Best Practice Guidelines for Ground-based Logging

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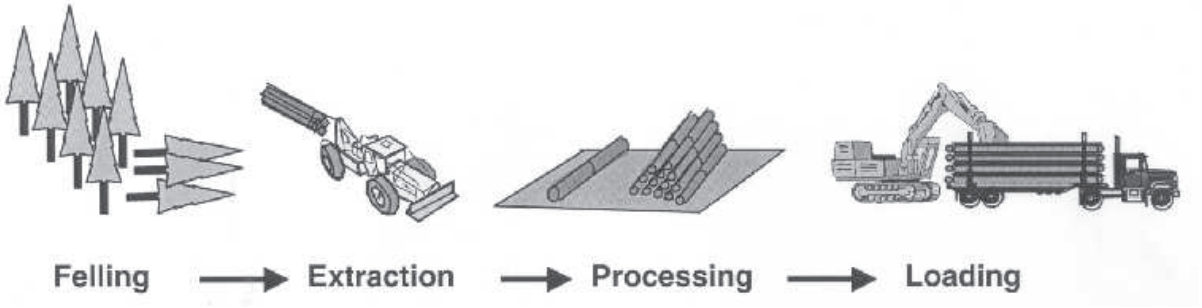
This Best Practice Guideline is to be used as a guide to certain ground-based logging procedures and techniques. It does not supersede legislation in any jurisdiction or the recommendations of equipment manufacturers.
FITEC believes that the information in the guideline is accurate and reliable; however, 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

Ground-based logging basics

What is ground-based logging?

Ground-based logging involves the following phases.



These **Best Practice Guidelines for Ground-based Logging** focus on the extraction phase of the operation. The tree felling, processing and loading phases are dealt with in separate Best Practice Guideline documents.

The main elements of the extraction cycle are as follows:

- Travel out from the landing
- Hook-on, grab, or load stems or logs
- Travel in to landing
- Position machine
- Break-out
- Unhook, drop, or unload stems or logs.

The aims of the extraction phase are to transport stems or logs from where they are felled to the landing:

- In a safe manner
- Without adverse environmental impacts
- At least cost.
- Efficiently
- While maximising the value to the forest owner

Ground-based logging is done with machines having either wheels or tracks. It is usually limited to slopes less than 22° (40%). Steeper terrain usually requires the use of cable logging systems.

Types of extraction machines

The main types of ground-based extraction machines are:

- Wheeled skidders
- Excavators
- Forwarders
- Tracked skidders
- Clambunk skidders

Wheeled skidders

Description

- Wheeled skidders are articulated four-wheel drive machines.
- They are used in production thinning (typical tree size of 0.2 to 0.5 m^3) and clearfell (typical tree sizes of 1.0 to 2.5 m^3) operations.
- Skidders are classed as either cable or grapple machines.
- *Cable skidders* employ a winch, rope (generally 25 to 30 m), and strops to attach and move felled trees.
- *Grapple skidders* use a large grapple (conventional or swing-boom) to grab the stems. Most grapple skidders are also fitted with a winch. The winch is used as a retrieval tool in case the skidder becomes stuck.
- Wheeled skidders shall have a certified Falling Object Protection Structure (FOPS), an Operator Protection Structure (OPS), and a Roll Over Protection Structure (ROPS). They shall also be fitted with a seat belt.
- There is a range of skidder sizes. They are described by the power output of the engine.

Cable skidder

Conventional grapple skidder

Swing-boom grapple skidder

Skidder size	Engine power output (kW)	Examples	Optimum drag weights on level terrain (tonnes)
Small	76 – 105	John Deere 540G Ranger F65 Timberjack 360	3–5
Medium	106 – 135	Caterpillar 525C Timberjack 460 Ranger H67 John Deere 640G	5–7
Large	136 +	Caterpillar 545 John Deere 748G Timberjack 560	7–8

Application

- The Approved Code of Practice for Safety and Health in Forest Operations (the Code) states that, as a guide, wheeled skidders should not operate on slopes that exceed 18° (30%) unless otherwise specified by the manufacturer. Where weather or ground conditions adversely affect machine stability, the maximum slope worked will be less than this.

  Where the stability of the machine cannot be assured and slopes exceed those stated in the Code, specific hazard control measures shall be put into place.

