline at 90° and a 10 tonne load placed on it, the compression in the tower is 27 tonnes.

If the guyline is moved out to 45°, compression in the tower is now 20 tonnes.

If the guyline angle is reduced to 30°, compression is reduced to 16 tonnes.

Compression failures of hauler towers are rare. However, if they occur they may be attributed to a previously dented or damaged tower.

The solution to reduce compression is to increase the angle between the guyline and the tower.



Tower compression decreases as the guyline angle increases

Effects of guyline angle on tension

Vertical angles

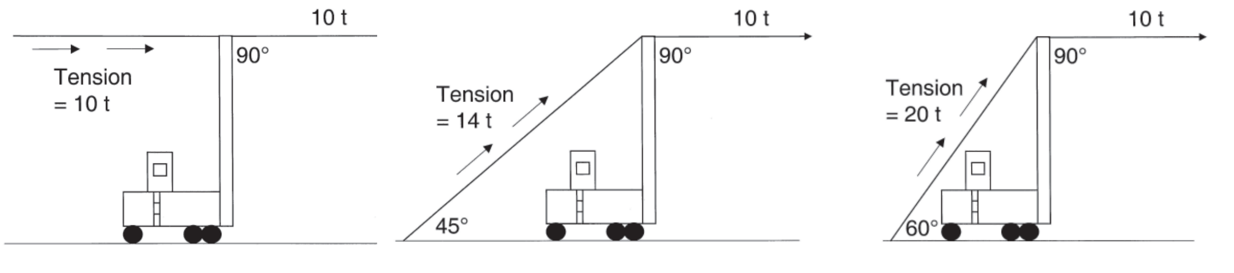
For a given load (skyline tension), the tension in the guyline increases as it gets steeper.

Examples:

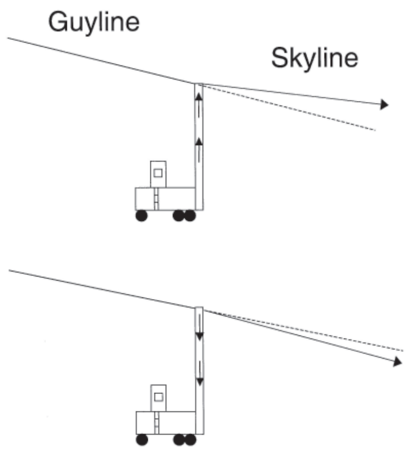
If the guyline is horizontal (vertical angle is 0°), the tension is equal to that of the skyline

If the guyline is steepened to 45°, the tension is now 14 tonnes

If the guyline is steepened to 60°, the tension increases to 20 tonnes



Effect of guyline angle on guyline tension



Upward (lifting) force (top) and downward force (bottom)

Guyline angles should be as flat as possible to avoid extreme tensions. An angle of less than 45° is recommended. However, this may not always be possible. In this situation, the **Approved Code of Practice for Safety and Health in Forest Operations** states that an addition guyline shall be installed to appose the haul line.

Guying above the tower can cause an upward (lifting) force on the tower. This occurs if the working rope(s) are angled above the guyline angle. If however, the working ropes angle below the guyline, a downward force is generated in the tower.

Horizontal angles

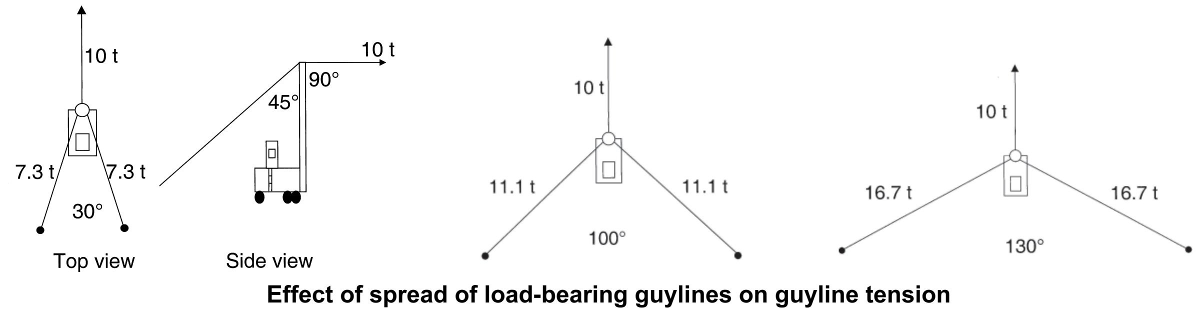
As the horizontal angle between load bearing guylines increases, tension in those lines increases.

Examples:

If a 10-tonne force is placed on the skyline, with two guylines equally spaced at 30°, with a vertical angle of 45°, the tension shared in those guylines is 7.3 tonnes.

If the angle between the guylines increases to 100°, the tension in each guyline increases to 11.1 tonnes.

If the angle between the guylines is further increased to 130°, the tension in each guyline is now 16.7 tonnes.



Effect of spread of load-bearing guylines on guyline tension

Guyline length and balancing

Guyline lengths

As the length of guylines increases, so does the amount of elastic stretch. This results in the tower movement increasing, which can work out anchors.

A rule of thumb is that guyline length should not exceed five times the tower height.

Where a combination of guy lengths is used on a single tower set-up, the guys should be pre-tensioned in proportion to their length.

Load-bearing guylines must share the load evenly to be effective. It is no good having four load-bearing guylines if only one is taking the tension.

Balancing guylines

Guylines should be balanced whilst under loaded tension.

Guylines of different length at the same tension have different amounts of sag or belly. When the load is applied, the short guylines would tighten first and would support much more of the load. This could lead to over-loading of the guyline or anchor, and possible failure.

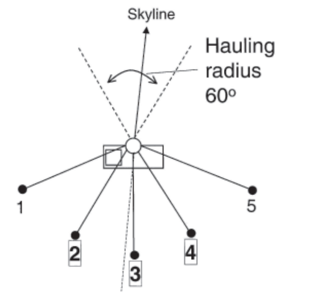
Signs of unbalanced guylines

Unbalanced guylines may caused the carrier chassis to twist on integral towers causing the following:

- Poor drum fleeting and excessive rope wear (pinching)
- Drum rubbing on guards
- Unusual gear noise
- Drum flanges visually out of line
- Unusual grease pattern on gears.

Hauling radius

The hauling (yarding) radius represents the horizontal angle in front of a hauler that can be worked safely from a single position or set-up. This is also termed working in lead.

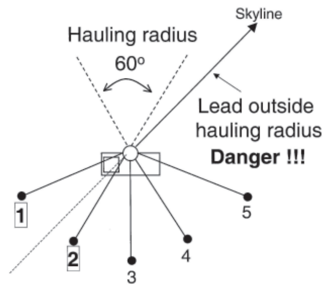


Working inside the hauling radius results in guylines 2, 3, and 4 taking the load

Leaning tower, 5 guylines

When the lead angle reaches the outer limits of the hauling radius, the hauler must be turned and/or guylines moved to accommodate the new lead angle. Failure to do this will reduce the efficiency of the guys in providing adequate support for the tower.

Many accident reports reveal operating outside the hauling radius as the cause of tower failures.

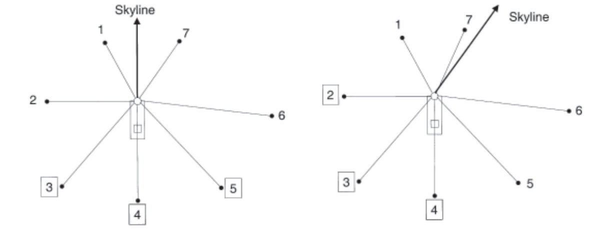


Working outside the hauling radius results in guylines 1 and 2 taking the load

Vertical front-mounted towers

Due to the arrangement on vertical front-mounted towers, the hauling radius can be up to 180° and more on some haulers. This type of hauler may only need to be turned once in a 360° setting.

In the case of a 7-guyline arrangement, as the lead angle approaches guyline 7, only that guyline needs to be moved, to avoid the operating ropes. All the other guys are in such a position that they need not be moved.



As the operation proceeds, guyline 7 is moved and the load-bearing guylines change

Swing yarders

The above rules also apply. The guylines must be kept in lead with the haul direction. This results in frequent guyline shifts.

How to identify guyline placement

Forward planning

Guyline placements should be planned in advance of shifting the hauler on to the site.

Forward planning improves efficiency by decreasing the time taken to set the hauler up. It also allows for plenty of time to select suitable anchor locations, and install or pre-rig them.

Of all the errors made with guyline systems, the most common is poor placement of the lines with regard to:

- Vertical angles
- Horizontal angle or spacing
- Length and balance.

Knowing the likely position of the hauler tower is critical for correct guyline placement. A range of factors, including the following, will dictate this:

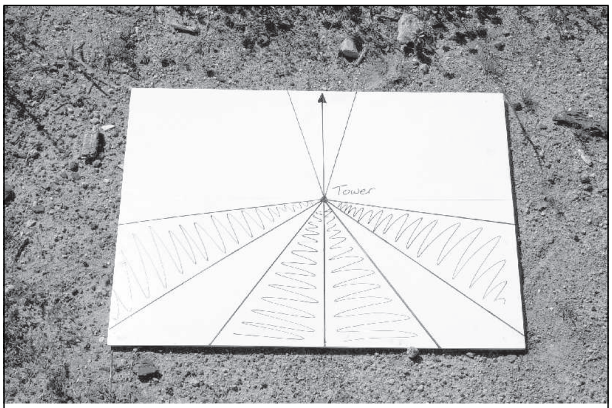
- Landing size and shape
- Available deflection
- Adequate space in front of the hauler to safely land drags
- The haul radius for the particular hauler being used
- Safe work zones for each activity on the landing
- The range of haul directions for the setting
- Access for a machine to clear landed drags from the chute
- The availability of adequate anchors or anchor positions.

Guyline positioning

A guyline marker board is a useful aid when planning the hauler and guyline positions on the landing. It shows the manufacturer's specifications for guyline placements.

Locating the guyline positions requires:

- Two people
- A short length of weighted string (e.g., a plumb bob)
- Guyline marker board
- Can of spray paint.



Marker board on the ground and aligned with the haul direction

Follow the steps below when planning the guyline placements:

(1) Place marker board on the ground where the tower is to be sited.

(2) The outer boundaries of the hauling radius will dictate how much of the setting you can safely pull before you need to move the guylines.

(3) Now choose guyline anchor locations.

One person stays at the marker board. The other person paces out the tower height in the direction identified on the board. For example, if identifying guyline placements for a 21-m-high tower, move at least 21 m away from the marker board. Anchor positions will be selected from beyond this distance. This ensures that the guyline angle will be less than 45°.

Identify suitable anchors or anchor positions that are in line with the marker board. The person at the marker board can accurately guide the other person by aligning the tower position with the short length of weighted string held over the anchor zone shown on the marker board.

Spray suitable anchor locations within the guying zone.

(4) Continue until all necessary anchor locations are identified. This may require turning the marker board or moving it slightly on the landing to accommodate the changes in haul direction.

(5) After the area around the landing has been felled, guyline extensions can then be attached to their particular anchors ready and waiting for the hauler shift.

How to rig the guylines

Guylines and extensions

(1) Thoroughly inspect all blocks, straps, guylines, shackles, and other rigging before they are used to guy up a tower.

(2) Check for damaged, cracked, or worn parts, loose nuts, need for lubrication, and the condition of the guylines and extensions. Check for other deficiencies such as:

- Broken wires
- Rope deformation
- Kinking
- Excessive wear on lines and terminals
- Bird caging
- Drum crushing

If any of these are found the rope must be removed from service.

(3) Also check raising equipment such as hydraulic rams and hoses, and the condition of the raising ropes.

(4) Ensure that the strength of any extensions is at least equal to that of the strongest working ropes being used.

(5) Avoid dragging extensions along gravel roads as this can cause unnecessary wear. It is better practice to coil them up and load them on to a truck or trailer.

(6) Make sure the guyline extension is the same lay as the guyline — that is, both should be either right-hand or left-hand lay. **Ropes of different lays should not be joined**.

(7) Secure the pins on all shackles used to join wire ropes. For example, use a grommet.

Guyline drums

(1) Make sure all ferrules are correctly housed.

(2) Always keep guylines tight and neatly fleeted - do not use hands for fleeting. Poorly fleeted guylines may crush and deform the rope. They may work loose causing an imbalance in the guyline system.

(3) Always leave at least four wraps of rope on each guyline drum; use an extension if the guyline is too short.

(4) Avoid a bight or fouling on the guyline when it is being tightened.

Avoid poorly fleeted drums - these may result in poor guyline balance

Safety strop

- Ensure the tower is fitted with safety equipment which confines the fall of the mainrope and damaged tackle in the event of failure of the lead block, blocks, or their securing tackle.

Balancing guylines

Follow the steps below when balancing the guylines:

(1) Pick up the skyline or mainrope to safe working load.

(2) Manually pull on the load-bearing guylines to see if they are equal.

(3) Lower the skyline.

(4) Adjust the tension in the load-bearing guylines to correct.

(5) Repeat until balanced.

(6) You will find that when there is no load on the tower, but the guylines are correctly balanced, short guylines will have more belly. The tower may feel floppy but the guylines are correctly balanced.

(7) Tensions on non-load- bearing guylines should be no higher than they need to be to provide stability.

Guyline maintenance

The job isn't over once the tower is up and you are pulling wood. You need to ensure that the guyline system is safe and will remain so through to the completion of a setting.

Routine checks like the following should be made once or twice daily to ensure no weak links appear in the guyline system:

- Check the guyline anchors for signs of movement:
  - Look for gaps behind the stump
  - Mobile anchors may show signs of sledging forward
  - Deadman may gradually lift out. A good idea is to spray a line of paint across the deadman and covering the ground beneath it. You will see if the deadman has moved because the mark on the extension will be forward of the mark on the ground.
- Check lines and terminals for rope deficiencies.
- Make sure you are hauling within the lead.
- Check the tension and balance in the load-bearing guylines (every skyline change or when you turn the hauler).
- Keep a check on shackles and other fittings. Make sure grommets are in place.

It is a good idea to have all workers learn and understand the fundamentals of guylines. This way, if a fault does appear it can be quickly identified and rectified. If any faults are identified, stop the hauler and remedy the fault before commencing further work.