- Wheeled skidders are best suited to downhill extraction where traction and travel speeds are greater.
- Cable skidders are better suited to rolling terrain than grapple skidders. When traction is lost, the cable skidder can drop the drag and drive forward while paying-out the winch rope. When positioned in a more suitable position, the drag can be winched to the skidder.
- The operator or breaker-out is required to pull-out the winch rope and attach the stems. At the landing, the operator or a landing worker is required to unhook the stems.
- The winch rope can be pulled manually uphill or downhill of the cable skidder. This allows stems to be extracted from short steep slopes otherwise too steep for the skidder.

- On flat terrain, a grapple skidder is faster than a cable skidder at gathering a full drag. The operator or breaker-out is not required, and this eliminates hazards associated with hooking-on and breaking-out. Swing-boom grapples are capable of working outside the line of the machine. This means the machine does less manoeuvring when gathering a drag than a conventional grapple skidder.
- Grapple skidders prefer butt-first presentation of stems for extraction as this aids traction and reduces load friction and stem breakage.
- The performance of a grapple skidder can be improved by bunching stems with another machine prior to extraction. A mechanised harvester, excavator, or a Bell loader can do this.
- In general, cable skidders are capable of extracting larger loads than grapple skidders. This is because the number of strops can be changed on the cable skidder to optimise the drag size. The ability to drop and winch the drag also allows bigger drags to be extracted. Drag size for a grapple skidder is limited by the cross-sectional area of the grapple.
- Cable and grapple skidders can be used in production thinning and clearfell operations. In production thinning operations, the cable skidder is usually preferred, as the grapple skidder requires stems to be bunched. Mechanised harvesters generally process stems into logs as well, which leads to a forwarder being the appropriate extraction machine.

Tracked skidder

Towed arch

Tracked skidders

Description

- There are two types of tracked skidder:
  - Conventional earthmoving or modified bulldozers that have rigid track rollers.
  - Flexible track skidders with suspension to allow the track to conform to the shape of the ground.
- Tracked skidders are equipped with winches, ropes, and strops, or a grapple (similar to wheeled skidders).
- Tracked skidders manoeuvre by altering the speed or direction of the two tracks. This allows them to turn within their own length.
- A conventional tractor may tow a two-wheeled arch to provide lift for the front of the drag and reduce friction. This enables larger loads to be carried.
- Tracked skidders shall have a certified FOPS, OPS, and ROPS. They shall also be fitted with a seat belt.
- Tracked skidders can be classified into four classes according to engine power output.

Tractor size	Engine power output range (kW)	Examples	Estimates of optimum drag weight, level terrain, no arch (tonnes)
Small	50 – 74	John Deere 450G Komatsu D37E-5, Caterpillar D3C	3–4
Small to medium	75 – 100	Caterpillar D5M, Komatsu D53A-7	4–6
Medium	101 – 130	John Deere 750C Caterpillar D6M, Caterpillar 572	6–8
Large	131 +	Caterpillar D7R Komatsu D65EX-12, Komatsu D85E-21	7–9

Application

- The Approved Code of Practice for Safety and Health in Forest Operations (the Code) states that, as a guide, tracked skidders should not operate on slopes that exceed 22° (40%) unless otherwise specified by the manufacturer. Where weather or ground conditions adversely affect machine stability, the maximum slope worked will actually be less than this.

  Where the stability of the machine cannot be assured and slopes exceed those stated in the Code, specific hazard control measures shall be put into place.

- Tracked skidders are suited to steeper terrain than wheeled skidders because of increased traction,stability, and ability to excavate skid trails. This also allows them to work more effectively on adverse slopes than a wheeled skidder.

- Travel speeds for bulldozers are slower than wheeled skidders. However, load sizes can be larger. Flexible track skidders perform similarly to wheeled skidders in terms of speed, but can pull a larger load.
- Often the tracking system is one of uphill climbing tracks and downhill extraction tracks.
- On steep slopes, the blade is used to help control the machine's descent.
- Grapple tractors are suited to large tree sizes since load accumulation and manoeuvring are difficult on steep slopes.

Flexible-tracked skidder

Excavators

Description

- An excavator comprises a tracked undercarriage and a continuous rotating upper body with hydraulically operated boom.
- These machines are often fitted with a heel (fixed or live) to allow stems to be grabbed beyond their balancing point.
- Excavators used for extraction shall have a certified FOPS, OPS, and a Cabin Operator Protection Structure (COPS). They shall also be fitted with a seat belt.

Excavator

- Excavator carriers can be classified into four classes (often the base weight of the machine will be increased considerably with the addition of guarding, strengthening, and an attachment such as a harvesting head).

Excavator size	Gross weight (tonnes)	Examples
Small	<20	Hitachi EX 120, Komatsu PC 150
Small to medium	20 – 25	Caterpillar 320 or 322, Hyundai 210 Komatsu PC 220
Medium	25 – 30	Daewoo290, Hitachi EX 270 Caterpillar 325, Komatsu PC300
Large	>30	Caterpillar 330, Komatsu PC400 Hyundai 290, Kato HD 1880

Shovel logging

Application

- The Approved Code of Practice for Safety and Health in Forest Operations (the Code) states that, as a guide, excavators should not operate on slopes that exceed 22° (40%) unless otherwise specified by the manufacturer. Where weather or ground conditions adversely affect machine stability, the maximum slope worked will actually be less than this.

  Where the stability of the machine cannot be assured and slopes exceed those stated in the Code, specific hazard control measures shall be put into place.

- Excavators can be used to bunch stems for extraction by a skidder or tractor, or they can extract logs or stems to the landing through a series of successive swing movements (termed shovel logging).
- An excavator is able to work in gully heads, where slopes are too steep for a wheeled skidder, or where the winch rope has to be manually pulled uphill. They can also turn the stems to provide for butt-first extraction.
- Excavators move relatively slowly. Their main advantages lie in their ability to slew the load, and in having good traction in soft ground conditions.
- They can be effective for shovel logging over short haul distances (100–150 m), for road-lining operations, and when ground conditions are too soft for wheeled machines.
- Repeated movements of stems during shovel logging results in most branches being removed. This can reduce trimming on the landing and the accumulation of trimming waste.
- The excavator typically opens a lane to the back of the felled block, then starts swinging bunches of stems to the landing.
- Soil disturbance associated with extraction can be less than for skidders and tractors as the excavator makes only one pass over the site.
- Excavators add flexibility to an operation as they can be used to bunch, extract, fleet, and load if necessary.
- Some excavators can be fitted with winches and ropes for hauling trees up to 250 m.

Clambunk skidder

Clambunk skidder

Description

- A clambunk skidder is an articulated six- or eight-wheel drive machine fitted with a loading crane and a large upward-facing grapple.
- The load capacities of clambunk skidders (such as Timbco, Timberjack 1710, Tigercat C640) are similar. Typical payloads range from 20 to 25 tonnes.
- Clambunk skidders shall have a certified FOPS, OPS, and ROPS or COPS. They shall also be fitted with a seat belt.
- The clambunk is able to load the butts of full tree lengths into the grapple and drag them out to the landing or roadside.
- The machine unloads either using its crane, or by opening the grapple and driving out from beneath the load.
- The clambunk can be fitted with wider than normal tyres, or with band tracks to reduce ground pressures and provide extra traction.
- The Timbco clambunk differs from the other two in that the cab and loading crane are both able to rotate for loading or reversing back into the cutover. In contrast, the operator's seat rotates to the back in the Timberjack and Tigercat models.

Application

- Clambunk skidders are not common in New Zealand. They are designed for clearfell operations on flat-to-rolling terrain.
- The Approved Code of Practice for Safety and Health in Forest Operations (the Code) states that, as a guide, clambunk skidders should not operate on slopes that exceed 18° (30%) unless otherwise specified by the manufacturer. Where weather or ground conditions adversely affect machine stability, the maximum slope worked will actually be less than this.

  Where the stability of the machine cannot be assured and slopes exceed those stated in the Code, specific hazard control measures shall be put into place.
- Clambunk skidders typically produce at high levels, normally at a level equivalent to that of two grapple skidders.
- They are suited to long haul distances of between 400 and 700 m. Also, they are capable of travelling loaded on steeper slopes than other wheeled skidders.
- They can be less flexible than conventional skidders, but very productive if terrain and haul distance suit them.
- Clambunk skidders work most effectively where a mechanised felling or bunching machine has bunched the stems.
- Landing operations must be matched to the clambunk extraction. Loads are simply dropped on the landing in a large pile. Another machine will be required to lay the stems out for manual processing. Alternatively, a mechanised processor can take stems directly from the piles.