Laying out wire ropes and lineshifts

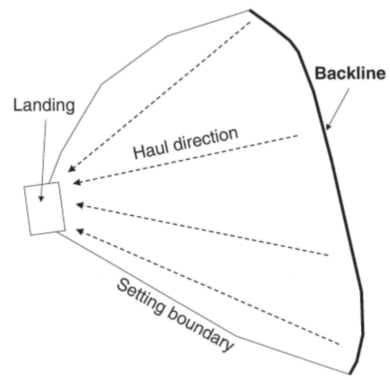
Lay-out basics

In most cable operations, the skyline and/or tailrope are strung out between the landing and the furthermost boundary of the setting. This is where the skyline and/or tailrope anchors are located, and is termed the backline.

The laying out of wire ropes involves rigging the anchors, and pulling the working ropes off the hauler and rigging them. When the backline is established, the anchors and working ropes are progressively moved along the backline as wood is extracted from the setting. This process of moving the anchors and rope is termed a lineshift.

When planning the backline consider the following:

- The cable system being used (rigging system, tailhold type)
- Ease of lineshifts - easier lineshifts mean less delay and therefore more production time
- Excessive binds which can lead to:
  - ¤ Wear on tailrope and blocks
  - ¤ Potential fire hazard through heat build up
  - ¤ Rigging bouncing around in an uncontrolled fashion
  - ¤ Slower outhaul of rigging.



Location of the backline

- Butt extraction as this is more productive (this will be influenced by felling and extraction direction)
- The location of any sensitive areas, such as streams and protected sites
- Compartment or setting boundaries defined by the forest owner.

Establishing the backline

- The backline is usually established by studying the harvesting plan and compartment maps (at some stage the backline(s) will run along the compartment boundaries).
- Walking the proposed hauler setting gives a better feel for the backline. The location of proposed anchor stumps can be identified before felling commences. Also any irregularities and hazards which may affect the faller can be identified early.

Forming the backline

The faller establishes the backline. He/she should consider the following:

- Leaving (and notching) high stumps to be used for tail block and skyline anchors
- Clearing a pathway between the anchor positions for easier carrying of rigging equipment and running of strawline
- Leaving standing trees if a tailtree is required
- Keeping in mind the path that the tailrope will follow, remove any major obstacles that could cause the tail rope to bind.

Selecting stumps to hang blocks

You need to choose stumps that will not pull out when tension is applied on the ropes and rigging at inhaul. Large fresh-cut stumps are the best choice.

Refer to the section on stump anchors (pages 71-73, 79, 80) for more details.

Correct positioning of the block for walking

Carrying blocks

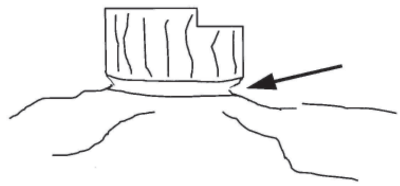
Carrying blocks can be hazardous as they can weigh up to 30-35 kg. There is a risk of back injury for the person carrying the block if the wrong technique is used. Also, there is a risk of injury though slipping and/or falling.

Heavy blocks should be lifted with a stable stance and with the knees bent. They should be picked up so they can be easily positioned on your back. The yoke should be opened so that when it is placed on your back, it hangs open in front of you.

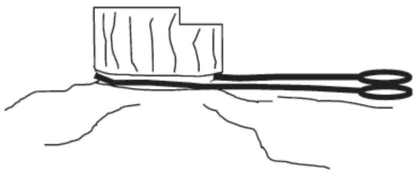
Once the block has been lifted it should be positioned high on your back, between your shoulder blades. It is preferable to ensure there is some clothing between the block and your skin. You need to lean forward slightly to ensure that your back and shoulders are taking the weight. This allows the block to be held in place with one hand on the open yoke, and leaves the other hand free to keep balance while walking.

How to hang a tail block or corner block

(1) With your chainsaw, clear an area around the stump. This makes easier access for notching, and will allow the block and the tailrope to operate freely.



Correctly notch the stump



Pull the eyes together so both sides of the strop are the same length

(2) Notch the stump:

- Position yourself in a safe, comfortable and balanced stance
- Make the cuts with the bottom edge of the chainsaw bar
- Watch what you are cutting and avoid over-reaching
- The first cuts are made at the right side of the stump. The following cuts will be made in a clock-wise direction around the stump. You will find that you will be moving backwards around the stump.

(3) Set the strop in the notch, bringing both eyes together in the direction of load. Ensure the strop is secure.

(4) Remove a gate pin and thread the yoke through the eyes of the strap, then lock the yoke by re-installing the pin. The head of the pin should be on the working side of the block.

Secure the pin (if a wire is used for locking purposes it shall be as large as the pin-hole will accommodate and have the loose ends bent over).

(5) Set the block in the direction of the load. Doing this prevents the strap from forming a kink and evens out the tension on both sides of the strop.

Laying out strawline

Strawline is either run directly off the machine or carried out to the backline in the form of coils. Sometimes in difficult areas helicopters are used to lay out strawline and take blocks and other rigging equipment to the backline. Setting up the blocks and running the strawline around the backline should be done prior to a hauler shift, thus reducing delays and increasing productive time

The following rigging equipment is required:

- Three or four tail blocks (Note: All blocks shall have a SWL at least equal to that of the rope that will run through them)
- Three or four block strops. (Note: The block strop shall be wire rope and at least the same SWL as the tailrope)
- Coils of strawline.

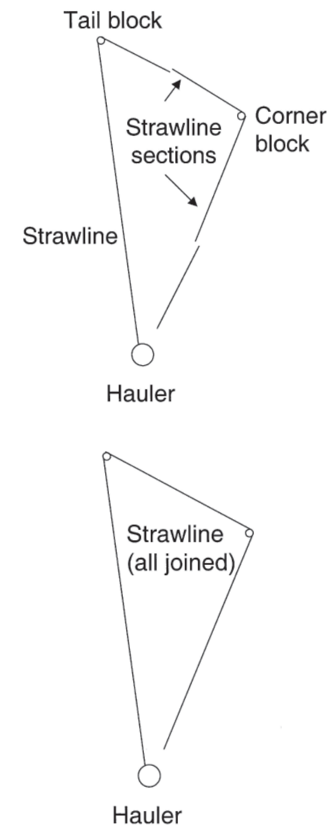
Use the following method to lay the strawline:

(1) Pull the strawline out as straight as possible (in the direction of haul) to minimise any bights.

(2) Where possible, lay the strawline over branches and other objects. This reduces rope wear and hazards associated with hang-ups springing free.

(3) Thread the strawline through the blocks, making sure that the strawline lies in the sheave properly. Loosely threaded line may tangle between the cheek plate and the sheave when the line is tightened.

(4) Make sure you connect the strawline sections with strawline hooks or connections. You may need to lace them to prevent them coming undone when pulling the tailrope around (wrapping the end around the joiner 1 or 2 times then back on to the hook).



Lay out (upper) and connect (lower) the strawline sections

Rigging procedures for highlead

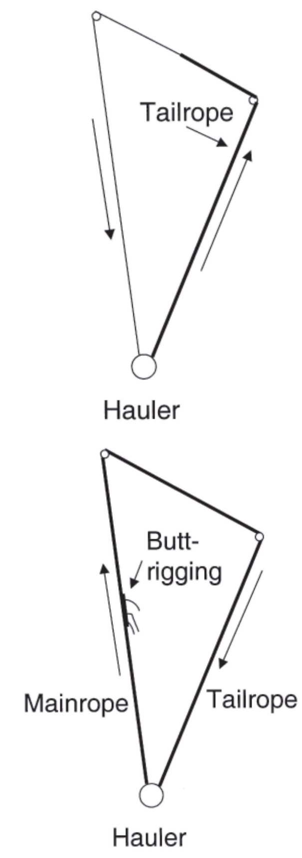
Setting-up for the first line

(1) The strawline must be strung through the tail block and corner blocks and all sections connected (as above).

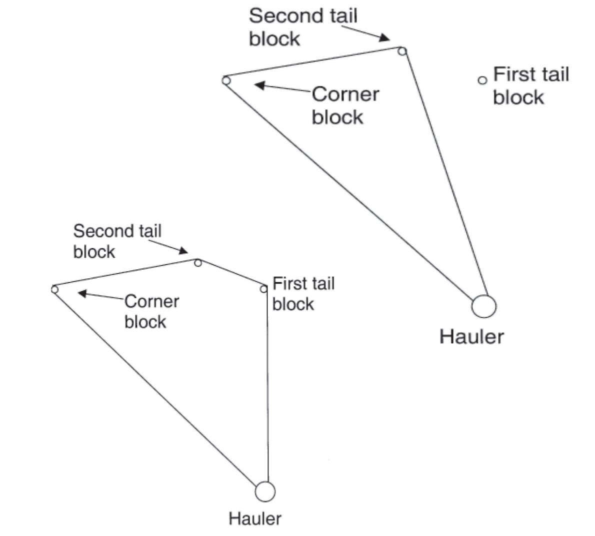
(2) The tailrope is connected to the strawline and pulled first through the corner blocks, then the tail block, before returning to the hauler. Workers should stand in a safe position, clear of hang-ups or hazards when the tension comes on the strawline. It is also important to make sure that the strawline is running through the blocks smoothly and unobstructed.

If any major binds or tangles arise, stop the ropes and remedy the problem.

(3) The tailrope is then hooked up to the trailing end of the butt-rigging which is connected to the mainrope. The butt-rigging is then run back to the tail block to clear the lines of any hang-ups.



Rigging for the Highlead system



Tripping the blocks

Lineshift towards corner block

Working towards the corner block is easily done by taking (tripping) the tailrope out of the first tail block and putting it in the second tail block. Then tightline the lines to form a new road.

This is the easiest method to move ropes for these reasons:

- No strawline is required
- Work is on clear ground
- Faster and thereby more productive
- Safer.

If the tailrope is likely to get hung-up, as it is tightlined across to the second block, two alternative methods are available, as shown below.

Method 1

(1) The mainrope is pulled into the landing and the tailrope is taken off the butt-rigging and joined to the strawline on the strawline drum.

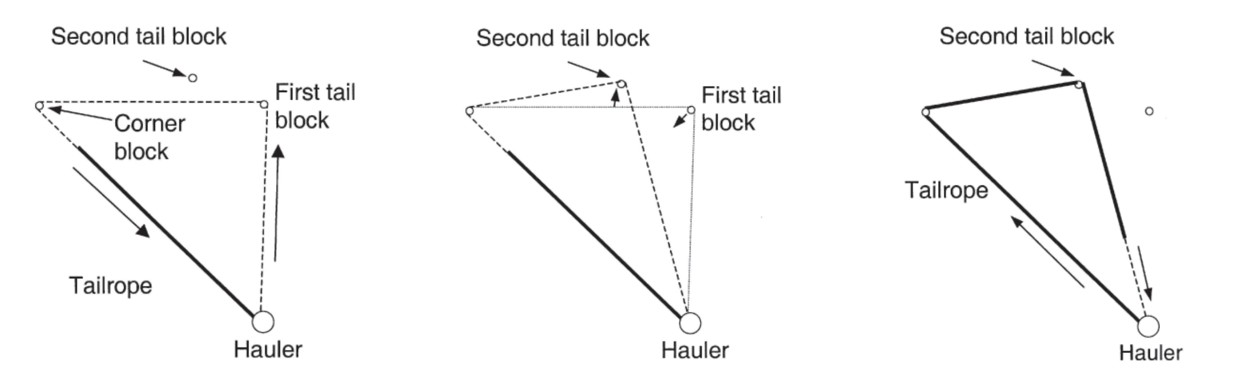
(2) The tailrope pulls the strawline back to past the tail blocks and the corner block, and is stopped.

(3) Slacken the ropes.

(4) Remove the strawline from the corner block.

(5) There should now be enough slack in the strawline to get it over any obstructions to form the path for the new road.

(6) The tailrope is pulled back to the landing and joined up to the butt-rigging.



Method 2

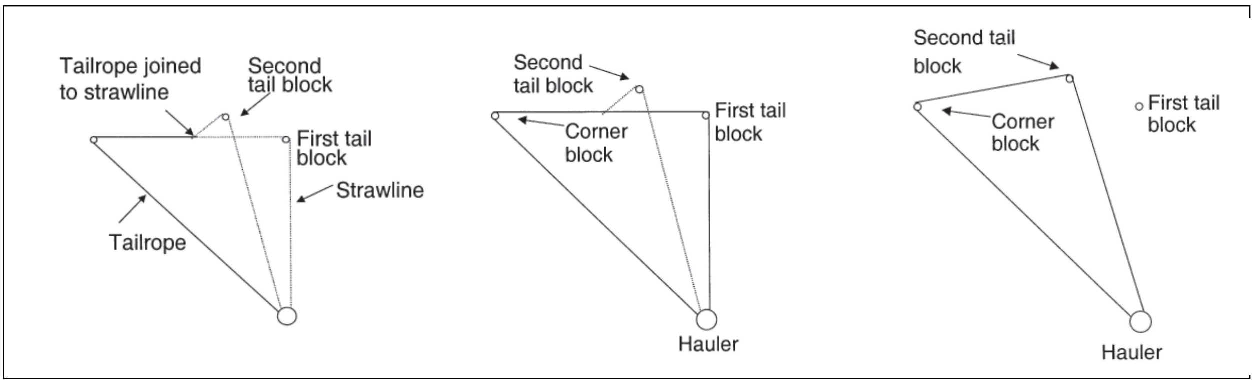
(1) Strawline is pre-strung from the hauler through the second tail block.

(2) The mainrope is pulled into the landing and the tailrope unshackled and joined to the strawline at the hauler.

(3) The tailrope pulls the strawline from the hauler out past the first tail block and is stopped when the end is at the second tail block.

(4) The tailrope is unhooked and joined to the pre-strung length of strawline.

(5) The strawline drum is engaged and pulls in the tailrope, which is then connected to the butt-rigging. The lines are tightened and a new road is formed.



Lineshift away from corner block

After the first hauling road is clear, the usual procedure to shift the ropes is as follows:

(1) A section of strawline is strung from the first tail block to the second tail block and back to the first tail block.

(2) The mainrope is pulled in, The tailrope is disconnected from the butt-rigging and joined to the strawline on the hauler.

(3) The tailrope pulls the strawline back to the first block and the ropes are slacked.

(4) The first tail block is removed.

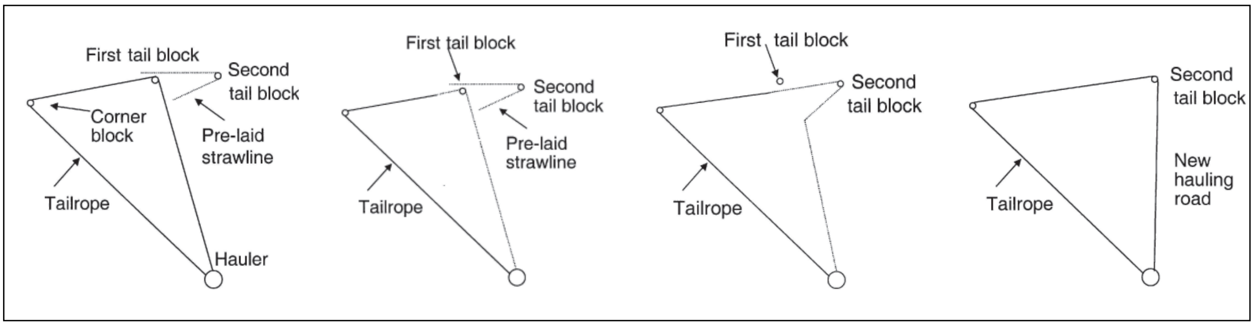
(5) The strawline from the hauler is disconnected from the tailrope.

(6) The tailrope is joined to one end of the pre-laid section of strawline and the other end is joined to the strawline from the hauler.

Note: At this point you may be required to lift the strawline over any obstacles that may prevent the tailrope from forming a new road when tightlined.

(7) The strawline pulls the tailrope through the second tail block and back to the hauler where it is joined to the butt-rigging

(8) The lines are tightened to form a new hauling road.



How to rig a skyline

The location of the first skyline road can be influenced by any the following:

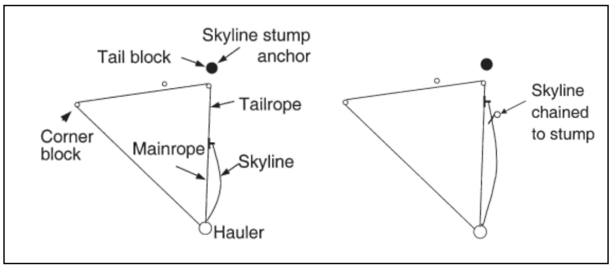
- Terrain features like a ridge or spur
- The time-span felled timber is allowed to be on the ground.
- Felling pattern

There are a number of different methods used to rig a skyline to a tailhold. The following is a manual method.

(1) Strawline is run around the layout and used to pull the tailrope around and back to the hauler where it is disconnected.

(2) Using a three-way swivel, the tailrope is shackled to one end and the strawline or (mainrope) to the other end. The skyline is shackled to the lower swivel section.

(3) The tailrope pulls out the strawline (or mainrope) and the skyline to the tail block.



(4) By using a pass chain (or similar), the skyline is chained to a stump or some other solid object. The skyline is lowered and the chain prevents the skyline from running away.

(5) The strawline (or mainrope) pulls the tailrope back a little distance, which creates slack allowing the skyline shackle to be removed from the swivel.

(6) The strawline (or mainrope) pulls the tailrope towards the hauler and a pass chain is attached to tailrope and skyline to pull the skyline slack. You will need to tie the chain a large enough distance down the hill to provide enough slack in the skyline for it to be tied to stumps or any other form of tailhold.

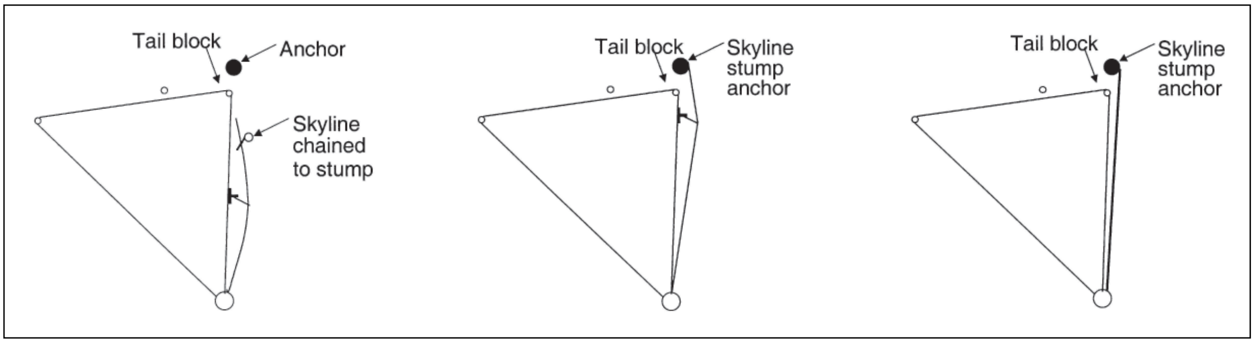
(7) The tailrope goes ahead and pulls slack in the skyline. You will be able to disconnect the first chain now that there is no tension on it.

(8) The slack end of the skyline is tied and shackled to a stump/s or other form of skyline anchor, and then the all the ropes are gradually slackened off to avoid shock loading in the lines.

Keep well clear of any blocks, lines, and the skyline anchor when slackening the lines.

(9) With all the ropes slack, you can now remove the pass chain from the tailrope and skyline.

(10) The lines are tightened and the tailrope is pulled to the landing by the strawline (or mainline) where they are connected to a carriage.



How to move a skyline towards a corner block

Note: This method does not apply to mobile tailholds

(1) The mainrope is hauled in and the tailrope disconnected from the carriage and joined to the strawline.

(2) The tailrope then pulls out the strawline.

(3) The skyline is slackened and the tailrope chained to the skyline to pull slack.

(4) Enough slack is pulled to allow the removal of the shackle and skyline from the anchor.

(5) The ropes are slackened gradually and the tailrope is tripped out of the first tail block.

(6) The tailrope is pulled ahead to the second tail block, bringing the skyline with it.

(7) The slack end of the skyline is tied to the pre-grooved stump anchor(s).

(8) The ropes are slackened and the chain is removed.

(9) The ropes are then tightened to position themselves on the new road.

(10) The strawline pulls the tailrope back in to the landing. The tailrope is finally connected back to the carriage.

Note: If conditions are such that the skyline or tailrope cannot be tightlined to the new road, the lines will have to be pulled back to the hauler and restrung.

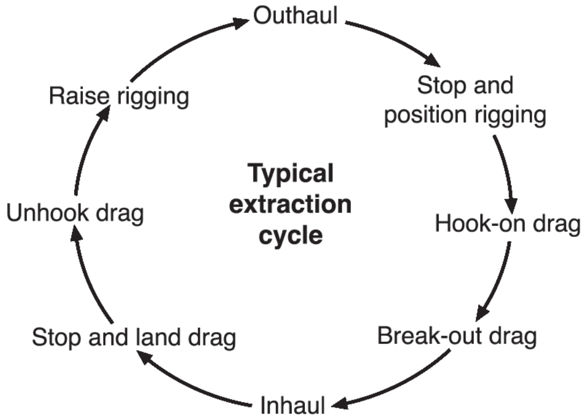
Breaking-out

What is breaking-out?

Consider the extraction cycle.

The breaking-out phase involves:

- Hooking on the drag
- Breaking-out the drag.



A typical extraction cycle where breaker-outs are used

Role of breaker-outs

Breaker-outs are responsible for:

- Planning extraction along an extraction corridor
- Directing the hauler operator to position the rigging
- Hooking on stems to optimise payloads and reduce breakage.

In addition, breaker-outs are often responsible for:

- Planning and directing lineshifts
- Rigging anchors and blocks
- Moving a mobile tailhold.

A crew will typically use one, two, or three breaker-outs over the duration of an operation. Four breaker-outs, in two teams of two, may be used for pre-stropping operations.

Crew effectiveness

The breaking-out crew should have one person in charge (head breaker-out). This person is the team leader, and should be someone with sound experience. This results in less confusion and maximises the effectiveness of the crew.

The head breaker-out is responsible for:

- Determining what stems to hook on to make an optimum drag
- Ensuring the drag is moved in a controlled manner until the hauler operator takes charge of it. He/she also identifies what action needs to be taken in the event of a mishap.
- Determining where to hook on the stems
- Managing the safety of the other breaker-outs
- Identifying the haul path

Effective communication between crew members is critical to ensuring the safety and efficiency of breaking-out.

The primary objective of the break-out phase is to maximise payload within the SWL of the working ropes. This is more critical than speed, which often compromises optimum payloads and safety. The productivity of the whole operation is largely controlled by the break-out phase.

Planning the drag

The next drag should be planned prior to the carriage/rigging being sent back. This minimises delays to production and allows breaker-outs to build optimal drag sizes. The following factors should be considered when planning the drag. Note that drags are usually extracted from the front of the corridor first.

Consider	Reason
Ease of access	Providing ease of access for the breaker-outs reduces the walk hindrance and allows for quicker and safer hook on.
Optimum drag size	The optimum drag size is the biggest drag that can be extracted without over-loading the rigging and hauler. • Drags that are too heavy will slow break-out and inhaul. They may also overload the rigging. • Drags that are too light will mean that the system is working under capacity - this is an inefficient use of labour and machines. It can be difficult to assess the optimum drag size without knowing something about the rope tension and/or deflection. If a tension monitor is fitted or the band brake correctly calibrated, the optimum drag size can be estimated.
Minimising stem breakage	Stem breakage will reduce drag volume and requires more extraction cycles to extract a given area.
Balance of wood flow to landing	Maintaining a balanced (uniform) wood flow is not always easy. Surges in productivity are common. Some of the reasons for this include: • Changing haul distances from the front to the back of the haul road • More lateral pulling is done toward the back of the haul road where the extraction corridor is often wider • Some drags are more difficult to hook on and break-out • Variations in tree size and stocking • Clean-up prior to a lineshift • Lineshifts • Other operational or mechanical delays
Work face clean-up	The job prescription will have a minimum log specification that must be pulled and the allowable level of merchantable waste. The breaker-outs should know this so that a costly re-work or penalty is not imposed on the contractor. The minimum log specification and cutover standard will vary between forest owners.
Minimising hazards	When planning a drag, the breaker-outs must be aware of hazards they may face, and make provision to avoid or minimise them.

Positioning (spotting) the rigging

Getting the butt-rigging or strops to land in the exact place requires skill. The benefit of landing the rigging in one go means shorter cycle times with the opportunity for increased production.

When positioning the rigging consider the following:

- Anticipate line or carriage movement
- Allow time for the hauler operator to react and to engage the controls smoothly
- Wait until the butt-rigging or carriage is stationary and the strops have stopped swinging before moving in.

Highlead system

Generally:

- Butt-rigging and strops will be lying on the ground
- Tightlining will lift the butt-rigging and make strops easier to untangle.

Scab skyline and fall-block systems

Generally:

- Lines will usually stop with rigging suspended
- Strops will move away from the hauler when the mainrope is slackened
- Strops will move towards the hauler when the tailrope is slackened.

If the rigging is suspended far off the ground, slackening the mainrope or tailrope will cause the rigging to drift beyond the desired point. This can be corrected by slackening the mainrope and tailrope alternately, or slackening only one rope but anticipating the drift.

If a gully is too deep and positioning the rigging takes too long, you may have to rig another system.

Slack-Pulling carriages

Working down a face:

- Stop the carriage a short distance before the drag. It is easier to pull slack downhill than uphill.

Working up a face:

- Stop the carriage a short distance past the drag for the same reasons.

Clamping carriages

When a carriage is not clamped to the skyline, it will roll freely. Therefore, the skyline tension on either side of the carriage will remain the same.

Once the carriage is clamped, any force applied to the carriage (during break-out) will cause a difference in skyline tensions across the carriage clamp. If the hauler operator applies enough mainrope tension, the tension in the front portion of the skyline will decrease. In contrast, the tension in the back portion of the skyline will increase. If tension is excessive, the back portion of the skyline or the tailhold anchor could fail.

Clamping carriage position and skyline tensions

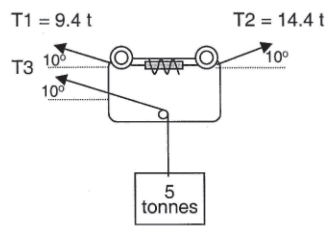
The effects on tensions of the mainrope angle as it passes through the carriage are illustrated for a given set of conditions as follows:

Carriage at right angles to the drag

If a clamped carriage is positioned so that the drag is pulled in at right-angles to it, the difference between the tension in the front and back portions of the skyline (T1 and T2) will be approximately equal to the drag weight plus any extra break-out forces.

This situation occurs most often when the relative hauler tower and tailhold heights are the same.

If the carriage is not clamped, T1 and T2 will equalise as the carriage moves on the skyline.



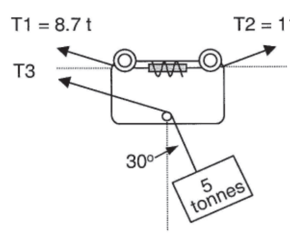
Carriage clamped directly above the drag

Carriage in front of the drag

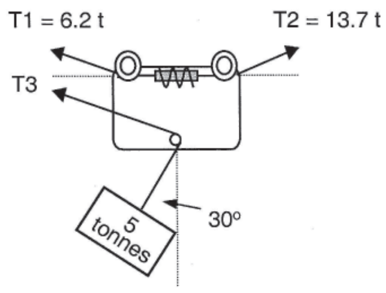
If the carriage is clamped in front of the drag, the difference between T1 and T2 will be less than in the previous situation.

This is the most desirable break-out position for a clamping carriage. It will occur when logging the front face of a setting (for example, the hauler side of a gully) and/or when the top of the tower is higher than the tailhold anchor (such as uphill extraction).

In these situations, the breaker-outs will clamp the carriage uphill in front of the drag, so that the slack can be pulled downhill.