Forwarders

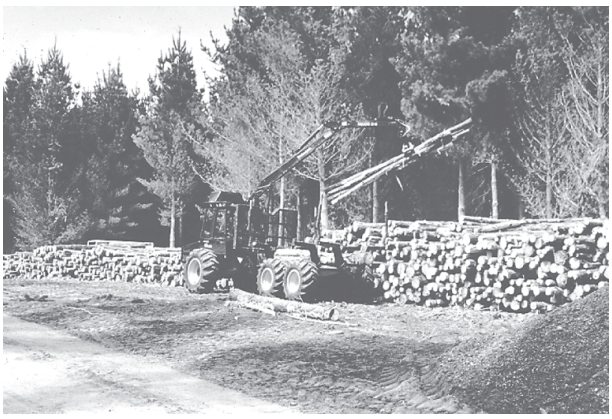
Description

- Forwarders are articulated four-, six-, or eight-wheel drive machines, equipped with knuckle-boom cranes. They are designed mainly for the transport or extraction of logs 3 to 6 m in length. They are a major part of the cut-to-length (CTL) system where logs are processed at stump rather than at the landing. This usually means that longer log lengths are not cut, which may have implications for value recovery to the forest owner. Worldwide, the CTL system is the most common extraction system.

Forwarder

- They range from the more basic, converted skidder designs, to sophisticated purpose-built machines.
- Forwarders shall have a certified FOPS, OPS, and ROPS. They shall also be fitted with a seat belt.
- Forwarders can be fitted with wider than normal tyres, or band tracks can be fitted for lower ground pressures and extra traction.
- Load capacity typically ranges from 14 to 18 tonnes.

Forwarder size	Payload weight (tonnes)	Examples
Medium	14	Timberjack 1410 Valmet 860
Large	18	Timberjack 1710 Valmet 890



Loading directly on to stacks

Application

- The Approved Code of Practice for Safety and Health in Forest Operations (the Code) states that, as a guide, forwarders should not be operated on slopes that exceed 18° (30%) unless otherwise specified by the manufacturer. Where weather or ground conditions adversely affect machine stability, the maximum slope worked will actually be less than this.

  Where the stability of the machine cannot be assured and slopes exceed those stated in the Code, specific hazard control measures shall be put into place.

- In New Zealand, forwarders are most commonly used in production thinning operations. They are also used in several clearfell operations (most clearfell operations use tree-length extraction).
- In clearfell and production thinning operations, forwarders often work in conjunction with harvesters.
- On flat ground, extraction is usually along a series of parallel trails. In production thinning operations, these trails are usually parallel to the rows. Rather than try to travel on a direct route to the landing, the forwarder will exit on to the road for travel to the landing.
- On rolling terrain, extraction is best done up and down the slope. Stability of the forwarder is significantly reduced if it is travelling loaded across the slope.
- Logs can be loaded directly from the forwarder to the stacks or a truck.
- Landing size will be smaller and the number of landing workers will be fewer than for equivalent full-stem operations.

Factors affecting performance

The performance of an extraction operation can be measured by:

- Safety statistics
- Machine availability
- Environmental impacts.
- Daily production
- Machine costs

The main factors affecting ground-based extraction are:

- Machine selection
- Terrain characteristics
- Soil conditions (operability)
- Mechanical reliability
- Interference
- Regulatory constraints.
- Piece size (linked closely to tree size)
- Haul distance
- Felling pattern and damage
- Landing size and layout
- Logging crew skill and motivation

Machine selection

Selection of the extraction machine(s) will need to take into account:

- Terrain (slopes) and soils
- Degree of processing at stump
- Overall unit costs ($/tonne)
- Environmental impacts.
- Piece size
- Productivity of felling and processing phases
- Worker/operator safety

Logging systems are rarely in balance, as different phases (felling, bunching, extraction, and processing) produce at different rates. This can be overcome by working phases or machines different numbers of productive hours per day. In this way, a productivity imbalance is corrected.