Carriage clamped in front of the drag



Carriage clamped beyond the drag

Carriage behind the drag

If the carriage is clamped beyond the drag, a block-purchase effect is created on the carriage clamp. In this case, the tension difference between T1 and T2 can be much greater than in the two previous examples. This is because the block-purchase magnifies the break-out force on the clamp, the back portion of the skyline, and the skyline anchor. As the clamp is released, T1 and T2 equalise causing a shock loading at the clamp. This can result in sudden failure of the skyline. The hauler operator will feel this equalising as the shock-loading is transferred to the hauler tower.

This situation is the least desirable break-out position for a clamping carriage.

It can occur when logging the back face of a setting (the far side of a gully) and/or when the tailhold is higher than the top of the tower (downhill hauling).

This situation is best dealt with by repositioning the carriage in front of the drag and clamping it for break-out.

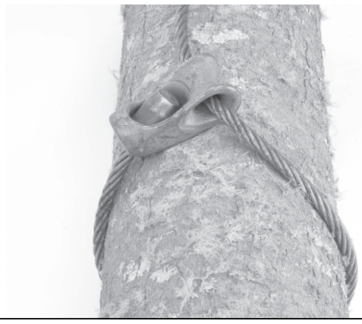
Hooking on a drag

General rules

Attaching a strop to a stem is a relatively basic process. However, some general rules apply for successful attachment.

- If stems are layered, hook on those on top first. This will free up stems underneath for following drags, and reduce breakage and break-out tensions.
- Hook on the furthest away stems first.
- At all times strops must be attached approximately 1 m ($1^1/_2$ times the butt diameter) from the end of the stem. This ensures that the stem falls below the strop and does not swing during inhaul. If stems are attached near their balance point (gut-hooking), they will swing during inhaul and will make landing and unhooking more difficult.

  If for practical reasons the stem cannot be attached within 1 m of its end, or the stem is likely to swing or up-end, the breaker-out shall notify the hauler operator.
- Pass the ferrule or chain hook end of the strop over the stem. Pull the end back under the stem and connect it to the choker hook or chain.


Incorrect (top) and correct (bottom) choking


Attaching wire rope strops

Basic technique

(1) Put the ferrule into the choker hook with the keyhole facing in towards the stem. This makes it easier to unhook at the landing.

(2) Hold on to the choker while wrapping the strop around the stem. If breaking-out downhill, the choker could slide out of reach.

(3) Put a slight bight on the rope so that it does not slip when tightened.

(4) If necessary, wedge a small stick between the housing and the rope to stop it slipping.

(5) Position the strop at least $1^1/_2$ times the butt diameter from the end of the stem, (butt ends are preferred). If this is not possible, re-strop once the stem has been broken-out, or notify the hauler operator.

(6) Walk back to the next strop and hook on remaining stems in sequence.

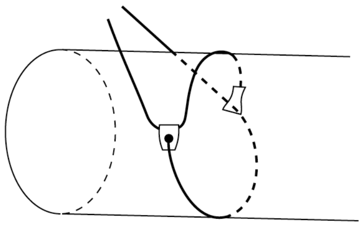
Alternative methods

- Double strop (two stems per strop) - used on small stems.
- Figure 8 - used on small stems or head pulls to stop the stems from sliding out.
    - ¤ The ferrule end of the strop is pushed under the first stem then over the second stem
    - ¤ The ferrule is then threaded under the second stem, back over the first stem and into the choker bell.
    - ¤ Avoid crossing strops over themselves as this causes rope damage.
- If a single strop is not long enough, two strops can be connected end-to-end. This method is often used to pick up stems that have fallen off a strop during inhaul.

  Use the following steps:
    - ¤ Lower butt-rigging to remove the ferrule end of one strop from the butt hook.
    - ¤ Attach the ferrule of the strop you removed to the choker hook of one of the other strops. With this extra length you can pull out the strop and choke the stem.

      Let the hauler operator know that you have lengthened a strop before sending in the drag.
- Another alternative is the bridle, where two strops are used to choke a stem just out of reach of a single strop.

Double strop



Bridle

Attaching chain strops

Basic method

(1) Connect the chain hook so the open side is away from the direction of pull.

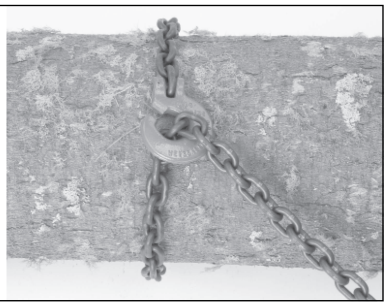
(2) Pull the chain tight before connecting.

(3) Position the strop at least $1^1/_2$ times the stem diameter from the end of the stem (butt ends are preferred). If this is not possible, re-strop once the stem has been broken-out, or notify the hauler operator.

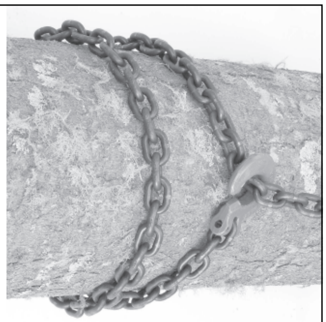
Alternative methods

If head-pulling or extracting small stems the hook can be double wrapped before being hooked to the chain. This reduces the risk of breaking the stem.

When head-pulling downhill, a variation on the double wrap may be used. This ensures that the strop remains done up during inhaul.



Single chain wrap



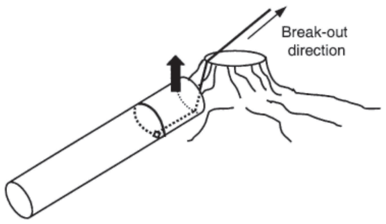
Double chain wrap

Alternative double wrap

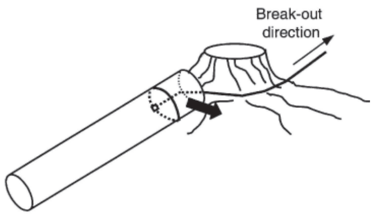
Dealing with obstacles or hang-ups

It is more desirable to move a stem around or over an obstacle by moving the carriage into a better position. However there are times when hang-ups can't be avoided and special techniques must be employed to move the stem.

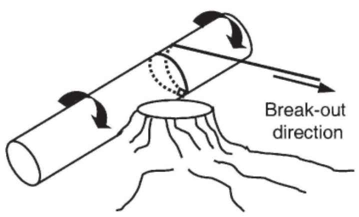
Three basic manoeuvres can be used to work around a hang-up: the jump, kick, and roll.



The jump



The kick



The roll

The jump

(1) Set the strop in the usual fashion. Then slip the choker bell or hook under the centre of the stem.

(2) The leading end of the strop is forced under the stem and is laid over the top of the obstacle.

(3) When the strop is tensioned, the bight of the strop over the obstacle will pull straight up on the end of the stem.

The kick

(1) The choker bell or hook is placed opposite the direction of pull and the leading end of the strop is again led around the end of the stem, but around the obstacle instead of over it.

(2) When tension is applied, the stem will be pulled sideways away from the obstacle.

The roll

(1) The strop is set in the normal fashion

(2) Once set, the strop is slid around the stem away from the desired direction of pull. The leading end of the strop will be wrapped around the stem.

(3) Once the roll is set, tension is applied rolling the stem away from the obstacle.

Moving into the clear

Before the signal is sounded for the drag to move, the breaker-outs must move:

- Out of the rope bight
- Out of reach of any stems which may swing or up-end. This should be at least the length of the longest stem away.
- To the uphill side of a drag
- Into a position where movement will not be constricted (there must be an escape route).

Breaking-out operations must also be at least two tree-lengths from the tallest tree being felled.

Dealing with a fouled drag

If the drag becomes fouled:

- Do not over-tension the ropes and rigging
- Signal the hauler operator to stop the ropes. Investigate the situation and assess the options.
- You may be able to use the tailrope to free the drag providing your tail rope has the capacity to do so. Be aware that higher forces on the tailrope and tail block can be expected when using this method. Do not exceed the SWL of the tailrope.

Procedure for breaking-out

(1) From a safe position to the side of the skyline, identify the position of the next drag.

(2) Signal the hauler operator to stop outhaul and lower the rigging in the correct position.

(3) Signal the hauler operator to stop lowering the rigging just as the strops hit the ground.

(4) Walk in to the strops, taking care to not slip or trip.

(5) The head breaker-out assigns the strops and stems/pieces to be stropped to each breaker-out.

(6) Each breaker-out pulls the strops out to their respective stem.

(7) Once standing clear of the rigging, the head breaker-out may signal the hauler operator to lower the rigging further to provide more reach.

(8) Hook on the drag. If you have finished, you may be able to help your mate(s) hook on theirs.

(9) Once the stems have been hooked on, retreat to a safe position above and preferably behind the drag.

(10) When everyone is standing in a safe position and is facing the drag, the hauler operator is signalled to raise the rigging and take up the load. The hauler operator should do this slowly so as to avoid breakage and reduce rope loadings.

(11) If using radio communication, let the hauler operator know when the drag is clear and now under their control.

(12) During inhaul and unhook, start planning the next drag. Remain in a safe position to the side of the skyline.

Landing the drag and unhooking

Basics

Inhauled drags are generally grounded in the area immediately in front of the hauler. This area is termed the chute.

The exception is where a swing yarder swings the drag sideways before grounding so that it is to the side of the yarder.

Hauler operators landing a drag need to consider:

- Workers and machines on the landing in close proximity to the hauler
- The ease and safety of unhooking
- The safety of any workers positioned downhill from the landing area.

A drag in the chute being unhooked

The following are general guidelines that relate to the landing and clearing of drags from the chute:

- All landing or skid workers must have a designated safe position outside the working area and be visible to machine operators. This area may also be used for maintenance of chainsaws.
- There should be no accumulation of slash or log residue in the chute that may pose a hazard for anyone unhooking.
- No person is allowed in front of the tower or hauler during the inhaul cycle

  EXCEPTION **unless that person is protected by an OPS certified cab with side intrusion**.
- Landing workers should not stand beneath guylines opposing the direct line of pull during the break-out and inhaul phases.
- Landing chutes must be long and level enough so that at least $^2/_3$ of the longest stem to be landed may rest on the ground.

Worker waiting in a safe position and watching the drag being landed

- During uphill extraction, the chute should be cleared of stems before the next drag is landed, unless:
  - The stems are fully contained in the landing
  - There are no persons working below the landing that may be struck by rolling objects coming from the landing.
- For downhill extraction, the chute must provide sufficient space for the stems to be landed and controlled in a safe manner. All machines (including the hauler) should be far enough back so those stems will not slide, roll, or swing into any machine.
- No person is to use a chainsaw on any stockpiled stems.
- Loaders and skidders used for clearing the chute must be clear of the chute during unhook, unless otherwise signalled by the person unhooking.

Landing the drag

- As the drag approaches the landing the hauler operator should throttle back on the moving ropes and/or slacken the ropes as appropriate to safely land the drag.
- The drag must not be landed until all workers are clear of the incoming drag and previously landed drags.
- If a worker is attending to the unhooking, he/she should be in clear view of the hauler operator during the landing phase.
- As the drag approaches the landing, it may need to be tightlined to clear any stems still in the chute. Alternatively, the skyline may need to be raised. If not, the incoming drag can shunt the previously landed stems forward towards the hauler.
- If hauling downhill, sudden braking of the tailrope can cause the elevated end of the drag to swing excessively. This can pose hazards for landing workers and machines near the chute.
- Lower the rigging so that there is adequate slack in the strops and so that they do not swing about when unhooked.
- If a stem(s) is gut-hooked, it will need to be lifted as high as possible on approach to the landing to clear the ground and previously landed stems. Be aware that it may be more difficult to safely ground a gut-hooked stem.

Hand signal for "a stem is still stropped"

Unhooking the drag

The procedure for unhooking a drag is as follows:

- Do not approach the drag until it and the rigging are stable and secure.
- Walk into the strops from in front of the drag, assessing the order that they will be unhooked. This will also allow you to assess if the stems are stable. If they are not, the hauler operator will need to raise and drop the rigging again to safely ground the drag.
- Unhook the lower strops first.
- Do not climb on elevated (and potentially unstable) stems.
- If the choker or chain hook cannot be safely reached or there is inadequate slack to unhook them, signal to the hauler operator to re-land the drag. Retreat to a safe position clear of the drag and ropes. Use the recommended hand signal to indicate the number of stems still to be unhooked.
- If a stem cannot be grounded safely, a loader or skidder can be used to reposition it. The person unhooking should retreat to a safe position before the machine moves in.

Elevated supports

Why rig an elevated support?

The shape of the terrain may limit skyline deflection or clearance. This may result in low or no payloads able to be extracted without exceeding rope SWLs or causing too much site disturbance. The solution may be to raise the skyline by rigging an elevated support.

Generally, elevated supports can provide the following benefits:

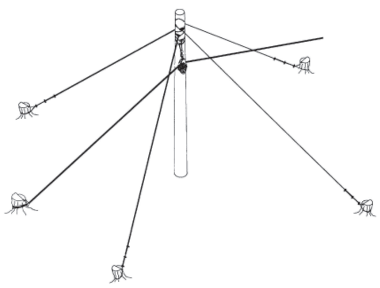
- Heavier optimum payloads or reduced rope tensions for the same payload
- Increased rigging clearance - this may reduce the time needed for breaker-outs to untangle strops, allow drags to be extracted from behind blind ridges, and keep a carriage off the ground
- Greater clearance over a sensitive site can be achieved
- Reduced soil disturbance
- Haul distances may be increased (and roading density decreased).

Types of elevated support

An elevated support may be used to:

- Raise the height of the skyline at the anchor end (Tailtree)
- Increase height part way along the span (Intermediate Support)

The most common elevated support is the tailtree. Here the working rope is elevated using a block and strops attached around the tree. The tailtree is usually prepared by delimbing and topping it, and anchoring it with guylines.

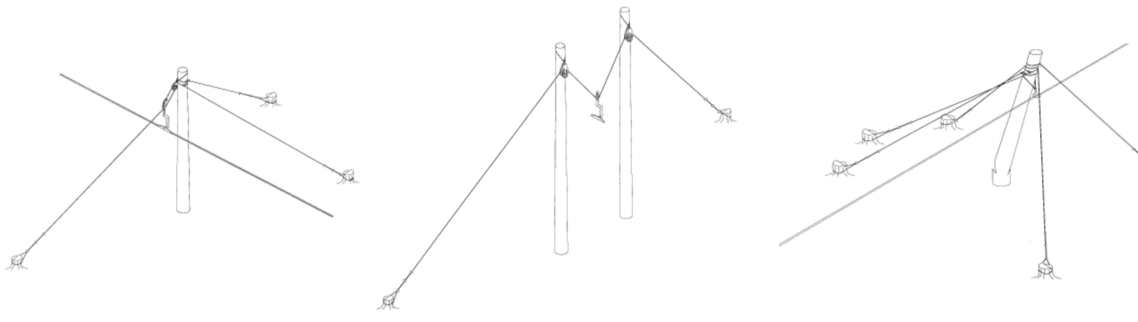


A rigged tailtree

Intermediate supports are used to elevate the skyline. They are located within the central part of the span. Unlike a tailtree, the carriage passes beyond the support tree. This requires the use of a open sided support jack and a carriage capable of passing the jack.

Intermediate supports usually comprise one or more trees rigged in a range of ways. These include the following:

- Single tree
- Double tree
- Leaning tree.

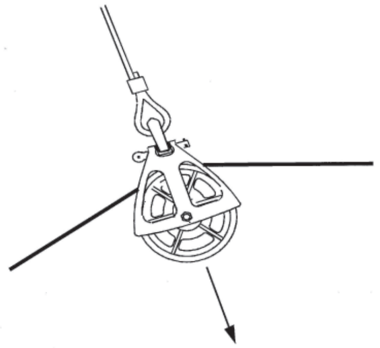


Single tree (left), double tree (middle), and leaning tree (right) intermediate supports

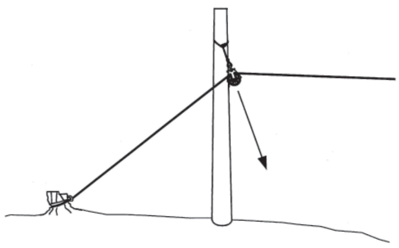
Forces on a support tree

There is always a downward force on a support tree. Therefore it must be strong enough to withstand this compression without buckling.

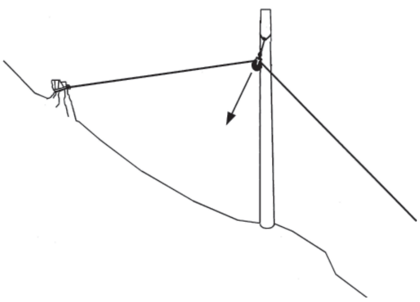
There is also a force imposed by the skyline.



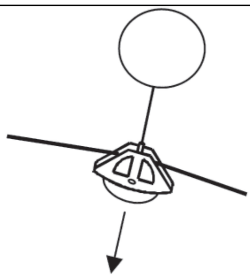
Direction of force



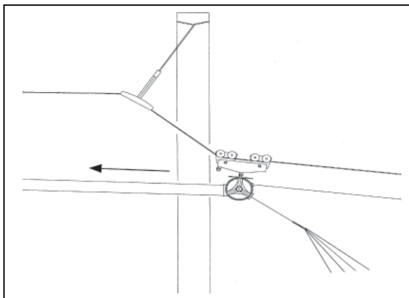
Resultant force on the tailtree is forwards



Resultant force on the tailtree is backwards



Sideways force on the tailtree (viewed from above)



Approaching the jack on inhaul

Forces on a tailtree

The block strop will hang in the direction of this force, which bisects the bight angle around the block. Depending on the angle on either side of the support tree, this force pulls the support tree either forward or backward. Properly installed guylines will resist all the forces trying to pull a tree.

Both **direction** and **size** of the resultant force depend on the bight angle.

When the skyline angle is flatter on the hauler side of the tailtree, the resultant force is towards the hauler. This situation, which occurs in most tailtree installations, requires guylines *behind* the tailtree to resist the resultant force.

The resultant force will be away from the hauler if the angle of the skyline is steeper in front of the tailtree than behind it. This often occurs when the carriage is close to the tailtree or when the skyline angle behind the tailtree is relatively flat (as in a downhill pulling).

These situations call for guylines *in front* of the tailtree to resist the resultant force trying to pull the tree over backwards.

Whenever the skyline is pulled sideways, a lateral force will also be imposed on the tailtree. This situation occurs when breaking-out with a MSP carriage or when bridling.

The size or magnitude of the lateral force depends on the bight angle around the block as viewed from directly above. For a given skyline tension, the greater the bight the greater the lateral force that will be exerted on the tree.

In this situation, extra guylines must be placed on the side of the tailtree opposite the skyline.

Forces on an intermediate support

When an intermediate support is used, the skyline passes over a support jack. One or more support trees at a planned location along the skyline corridor elevate this jack.

Note:

- The support jack must be able to swing clear of the support tree(s)
- The vertical skyline angles on each side of the support jack must allow the carriage to ride over the jack. If the angle on the tailhold side of the jack is too steep the carriage will tend to dive beneath the jack on inhaul.

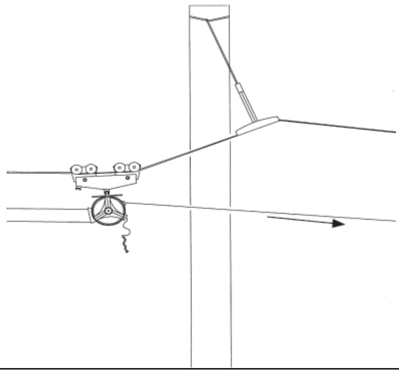
As the carriage and drag approaches the support tree during inhaul:

- The skyline is pulled down, and
- The jack swings further forward, towards the hauler.

As the carriage approaches the support tree during outhaul:

- The skyline is pulled down (in the opposite direction to uphill hauling)
- The jack swings backwards, away from the hauler.

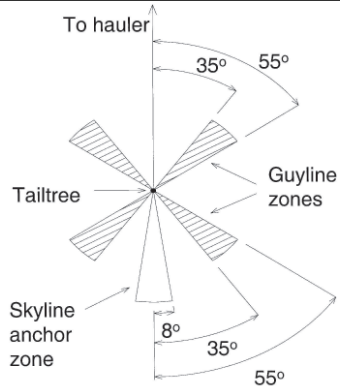
In addition to forward and backward forces, the support line on a single tree intermediate support pulls the jack away from the tree, at 90° to the skyline.



Approaching the jack on outhaul

Guyline requirements for tailtrees

During hauling, most tailtrees are subject to all the forces discussed above. A general guide for guyline anchor locations is shown at right.



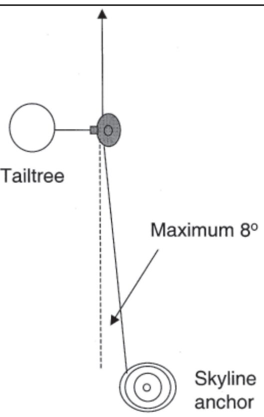
Guyline anchor zones

Guyline placement will depend on:

- Whether the dominant force on the tailtree is forward or backward
- The degree of lateral hauling (sideways force on the tailtree)
- Where the stems are being extracted from.

If there is no forward or backward force on the tailtree, all four guylines should be rigged.

When the dominant force on the tailtree is forward towards the hauler, the back two guys (1 and 2) will support most of the load. There will also be a sideways load imposed by the skyline. This requires a third guyline to the front of the tailtree on the side opposite the skyline (3). The fourth guyline (4) takes essentially no load unless lateral pulling from the tailtree side of the skyline, when the skyline is pulled over to the tree.



A bight in the skyline holds it clear of the tailtree

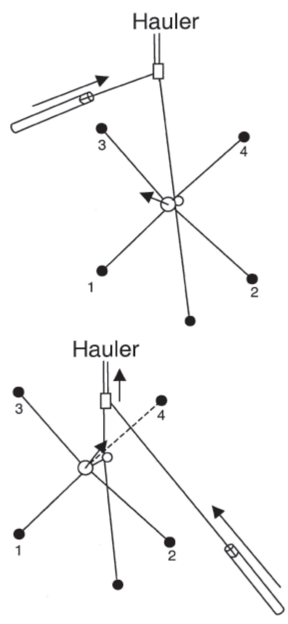
Having a slight bight in the skyline can help counter this sideways movement of the skyline. The bight should be away from the most effective guyline placements.

Although the bight will pull the tree towards the skyline (thus opposing forces from the other side of the tree), the skyline itself should *never* be considered as a guyline.

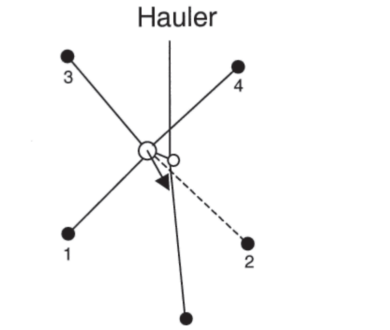
The maximum bight in the skyline should not exceed 8°.

If such lateral hauling from the tailtree side of the skyline is planned, it is recommended that the fourth guyline be rigged.

If all four guylines are rigged, it is possible to drop the fourth guyline (4) to reduce the chances of fouling the guyline when hauling from behind the tailtree on the skyline side



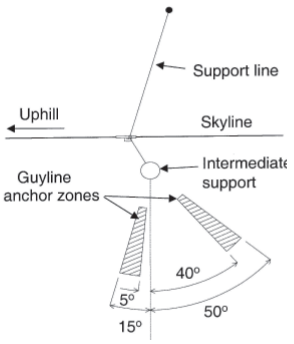
All four guylines must be rigged if lateral hauling from the tailtree side (upper). The fourth guyline (4) can be dropped if hauling from behind the tailtree on the skyline side.



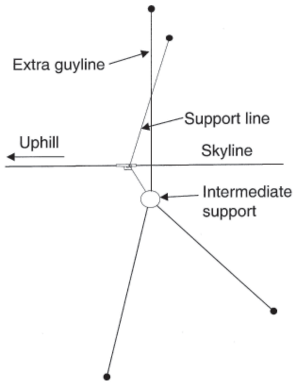
Guyline layout when the dominant force on the tailtree is backwards

When the dominant force on the tailtree is backwards (away from the hauler), the front two guylines (3 and 4) take most of the load. There will also be a sideways load imposed by the skyline. This requires a third guyline to the rear of the tailtree on the opposite side to the skyline (1). In this case, the back guyline on the skyline side (2) feels no load unless lateral hauling from the tailtree side, where the skyline has moved across to the tailtree. In this case, this fourth guyline must be rigged.

If all four guylines are rigged, there is little advantage in dropping the fourth guyline when hauling from behind the tailtree on the skyline side, as the front guyline must remain rigged.



Support tree guyline layout



Adding an extra guyline

Guyline requirements for intermediate supports

Guylines and support lines must be arranged to resist whatever forces will be imposed on the support tree.

Note that the correct position of guylines is relative to the direction of dominant force on the support tree. When hauling uphill, the guylines and support line need to resist the forward movement of the support tree.

If a support tree needs extra support, rig a third guyline on the same side of the skyline as the support line to help stabilise it.

Planning requirements

System compatibility

- Tailtrees can be used with any cable system to elevate either the skyline or tailrope block.
- An intermediate support can be used on standing skyline systems where the carriage has open-sided skyline sheaves to pass the support jack.

Selecting support trees

Desirable characteristic	Comments
Large diameter	Select biggest tree in a suitable location
Straight	Offers best resistance to buckling
Suitable lean direction	Relevant if the tree is to be topped
Free of visible defects	Defects may indicate weakness
Small branching	Easy to trim, possibly stronger trunk
Undisturbed ground around the tree	Disturbance of the root system may weaken the tree
Location provides: • Adequate lift and access to felled timber • Minimal load on tree • Adequate anchoring opportunity.	- For tailtrees, the best position may be within the stand to allow guyline anchors. - Stems can be extracted from behind a tailtree if necessary. - For intermediate supports, the trees must be in line with the skyline

Selecting suitable anchors

Because elevated support trees are often sited away from easy access, stump anchors may be more feasible than artificial anchors. Note the following:

- Stump anchors are preferable to standing trees
- Stumps should be selected and prepared as for other cable logging applications
- If there is any doubt about the security of an anchor stump, connect it or tie it back to another stump
- If a standing tree is used, restrain guylines from sliding up the tree with rigging equipment (e.g., with tree plates, dogs, or by virtue of the angle at which the guyline contacts the tree).

Equipment requirements

The equipment required to rig an elevated support tree is as follows:

- Blocks
- Guylines
- Support jack, or block (for tailtree)
- Personal Protective Equipment (PPE)
  - Hi-vis helmet, with hearing protection fitted
  - Protective eyewear, unless they increase hazards for the wearer
- First aid kit
- Two people (both capable of climbing)
- Climbing equipment:
- Block strops (straps)
- Rope clamps
- Chainsaw, wedges, and hammer
  - Safety boots
  - Hi-vis garment
  - Protective gloves for handling ropes and blocks
- Means of communication

Climbing harness (two sets)

- Must comply with AS/NZS 1891.1 :1995 *Safety belts and harnesses*, or any other standard which embodies the same or more stringent criteria.

Climbing rope (lanyard):

- Must either be laced to the climbing belt, or pass through at least three rings secured around the belt
- Must have an eye in one end
- Must have an independent wire rope core (IWRC) if any cutting implements are to be used up the tree
- Must be long enough to pass around the climber, the tree, and be tied back on to itself

Note: (IWRC of 8-mm diameter is a good compromise between safety and flexibility).

Climbing irons (spurs) (two sets)

- Which can be securely fastened to feet and legs.

Light rope

- For attaching implements (e.g., pruning saw, chainsaw) to climbing belt
- Must be long enough to allow attached implements to hang just below climber's feet at full stretch.

Chainsaw topping

- Climber must be in a stable position and use chainsaw with both hands.

Safety chain

- 8 mm high tensile or stronger
- With grab hook (or similar) to wrap around the trunk below the level at which the tree will be topped.

Getting ready to climb

Before getting ready to climb, lay out and check all equipment that will be used up the tree.

Do not use anything that is not in good working condition.

Preparing the chainsaw

A warm saw is easier to start up the tree. The person not climbing can prepare the saw while the climber gets ready.