However, it may be difficult to overcome this imbalance if the extraction machine is:

- Too small for the piece size
- Too slow for excessive haul distance
- Unable to extract from slopes
- Mechanically unreliable
- Operated by an inexperienced operator.

In this case, there may be little that can be done in the short term to overcome the lower-than-desired production performance of the system.

Piece size

Piece size is the average size (m^3 or tonnes) of the extracted pieces of a felled tree (butt logs and top pieces).

Piece size has a major effect on production levels. Production typically increases with piece size, as less work is required to achieve a desired drag or load size. For instance, fewer stems need to be hooked on, and unhooked, in a cable skidder or tractor operation. Alternatively, fewer stems or logs need to be loaded on to a clambunk or forwarder to achieve the optimum load size.

However, if the piece size is too large for the extraction machine being used, then production actually slows down.

Piece size generally varies throughout a block because of felling breakage and changes in aspect, elevation, and soil. This will result in variation of daily extraction production and may have an adverse effect on the performance of other phases of the operation.

Terrain characteristics

The most important terrain feature is slope. There are recommended maximum slope limits for different machine types based mainly on hazard severity. There are also practical limits after which production becomes more costly. This is particularly so when considering adverse (uphill) slopes (*see* table).

Extraction machine	Maximum operating slope (º)	Adverse slope limit (º)*
Wheeled skidder	18	10
Bulldozer	22	15
Flexible tracked skidder	22	20
Excavator	22	20
Clambunk	18	10
Forwarder	18	15

* Data sourced from McDonald, A.J. (1999): Harvesting Systems and Equipment in British Columbia. *FERIC Handbook No HB-12*.

Other important terrain features include:

- Shape of the terrain
- Ground roughness
- Obstacles, such as rocks and old stumps
- Tomos
- Bluffs
- Seepage heads

Haul distance

The distance an extraction machine travels, from the hook-on/loading point to the landing, is termed the haul distance. From a planning point-of-view, the haul distance is usually the straight-line distance. The exception is where formed contour tracks are used.

The average haul distance is the average distance from the landing to where each drag or load was accumulated. Generally, this average is about $^2/_3$ of the maximum haul distance where a central landing is used.

The greater the haul distance, the longer the travel in and travel out times. This results in a slowing of production as more time is spent travelling with each drag or load.

Haul distance varies as a setting is worked. When a block is first opened, the haul distance is short. As the felling moves away from the landing, the haul distance increases. Contractors aim to mix short and long haul distances to ensure that the flow of wood to the landing(s) is kept constant during the operation.

Soil conditions

The main soil conditions that affect logging performance are soil texture (i.e., clay, silt, sand, or gravel), drainage, and rainfall.

Clay-rich soils are poorly drained and easily compacted by extraction machines when wet. Forest owners try to avoid working on such soils during winter and spring when the risk of compaction and runoff are higher. Despite this, heavy prolonged rainfall during any time of the year can increase the risk of these impacts. From an operational point-of-view, wet soil conditions can reduce traction to a point at which loaded travel is very difficult.

Felling should minimise breakage and allow for efficient extraction

Felling pattern and damage

The felling operation should present stems for efficient extraction. Butt extraction reduces stem breakage and can improve machine traction. If a cable skidder or tractor is used, access to the stem for hook-on is much easier, thereby reducing hook-on times. Bunching by harvester or excavator, and drag accumulation by a grapple machine are more efficient if stems are presented butt-first.

Felling breakage should also 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.

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
- How much preventative maintenance is done
- The care showed by the machine operator(s) in looking after the machine.

If the extraction machine is limiting production, any down-time will reduce daily production. The flow-on effect may be an imbalance in the operation, and the under-utilisation of other machines and phases.

Landing location

Landing locations are decided during the harvest planning phase. The harvest planner aims to locate the landing(s) in the best position by considering:

- The logging system
- Haul distance

- The availability of a suitable area (size, slope, and shape)
- Presence of adverse slopes for extraction
- Vehicle and extraction machine access to the landing
- Drainage of the approach road, skid trails, and landing
- Landing construction costs
- Environmental issues, such as proximity to sensitive cultural sites, boundaries, and waterways, and potential soil, water, and visual impacts
- Future needs for the landing.