To prepare a chainsaw for tree use:

(1) Check over the chainsaw, including fuel and oil

(2) Start it up using an approved cold-start method

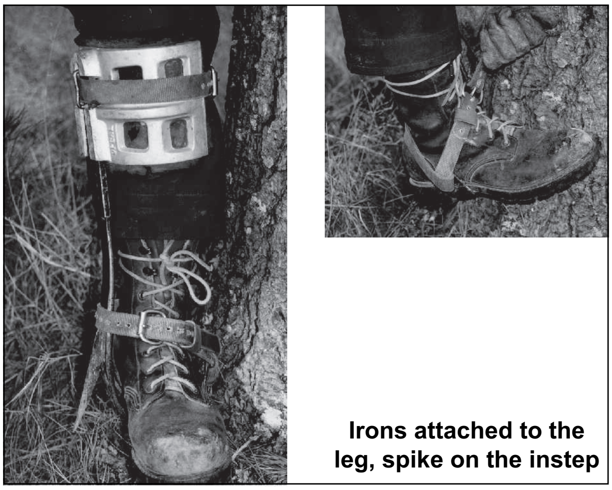
(3) Let it warm up and then switch it off

(4) Set the chain brake

(5) Tie the light rope to rear handle of chainsaw.

Attaching irons to boots

Attaching the irons should be completed just prior to beginning to climb. Wearing irons on the ground can be hazardous because of the risk of injury from the spike.



Irons attached to the leg, spike on the instep

(1) Attach irons on to your boots with the pad against the front of your leg and the spur on your instep.

(2) Pass the lower strap through the climbing iron keeper so that the buckle end is to the heel side and the strap faces away from your boot.

(3) Adjust the strap so that the buckle ends up on top of your boot when tight.

(4) Cross the strap where it attaches to the climbing iron, so that the long end passes:

- Around the back of your boot above the heel
- Around your ankle
- Down across the top of foot where it meets the buckle end of the strap.

(5) Pull the strap as tight as possible so that the spur moves with your boot.

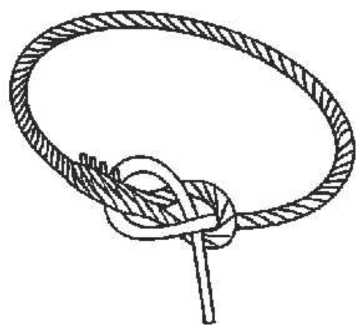
A loose lower strap makes it difficult to properly place and remove the spur in the tree when climbing. There is also a risk that the climbing iron will come out from in front of the heel.

(6) Attach the top strap around your leg to make a snug fit. Ensure there are no trouser wrinkles or seams between the strap and your calf muscle.

Climbing a tree

Follow the steps below when climbing a tree:

(1) Put the climbing belt/harness around your hips and do up the buckles firmly. Do not position the belt up by your waist. A low belt reduces strain on the lower back and enables a good working position.



Sheet bend knot

(2) Tie the light rope (attached to the chainsaw) to the climbing belt. The saw should hang just below your feet.

(3) Stand at the foot of the tree:

- Pass the climbing rope all the way around the tree
- Pass the dead end of the rope through the eye
- Secure the rope with an easily adjustable mechanism (e.g., sheet bend knot).

(4) Begin to climb the tree:

- Pull your upper body in towards the tree to get slack in the climbing rope
- Flip one or both sides of the rope up to shoulder height
- Lean back into the rope with each step to take the weight off your spurs. Hold on to the climbing rope with both hands. If you grab the tree and pull in towards it, the climbing rope will go slack and drop down, and you may not be able to get it back up.

(5) Continue climbing the tree:

- Take 3-4 small steps up and then flip the rope up again
- Stand in close to the tree and pull the slack around to where the knot is
- Reach across with your opposite hand, hold the slack, and work excess rope through the knot *without untying it.*
- To lengthen the climbing rope, work slack from the dead end of the rope through the knot *without untying it.*

Do not take big steps when climbing - it is hard work and makes placing and removing spurs harder.

Working in a tree

General safety guidelines

Follow these general safety guidelines when performing any work up a tree.

(1) Get into a secure position:

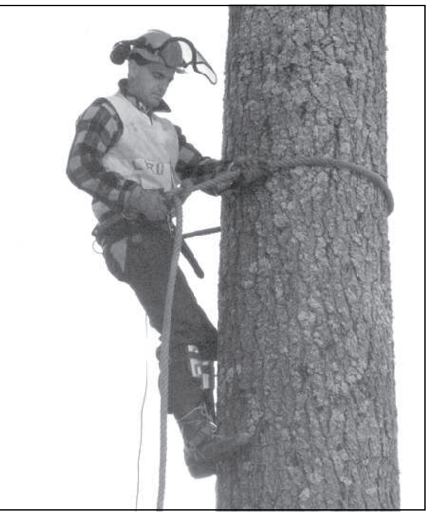
- Climbing rope around the tree, just above waist-level
- Lean comfortably back into the climbing rope
- Set both spurs securely into solid wood
- Share your body weight between the rope and spurs
- Leave both your hands free.

(2) Always keep the climbing rope above horizontal. If the rope is too low you could flip over backwards or upside down.

(3) Using an axe or pruning saw:

- Cut the limbs off close to the trunk of the tree
- Avoid leaving stubs or coat hangers (unless required for rigging)
- Do not cut too near climbing rope.

Lean back against the climbing rope



Adjust the climbing rope as you climb

Starting the chainsaw up the tree

Lower the chainsaw on its rope before climbing further

Chainsaw guidelines

Follow these general guidelines when using a chainsaw in a tree.

(1) Either start the saw on the ground, engage the chain brake, and pull it up on the light rope when needed, or start the saw while up the tree (the former makes it easier to climb the tree).

If starting the saw while up the tree

- Warm-start chainsaw with chain brake set
- Hold the saw with a straight arm
- Use short, sharp pulls of the starter cord.

Note: *Drop starting* remains the most practical way of starting a warm chainsaw up a tree. However, the use of this starting technique should be minimised.

(2) Cut the limbs from a safe position:

- Move around the tree rather than try to reach too far
- Work anti-clockwise up tree
- Keep the tree between you and the bar
- Always limb to the right.

(3) Do **not** cut in front of your body
Do **not** over extend (reach)
Do **not** cut to the left
Do **not** try to reach up too high

(4) Whenever you need to move:

- Set the chain brake
- Lower the chainsaw on its rope.

Topping trees

Why top a support tree ?

Support tress shall be topped if there is a risk of the treetop falling during the extraction operation, creating a hazard for workers.

There are several reasons for topping a support tree:

- Until secured with guylines, the tree will be susceptible to windthrow
- Topping reduces the hazard zone around the support tree (breaker-outs must move two tree-lengths away before signalling the drag to be moved)
- Top weight adds momentum to any tree movement:
  - Guylines have to support higher peak loads
  - The treetop could break off as guylines tighten and arrest tree movement.

Guidelines for tree topping

Do not top trees when wind or other conditions create a hazard.

Only persons trained in the proper techniques and having the required skills should top trees.

Usual felling principles and techniques must be used.

The chainsaw bar should be just long enough to make all felling cuts from one side.

Leave some “coat-hangers” near top of the spar. They may be useful later to help support rigging components.

Top the tree 1–2 m above where the skyline block and guylines will hang. This allows the pass block to hang higher and makes installation of rigging components easier.

Procedure for tree topping

Follow these steps to top a tree:

(1) Determine the felling direction for the treetop.

(2) Ensure there are no obstructions that the top could hit as it falls.

(3) Wrap the safety chain around the tree just below where it will be topped. This prevents tree splitting/ slabbing down inside the climbing rope.

(4) Get into a safe and comfortable position before making any felling cuts.

(5) Put in a Humboldt scarf, no more than $^1/_3$ the diameter of tree.

(6) **Optional**

Wing-cut the tree on each side of the scarf:

- Wing cuts must be placed well into the white wood, not just bark.
- Wing-cuts are preferable to horizontal side-cuts.

Important note: If using horizontal-side-cuts, all cuts must line up with the back cut, on the same plane, so that no wood will remain below the back cut to break away with the saw as the top falls.

(7) Begin the back cut. Even if the back-cut will be a single cut, put in a wedge as soon as possible to minimise the risk of the top sitting back and pinching the saw.

(8) Complete the back cut:

- Move to a position 45° from the back cut
- Pull out the saw
- Set the chain brake
- Lower the saw on its rope (saw must be below foot level)
- Brace yourself against the tree (keep one hand up against the tree to stop your head hitting the tree if it shakes)
- Watch for the unexpected as the top goes out.

Note: For details of tree rescue see the unit standard “Rescue a disabled person from a tree or spar”.

Locating anchors for a tailtree

(1) Locate the skyline anchor slightly to the side of the straight line from the hauler to the tailtree. This slight bight directly ensures that the skyline block is kept away fro the tree. The maximum bight angle is 8°. The bight should be on the side of the tree opposite the most secure guyline placements.

(2) Locate the skyline anchor far enough behind the tailtree to ensure that the vertical angle of the skyline measured at the anchor is less than 45°.

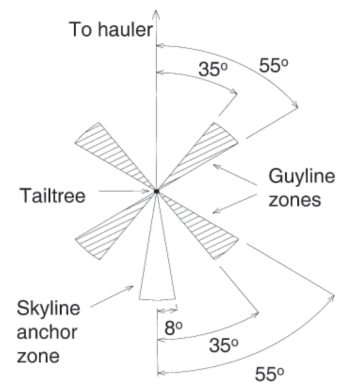
The horizontal distance behind the tailtree depends on the slope of the ground behind the tree.

(3) Standing next to the tailtree:

- Face at 90° to the straight line from tower to tailtree
- Extend one arm along the line towards hauler, the other along same line towards skyline anchor
- Look straight ahead, close your eyes, and bring hands together. The direction you are pointing will be about 90° to the skyline.

(4) Turning 45° towards hauler:

- Extend one arm in the direction established in Step 3, the other towards the hauler, so that they form a right angle
- Close your eyes and bring your hands together. This is the directional line to one of the front guyline anchors.



General guyline layout for a tailtree

(5) Adapt procedure to find directional lines for the three other guylines.

Exception

If there are no anchors available on a directional line, move the guylines to where they can resist the forces imposed on the tailtree. For example, shift the rear guylines in towards the skyline to better resist the forces trying to pull the tree forward. Then shift the front guylines away from the skyline to compensate for any loss of lateral stability.

Equipment for tailtrees

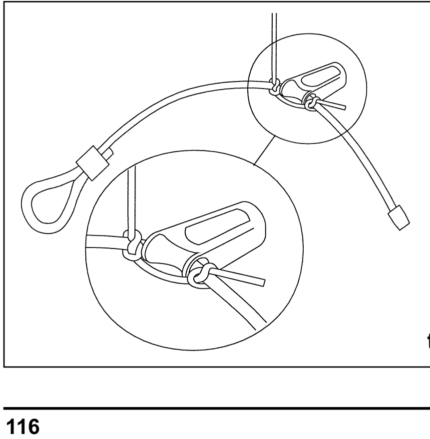
Rigging equipment to assemble in addition to that already listed for climbing.

Item	Comment
Pass block and strop	• Lightweight construction (used with pass rope to position the rigging up tree).
Lightweight pass rope.	• Generally 13-mm natural fibre. • Long enough to run from ground, through the pass block (about 2 m above rigging height), and back to ground.
Skyline block (if applicable)	• Remove the bridge between the line guards and yoke on skyline block, as it is not needed here and only makes aligning the yoke-pin holes harder.
Skyline shoe (if applicable)	• Grease the surfaces that contact the skyline, so that it can slide easily as the shoe is raised and during operations. Shoes with a plastic bearing surface do not need greasing.
Skyline extensions	• Optional (allow the tailtree to be rigged ahead of time), but must be same rope strength as skyline.
Four guylines	• Each with 33% SWL of the skyline SWL. • Long enough for 45° angle between anchor and tree • Fitted with terminals suited to the type of anchor used. For example: - Stump anchors = ferrules at each end, choker bell in middle - Mobile tailhold = ferrule, choker bell in middle, and eye.
Sundries	• Bulldog clamps to secure guyline to stump. Note that three bulldog clamps are needed per guyline. • Wrench or spanner to fit the clamps. • Deep socket and breaker bar.

Rigging a tailtree

Preliminary steps

(1) Notch the anchor stumps using normal notching criteria and practices.



Attaching the pass rope to the block strop

(2) Attach the end of the lightweight pass rope to your climbing belt.

(3) Climb, limb, and top tree if required.

(4) Pull the pass block and strop up and hang the pass block. Ensure the block is high enough to pull the rigging up to required height.

(5) Run the pass rope through the pass block and feed slack down to the ground. The ground person can now attach the rigging items to one end of the pass rope, and use the other end to haul them up to the climber.

Preparing the skyline block strops

The ground person prepares the block strops while climber limbs the tree:

(1) Estimate the circumference of the tree at the point where the strops will be hung.

(2) Slide the choker that distance along the strop *away* from the ferrule end.

(3) Tie the pass rope to the strop just past the choker hook *away* from ferrule end.

(4) Hold the choker hook against this first pass rope knot and tie the dead end of the pass rope to the strop just on the ferrule side of the choker hook (use a clove hitch or several half hitches).

Do not tie the pass rope through the choker hook itself. The two pass rope knots should hold the choker hook in place on the block strop.

(5) Raise the block strops up to the climber, one at a time.

Hanging the skyline block strops

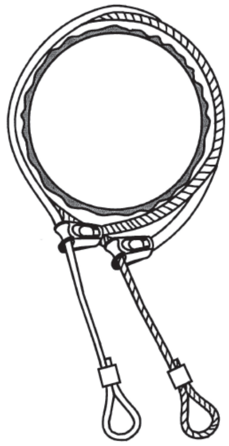
The climber hangs the strops:

(1) Ask the ground person to pull the prepared block strop up into position.

(2) Pass the ferrule end around the tree. Fit the ferrule straight into the choker hook. Untie the pass rope.

(3) Repeat the process if using two block strops, passing the second strop around the tree in the same direction as the first.

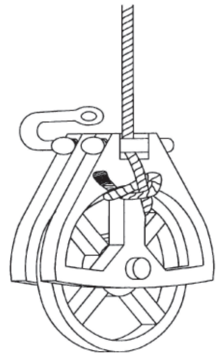
(4) Arrange the ferrules so that each one is in the choker hook of the other strop. This “Swede Hitch” allows the two block strops to share the load evenly.