These factors may conflict, resulting in a landing position that is not the best for the extraction phase of the operation. This may also result in longer haul distances and adverse slopes that will affect extraction efficiency. The landing location may also affect the size and layout (processing and loading area, and stack locations) of the landing.

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 layed out, interference between the different phases can occur. This may also 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 of vehicles off the main carriageway and away from landing activities
- Adequate storage and smoko/rest area.

Landings are normally seperated into different work areas.

Separate work areas reduce machine hazards for manual workers

In a ground-based operation, areas should be defined for:

- Entry on to the landing, and dropping of the load
- Log stacks
- Smoko facilities
- Fuel storage
- Processing
- Loading
- Saw/machine maintenance
- Waste disposal.

Crew skills and motivation

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

A logging system cannot operate efficiently without a skilled and motivated crew. Another important factor is effective communication between crew members. These factors combine to ensure that the different phases of the operation integrate with little 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 the responsibilities and tasks must be clearly assigned.

Regulatory constraints

Regulatory constraints 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.

System selection

There are different types and sizes of extraction machines available on the market. To ensure the extraction operation is efficient and safe, the machine type and class must be matched to the operation.

Whether considering a production thinning or clearfell operation, the extraction phase must be matched to:

- Piece size
- Soil condition (seasonal wetness)
- Typical haul distances
- Terrain (slope, presence of adverse haul slopes)
- Felling/bunching operation(s)
- Processing and loading productivity.

The aim is to select the most cost-efficient extraction system that matches the requirements listed above, and provides a safe working environment for the operator and other workers. The table below provides a summary of operating condition for each machine type. Also shown is a rating of hazard severity associated with each machine and combination.

Type of operation and terrain	Maximum operating slope (°)	Soil condition	Machines used	Comments	Relative hazard rating*
Clearfell – flat to rolling terrain	18	Dry (well - drained)	• Wheeled skidder - Cable - Grapple • Excavator • Clambunk • Forwarder	 Breaker-out required. Stems preferably bunched. Short haul distance <150 m. Long haul distance (400–700 m) Logs processed and pre-sorted by harvester.	 H M L L L
		Wet (poorly drained)	• Wheeled skidder • Excavator • Excavator/wheeled skidder • Flexible track skidder	Wide tyres required. Shovel logging. Shovel logging to designated tracks. Stems preferably bunched.	M–H L L–M M–H
Clearfell – steep terrain	22	Dry (well - drained)	• Tracked skidder - cable - grapple • Excavator/wheeled skidder • Flexible track skidder	 Pull winch rope. Stems must be pre-bunched. Skidder confined to flat-to-rolling terrain. Pull winch rope or stems pre-bunched.	 H M M M–H
Production thinning – flat to rolling terrain	18	Dry (well-drained)	• Wheeled cable skidder • Forwarder	Full stem extraction. Rope pulled to stems. Requires mechanical felling and processing at stump.	 H L
		Wet (poorly drained)	• Tracked cable skidder	Rope pulled to stems.	H
Production thinning – steep terrain	22	Dry (well-drained)	• Tracked cable skidder	Work on formed tracks and pull winch rope.	H

* H = high, M = medium, L = low.

Data from McDonald, A.J. (1999): Harvesting Systems and Equipment in British Columbia. *FERIC Handbook No HB-12*.

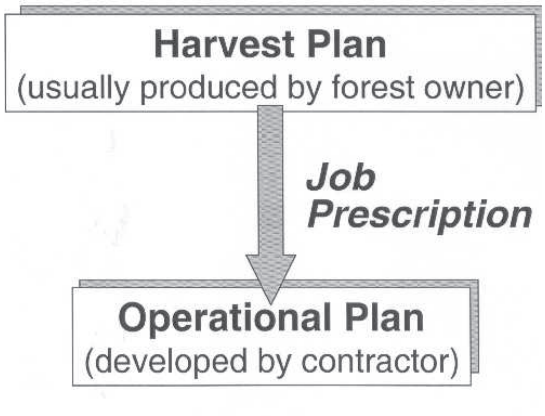
Planning issues

There are two main types of planning for ground-based operations.

- Harvest planning
- Operational planning.

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

The job prescription contains information gathered during the harvest planning process. In addition, it defines the standards to which the operation must comply. This allows the contractor to plan his/her operation for maximum cost-efficiency.