Block strops in Swede Hitch formation

Preparing the skyline block

The ground person ties the pass rope on to the skyline block. The yoke should be open and the rope should pass behind the pin on the open side. This allows the climber to hang the block yoke in the strops while the ground person supports all the weight with the pass rope.



Attaching the skyline block to the pass rope

Hanging the skyline block

The climber can now hang the skyline block:

(1) Ask the ground person to raise the skyline block to the desired position.

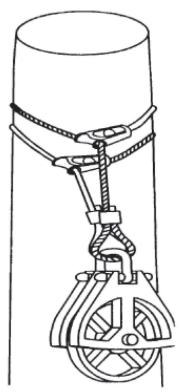
(2) Hook the block yoke into eye(s) of the block strop(s). Remove the yoke pin from the open side.

(3) Ask the ground person to raise the block using the pass rope so that the yoke closes. Refit the pin.

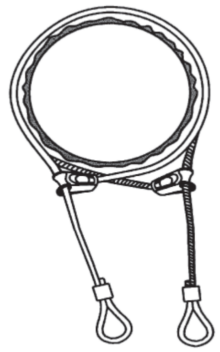
(4) Ask the ground person to lower the block on the pass rope until the strop(s) supports the block’s weight.

(5) Untie the pass rope and feed slack down to the ground person.

(6) Put a grommet or locking pin through the yoke pin.



The skyline block correctly hung



Correctly fitted guyline strops

Hanging the guylines

The ground person attaches the pass rope to a guyline, using the same technique as for the block strops. The climber then hangs the guyline:

(1) Ask the ground person to pull the prepared guyline up into position.

(2) Pass the ferrule around the tree, and hook the ferrule into the choker hook.

(3) Align the guyline on the tree so that the choker hook will induce a slight bight after the guyline has been attached to the anchor and tensioned.

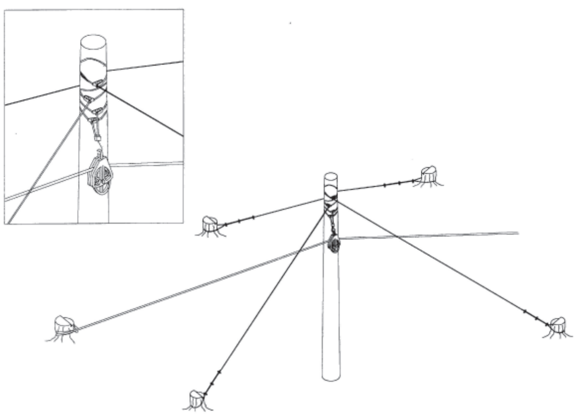
(4) Fit the other guylines:

- *Do not* cross-connect the ferrules and chokers (as with the Swede Hitch)
- Ensure that the ferrules are passed around the tree in alternate directions (to reduce twisting forces in the tree).

(5) Take the pass rope out of the pass block and put it through the skyline block. Feed slack down to the ground person.

(6) The climber now descends the tree.

(7) The guylines are now attached to the anchors and are tensioned.



Completed tailtree

Final steps

The following steps complete the rigging process:

(1) Pull the strawline back through the skyline block using the pass rope.

(2) Use the strawline to pull the skyline, tailrope, or skyline extension through the skyline block.

If the strawline is too light to pull the skyline, use it to pull the tailrope through the skyline block first. The tailrope can then be used to pull the skyline through.

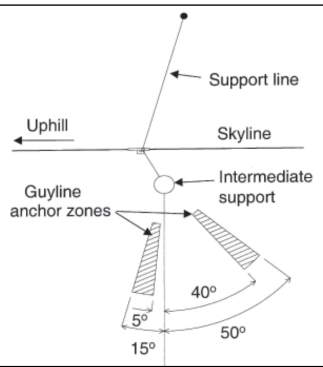
(3) Climb the tree to remove the pass rope, pass block, and pass block strop from the tree. Drop them to the ground, ensuring that these objects will strike no one.

(4) Finally, the skyline is attached to its anchor.

Uncertain tree strength

If a tree is too small for the expected compressive loadings, three evenly spaced buckle guys may be added to increase its stability. Install these $^2/_3$ of the height of the other guylines up the tailtree.

Note that buckle guys can be a smaller diameter than the ordinary guylines.



General guyline lay out for uphill extraction

Locating anchors for intermediate support trees

To correctly locate guyline anchor stumps, first calculate or visualise the forces the guylines will have to resist. The correct position of guylines is relative to the bight angles induced on the support jack during operation.

Guylines and support lines must be arranged to resist the forces that will be imposed on the support tree.

Guyline zones are best identified with a magnetic compass.

If a tree needs extra support, rig a third guyline on the same side as the support line to help stabilise it.

Equipment for intermediate support trees

Rigging equipment needed in addition to climbing equipment is listed below.

Item	Comment
Pass block and strop	• Lightweight construction (used with the pass rope to position the rigging up tree).
Lightweight pass rope	• Generally 13-mm natural fibre • Long enough to run from the ground, through the pass block (about 2 m above the rigging height), and back to ground.
Intermediate support jack	• Grease the shoe of the jack liberally so the skyline can slide easily as it is raised and during operations. • Note that shoes with a plastic bearing surface do not need greasing.
Intermediate support line	• Same strength as the guylines (with 33% SWL of the skyline SWL). • A ferrule at one end and an eye at the other. • Long enough to run from the ground, up the tree to support the line block, and back to the ground.
Support line block(s)	• Must be strong enough to support skyline, jack, carriage, and drag during operation.
Strop(s) for intermediate support line block	• Two strops with *combined* strength equal to a rope one size larger than the skyline, *or* • One strop equal in strength to a rope one size larger than the skyline. Block strops should have: ¤ An eye at one end, a ferrule at the other ¤ A choker hook in the middle. Eyes in both ends are acceptable if some means of holding the strop(s) up the tree is used (e.g., gate-latch staples).
Minimum of two guylines	• Each with 33% SWL of the skyline SWL. • Long enough for the 45° angle between the anchor and tree • Fitted with terminals suited to type of anchor used: ¤ Stump anchors = ferrules at each end, choker bell in middle
Sundries	• Soft wire or twine. • Bulldog clamps/dog spikes to secure guyline to the anchor. Note that three bulldog clamps are needed per guyline.

Rigging a single tree intermediate support

Preliminary steps

(1) Notch the anchor stumps using normal notching criteria and practices.

(2) Attach the end of the lightweight pass rope to your climbing belt.

(3) Climb, limb, and top tree if required.

(4) Pull the pass block and strop up and hang the pass block. Ensure the block is high enough to pull the rigging up to the required height.

(5) Run the pass rope through the pass block and feed slack down to the ground. The ground person can now attach the rigging items to one end of the pass rope, and use the other end to haul them up to the climber.

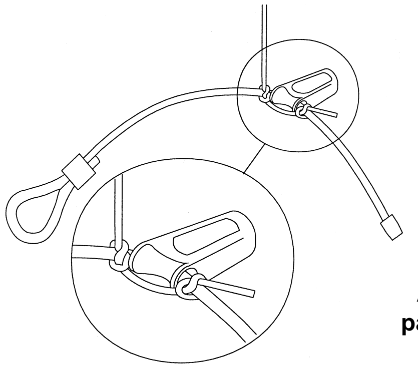
Preparing the support line block strops

The ground person prepares the block strops while climber limbs the tree:

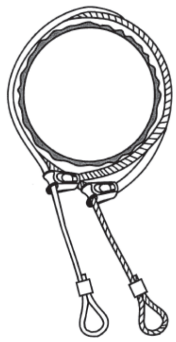
(1) Estimate the circumference of the tree at the point where the strops will be hung.

(2) Slide the choker that distance along the strop *away* from the ferrule end.

(3) Tie the pass rope to the strop just past the choker hook *away* from ferrule end.



Attaching the pass rope to the block strop



Support line block strops in Swede Hitch formation

(4) Hold the choker hook against this first pass rope knot and tie the dead end of the pass rope to the strop just on the ferrule side of the choker hook (use a clove hitch or several half hitches).

Do not tie the pass rope through the choker hook itself. The two pass rope knots should hold the choker hook in place on the block strop.

(5) Raise the block strops up to the climber, one at a time.

Hanging the support line block strops

The climber hangs the strops:

(1) Ask the ground person to pull the prepared block strop up into position.

(2) Pass the ferrule end around the tree. Fit the ferrule straight into the choker hook. Untie the pass rope.

(3) Repeat the process if using two block strops, passing the second strop around the tree in the same direction as the first.

(4) Arrange the ferrules so that each one is in the choker hook of the other strop. This "Swede Hitch" allows the two block strops to share the load evenly.

Preparing the support line block

The ground person ties the pass rope on to the support line block. The yoke should be open and the rope should pass behind the pin on the open side. This allows the climber to hang the block yoke in the strops while the ground person supports all the weight with the pass rope.

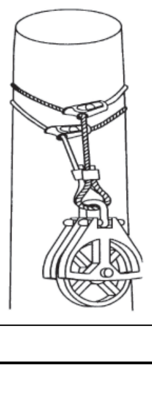
Hanging the support line block

The climber can now hang the support line block:

(1) Ask the ground person to raise the support line block to the desired position.

(2) Hook the block yoke into eye(s) of the block strop(s). Remove the yoke pin from the open side.

(3) Ask the ground person to raise the block using the pass rope, so that the yoke closes. Refit the pin.



The support line block correctly hung

(4) Ask the ground person to lower the block on pass rope until the strop(s) supports the blocks weight.

(5) Untie the pass rope and feed slack down to the ground person.

(6) Put a grommet or locking pin through the yoke pin.

Hanging guylines

The ground person attaches the pass rope to a guyline, using the same technique as for the block strops. The climber then hangs the guyline:

(1) Ask the ground person to pull the prepared guyline up into position.

(2) Pass the ferrule around the tree, and hook ferrule into the choker hook.

(3) Align the guyline on the tree so that the choker hook will induce a slight bight after the guyline has been attached to the anchor and tensioned.

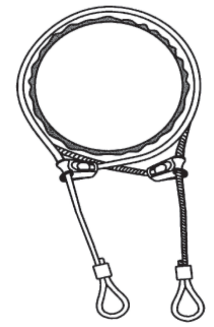
(4) Fit the other guylines:

- **Do not** cross-connect the ferrules and chokers (as with the Swede Hitch)
- Ensure that the ferrules are passed around the tree in alternate directions (to reduce twisting forces in the tree).

(5) Take the pass rope out of the pass block and put it through the support line block. Feed slack down to the ground person.

(6) The climber now descends the tree.

(7) The guylines are now attached and are tensioned.



Correctly fitted guyline strops

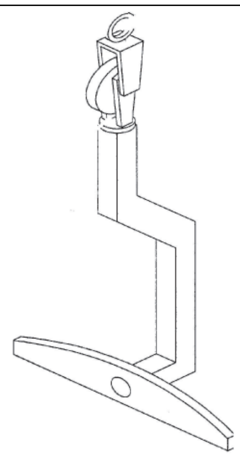
Rigging the support jack and raising the skyline

(1) Thread the eye of support line through the sheave in the support jack. Attach the pass rope to the support line, and use the pass rope to pull the support line through support line block.

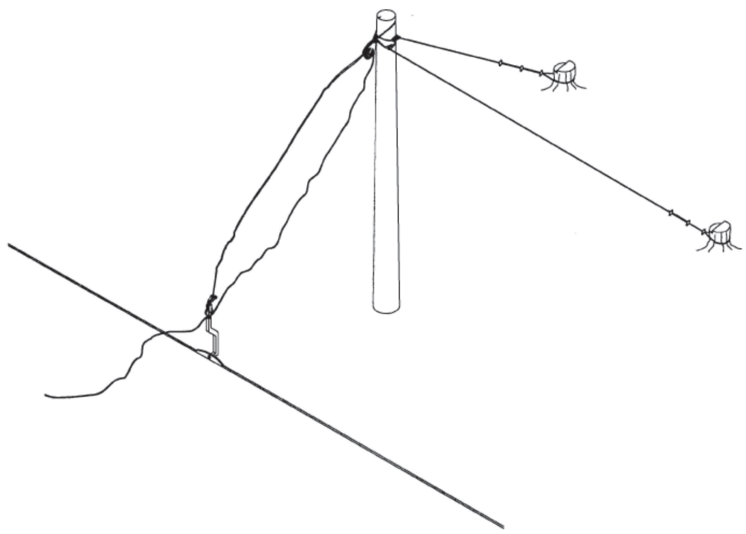
(2) Attach the support line eye to the jack.

(3) Lay the skyline out between the trees, and *under* the support line. Position the skyline in the shoe of the jack.

(4) Pull the support jack and skyline up to the desired position in the tree (use mechanical assistance, or additional personnel, etc.).



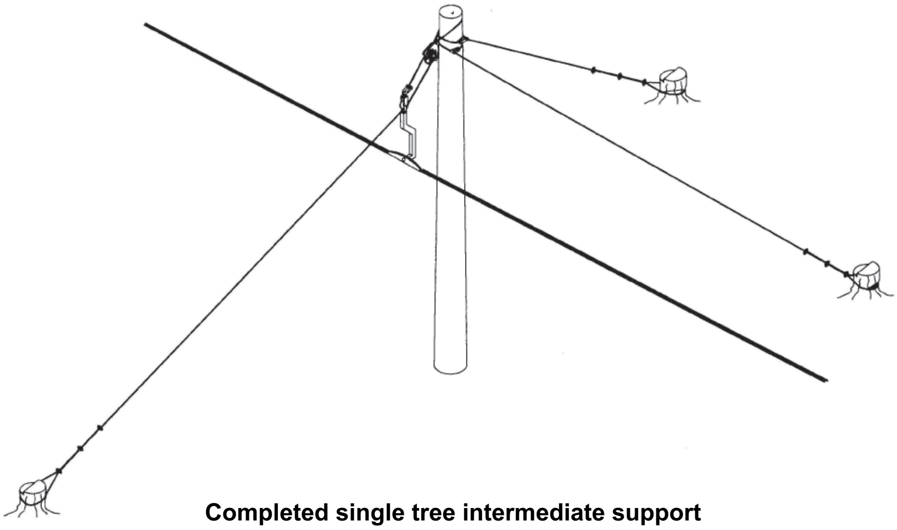
Intermediate support jack



Skyline in support jack, support line about to be tensioned and tied to stump

Use soft wire or twine to retain the skyline in the shoe while it is raised. The wire/twine will not interfere with operation of the system, as the carriage will cut it as it passes over.

(5) Attach the support line to the anchor as if it were a guyline to complete the single tree support.



Completed single tree intermediate support

Glossary of terms

Average haul distance	The average distance that drags will be extracted from the cutover to the landing.
Anchor	Any stump, tree, deadman, rock, mobile tailhold, etc., to which skyline, guyline, or rigging blocks are secured.
Aspect	Compass direction to which a slope faces.
Back guy	Line behind the tower or support tree, opposite the main line or skyline.
Backline	(1) Boundary line marked by blazed or painted trees indicating the cutting area.
	(2) That portion of the tailrope from the hauler to the first corner block.
Bardon hook	A type of choker hook used with wire rope strops for gripping trees or logs to be skidded.
Barrel	Central portion of a winch drum on which the rope is spooled.
Barrel swivel	(Syn. butt chain swivel). A swivelling device used in hauler butt-rigging.
Bight	An angle between two parts of a rope running round a block or obstruction (e.g., a stump). "In a bight" is a dangerous position.
Bind	Term used to describe an operating rope being held out of line by an obstacle such as a stump, log, or standing tree that causes considerable friction and eventual deformation of the rope.
Birdsnest	A tangle of loose or damaged rope.
Blind lead	A difficult haul path where the line of sight from tail block to the tower is obstructed by an intermediate ridge or convex slope.
Block	Metal case enclosing one or more sheaves to change direction of a rope or increase pulling power.
Block strops	(Syn. straps). A short length of wire rope with an eye in each end used to hang a block.
Breaking strength	(Syn. ultimate load, ultimate yield, ultimate strength). **(Not to be confused with SAFE WORKING LOAD)**. The greatest loading that a wire rope (or material) can withstand without breaking.
Bridling	(Syn. side blocking). A method of laterally displacing the fall block and/or rigging, to increase skyline corridor width.
Buckle guy	Line attached to the middle of a support tree or spar to resist a buckling force.
Bull block	Mainrope block in highlead logging. Large block having a throat opening of sufficient size to allow the butt-rigging to pass through.
Butt	Base of a tree. Large end of a stem or log.
Butt hook	Heavy hook on the butt-rigging or dropline to which strops/chokers are attached. Also known as bull hook.
Butt log	First log cut above the stump.
Butt pulling	Hauling with strops attached to the large end of a log.
Butt-rigging	System of swivels and shackles that connects the tailrope and mainrope to which strops are fastened.
Cable clamp	A clamp designed for joining two sections of light wire rope. Most often used to form an eye, or loop around a stump.
Cable logging	Any hauling system employing a stationary machine with powered drum(s), spars, blocks, wire rope, and butt rigging to haul logs from the felling site to an assembly point or landing.
Carriage	A load-carrying device that travels freely on sheaves running on a wire rope for hauling or loading logs.
Chain hook	Same as binder. Used to tighten and fasten a chain strop.

Glossary of terms (cont...)

Choker	*See* Strop.
Choker hook	(Syn. choker bell). Connector on a wire rope strop (choker) which enables a noose to be formed around the end of a stem.
Chord	Straight line from the top of the tower to the tailhold.
Chute	The space in front of a hauler where stems are landed.
Clearance	The minimum vertical distance between a laden skyline and the ground.
Clearfelling	All merchantable trees on a setting to be extracted are felled.
Climbing spurs	(Syn. rigging spurs). Strap-on metal spikes to enable a rigger to climb a standing tree.
Closing line	Line used to close a grapple carriage.
Coathanger	Stub left by not cutting branches close to the stem or trunk.
Compartment	Forest management subdivision or block of land, usually of continuous land ownership.
Concave slope	(Syn. concave face). Hillside where the top can be seen from the bottom (and vice versa).
Convex slope	A hillside where the top cannot be seen from the bottom (and vice versa).
Crew	(Syn. gang). A team of workers needed to work one logging operation.
Cycle	Complete set of operations or tasks that is repeated.
Deadman	Anchoring device (usually a log) buried in the ground to which a guyline or anchor line is attached.
Deflection	The vertical distance between the chord and the skyline at mid-span, usually expressed as a percentage of the horizontal span length.
Directional felling	Modifying the felling direction to suit specific conditions (extraction direction, avoid boundaries, streams etc).
Drag	Load of stems and/or pieces being hauled.
Dropline	Wire rope, which can be lowered from a carriage, to which stems are attached by means of strops.
Drum	*See* Winch.
Dyform rope	A compacted strand rope in which the strands, initially of oversized diameter, are run through a die to reduce the diameter of the finished rope.
Elastic limit	Up to this tensional limit a wire rope will return to its original length after the tension or load is removed.
Equalising block	Block used to distribute a load equally between anchor points.
Escape route	A predetermined (and prepared) track by which workers may move away from a hazard area.
Extension	A rope joined to another rope to increase its length.
Eye splice	Loop formed by bending the end of the rope back on itself and splicing it into the line.
Fairlead	Device containing pulley wheels or rollers so that the winch can pull in the cable from any direction without damage.
Fall-block	Block to lower butt-rigging and strops to the ground. The block is long and narrow, with the pulley wheel(s) at the top, and balanced so that most of the weight is at the bottom.
Faller	One who fells trees.
Ferrule	Metal band or socket fitted to the end of a wire rope.

Glossary of terms (cont...)

Figure 8 Method of wrapping a wire rope strop around two stems whose ends are together.

Fleet angle Angle subtended from the centre line of a fairlead or fixed sheave, between the drum flange and the centre point of the drum barrel.

Fleeting Positioning logs by machine in preparation for a subsequent operation.

Flying (number) strops Number of strops attached to the butt-rigging or dropline.

Grapple Hinged mechanism capable of being opened and closed; used to grip stems during yarding.

Grapple yarding Cable hauling with grapple instead of strops. Usually by swing yarder.

Gravity return Any cable system that depends on the force of gravity for downhill travel of the carriage.

Grommet (syn. Molly, Molly Hogan). Short length of wire rope that is wound to form a loop; used as a temporary connection between the eyes of two ropes.

Ground-lead Where hauled drags are not lifted from the ground.

Gut hook To attach a strop to a stem so that it swings when lifted off the ground.

Guyline A length of wire rope attached or blocked to near the top of a tower, spar, or support tree. Holds the tower, etc., upright against the forces imposed upon it in hauling.

Hammerlock Device for connecting chains.

Hauler (syn. yarder). In cable logging, a machine equipped with winches and a power source, which operates from a set position to haul drags of logs from stump to landing.

Highlead A simple cable system employing a mainrope, tailrope, and butt-rigging.

Hot deck Logs are loaded out within shift.

I.W.R.C Independent Wire Rope Core.

Inhaul Segment of an extraction cycle where the drag is hauled in towards the landing.

Interlock Device that allows the mainrope and tailrope drums to be operated together as a single unit to maintain running line tension.

Intermediate support A device (e.g., support tree or portable lattice spar) to which a tree jack is attached to support the skyline, in order to maintain clearance over an obstacle or convex ground.

Jack (Syn. skyline jack). Device for suspending the skyline in an intermediate support or tailtree.

Landing Cleared area to which drags are hauled, and may be where they are subsequently processed, stored, and loaded-out.

Lang lay Wire rope in which the individual wires are wound in the same direction as the strands.

Lateral hauling (Syn. lateral pulling). In skyline logging, initial breaking- out and movement of the drag to the skyline haul path.

Lay (1) Position on the ground where a tree will fall when severed from the stump.

(2) Describes the direction strands of wire rope are wound about the core.

Layout Position of the running lines in a cable hauling system.

Line pull The pulling force exerted on a rope from a drum, usually measured when drum is half full; expressed in kilograms or tonnes.

Live skyline Skyline system that requires the skyline to be lowered to lower the strops to the ground.

Glossary of terms (cont...)

Loaded deflection	The vertical distance between a chord and a skyline measured at mid-span when the skyline is supporting a drag, expressed as a percentage of the horizontal span length.
Logging system	Method of harvesting, usually with a descriptive term such as skyline, skidder, mechanised, etc.
Long span skidding	Cable system capable of hauling drags or loads for 1000 m or more.
Long splice	*See* Splice.
Mainrope	(Syn. mainline). The wire rope used to pull the carriage or butt-rigging in to the landing.
Marlin spike	Iron tool that tapers to a point. Used to separate strands of rope.
Mobile hauler	A cable hauler with an integral tower, mounted on a tracked or rubber-tyred carrier.
Mobile tailhold	A self-propelled anchor unit, such as a tractor or excavator, to which ropes and blocks are attached.
Mobile tailspar	Short spar, usually mounted on a crawler tractor, used to facilitate rope shift and increase clearance.
Multispan skyline	Skyline having one or more intermediate supports.
Northbend	A standing skyline system employing a fall-block on the mainrope to lower the butt-rigging to the ground.
Notch	Groove cut in an anchor stump to prevent a rope slipping off.
Open-side carriage	Skyline carriage that opens on one side allowing it to travel over intermediate support jacks.
Operating ropes	Moving ropes which are reeled in or out during hauling.
Outhaul	Segment of a cable logging extraction cycle where the rigging or carriage travels from the hauler or landing, out to the cutover for the next drag.
Over run	Where rope being spooled off a drum is allowed to go slack; often results in a birdsnest.
Overwound	Rope reeled on or paid off the top of a drum.
Pass block	Light weight block hung at the top of a support tree and used to lift the skyline block/jack and other gear in rigging the tree.
Pass chain	A chain which is used to pull or hold a rope.
Payload	Net weight of the load of a loaded vehicle; gross minus tare weight.
Pre-rig	Rigging an anchor or support tree before a logging crew shifts to the site.
Pre-stropping	Where strops are attached to stems for the next drag while previous drag is being extracted.
Profile	Graphic representation of a ground configuration.
Reach	Distance spanned by a skyline.
Rider block	A single-sheave carriage.
Rig	To install the blocks and lines used in a cable logging system.
Rigging	Ropes, blocks, strops, etc., and other components used in cable logging systems.
Roll	A technique involving positioning a strop in such a way that it causes a stem to roll in a desired direction when the rope is pulled (usually to clear an obstruction).
Running line	Moving cable.

Glossary of terms (cont...)

Running skyline Cable system employing a rider block on the tailrope to provide lift for the carriage or butt-rigging. As the mainrope is pulled in, the tailrope is slackened, and vice versa.

Safe working load (SWL) A permissible load that can be applied to a rigging component (wire rope, shackles). Defined by applying a factor of safety (FOS) to the breaking strength. In forestry in New Zealand, a FOS of 3 is applied, meaning the SWL is $^1/_3$ of the breaking strength.

Sag Slack in a cable, particularly in a skyline.

Scarf Wedge-shaped notch cut in a tree above the stump, to control the tree's direction of fall.

Setting Area logged to one hauler set up.

Shackle A U-shaped metal connector, having a removable pin or threaded bolt through its ends, used on rigging, blocks, strops, etc.

Shay swivel Fitting used to attach the slack pulling line to the main line on a skyline system.

Sheave Grooved wheel or pulley. A component of a block or carriage.

Shotgun system A live skyline system where the carriage travels out from the landing by gravity. Used in uphill logging.

Single span skyline Skyline system without an intermediate support.

Skyline A wire rope extended between the hauler and the tailhold, which provides lift to a drag of logs, and upon which the carriage travels.

Skyline carriage Wheeled device that rides back and forth on the skyline for hauling.

Skyline road Area bounded by the length and lateral yarding width of any given skyline setting.

Slack Section of rope which is free of tension.

Slack-pulling carriage Carriage designed to feed out slack to facilitate breaking out, or to pull laterally a distance from the skyline path.

Slack-pulling line A rope used to pull out the mainrope or a dropline through a slack-pulling carriage.

Slackline system Live skyline system employing a carriage, mainrope, and tailrope. Strops are connected directly to the carriage.

Southbend system A Northbend system modified to increase lift by feeding the mainrope through a sheave on the carriage and attaching it to the fall-block.

Span Horizontal distance between skyline supports (usually tower and tailhold).

Splice Section of rope (hemp, wire, etc.) woven into another piece of rope (e.g., long splice) or back into itself (e.g., eye splice).

Spool To wind cable smoothly on a drum.

Spot To place the butt-rigging, grapple, or strops over a proposed drag.

Straw drum Small drum on a yarder that handles the strawline.

Strawline Light-weight line used to layout or shift working ropes. Can be spooled on the strawline drum or be as separate coils (usually 80 m) for carrying.

Strop (Syn. choker). Short length of wire rope or chain, fitted with a hook (choker or chain), which is used to form a noose round the end of a stem for extraction.

Support tree Tree rigged as either a tailtree or intermediate support.

Tagline An extra rope often attached to a Northbend carriage to stop the carriage rolling along the skyline when the mainrope is slackened.

Tail block Block fixed to anchor the tailrope.

Tail spar *See* Tailtree.

Glossary of terms (cont...)

Tailtree Tree to which the back end of the skyline is elevated using a block or shoe to provide additional lift over the back portion of the span.

Tailhold The anchor for the skyline and/or tailrope. Most often a stump, deadman, or machine.

Tailrope (Syn. haulback). A rope used to return the mainrope, butt-rigging, and/or carriage, grapple, etc., to the break-out point.

Tightlining Tightening the mainrope and tailrope by braking one against the other.

Topographic map (Syn. topo map, contour map). A map showing natural features by means of contour lines and elevations.

Torque Rotational (or twisting) force from an engine or motor.

Torque converter A device to transmit the correct torque from the engine to the driveshaft of a vehicle, winch, etc.

Tower Steel mast fixed at the winch unit to provide lift for the fairlead or block.

Tree plate A steel plate with a hook at the bottom, spiked to a standing tree anchor or wooden spar at the point where guylines and straps are hung; designed to prevent ropes cutting into the wood or moving up/down the tree.

Tree shoe Device in the shape of a segment of a circle used to support the skyline from a support tree.

Underwound Rope reeled on or wound off the bottom of a drum.

Wing-cut Optional felling cuts made into side of the hinge to minimise side slabbing during felling.

Working drum A drum that can reel a rope in or out during a hauling cycle.

Wrap To turn a rope around a drum, stump, etc.

Wrapping The action of two moving ropes winding around each other.