Harvest planning

The forest owner usually develops the harvest plan. This is developed up to 2–3 years prior to the harvesting operation to ensure that any earthworks required can be constructed and allowed to consolidate before being used.

The harvest plan provides the following information:

- Stand information
- Road lines
- Likely extraction directions
- Location of landings
- Setting boundaries
- Average haul distance
- Suitable machine types (but not necessarily the actual machines to be used)
- Permanent or temporary waterways and crossing points
- Environmentally sensitive areas (including historic and archaeological sites).

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 be submitted along with a Resource Consent application 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 adverse impacts on the site. In doing so they consider the potential effects of operations on onsite and offsite values.

They have to consider:

- Location of haul tracks, roads, and landings
- Trees bordering sensitive areas and riparian zones
- Controlling water runoff
- Boundaries
- Adjacent properties
- Waste disposal
- Fuel and oil storage
- Physical resources.

Areas bordering streams may need protection

The logging operation will need to comply with environmental standards defined by the forest owner, and local and regional authorities. The resulting plan should 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 harvesting contractor detailing the requirements for the harvesting operation. It outlines at the compartment and setting level:

- Species
- Type of operation
- Environmental risks
- Resource Consent number (if applicable)
- Allowable residual tree damage (in production thinning operations.
- Terrain and soil classification
- Main access roads
- Post-operation clean-up requirements
- Known hazards associated with the area to be logged

Attachments may include:

- Harvest planning map
- Stand data report (plot details e.g., stocking, piece size, percentage log qualities)
- Resource Consent
- Historic Places Consent
- 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)

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 considers more detail than the harvest plan in terms of machine usage and timing. It is based on the specific working patterns of the crew.

Roads and landings are in place when the logging crew arrives. Therefore, 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 (felling progression, use of landings, siting of main extraction tracks)
- The layout of the landing, including:
    - Entry points for extraction machine(s)
    - Safe areas
    - Truck loading area
    - Processing waste location
    - Processing areas
    - Location of stacks
    - Warning sign locations
- Hazards associated with the block and means of controlling them.

Felling and extraction activities

The felling and extraction activities should be planned, and communicated to the crew. The contractor and/or foreman will decide on the work pattern to be used. They should consider the efficiency and hazards associated with each activity. They should aim for constant woodflow to the landing by altering the felling locations, the number of felled stems on the ground, and where the wood is to be extracted.

The work pattern adopted will need to consider the following:

- The type of extraction operation (production thinning or clearfell)
- Tree lean and felling direction
- Extraction direction (uphill or downhill)
- Type of extraction machine used
- The need for a breaker-out
- The proximity to other operations (particularly felling)
- Variation in topography over the block
- Variation in ground conditions (wet *vs* dry areas)
- The shape of the block
- The location of entry points on to the landing
- The layout of the landing activities
- The desired flow of wood on to the landing to match the landing activites
- The number of trees to be felled and extracted to each landing during multi-landing operations
- Stem or log age limits.

Normally, felling starts at the lowest point on the terrain, or downwind in a flat or undulating area. At the initial point, cross felling may be necessary to avoid sensitive boundaries or waterways.

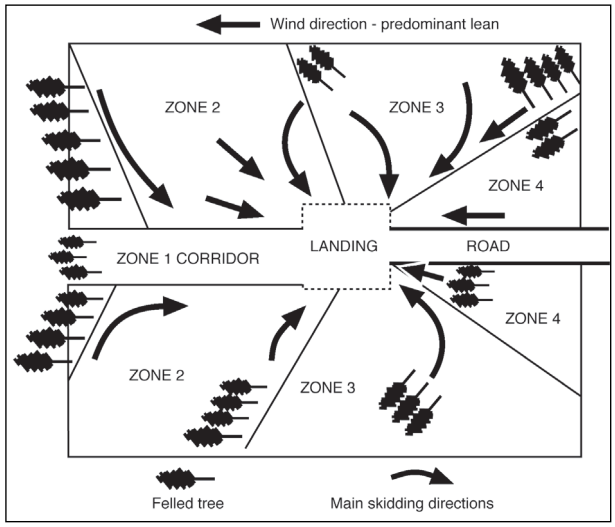
Where possible, the felling and extraction pattern is planned to suit the predominant lean and extraction direction. The felling and extraction activities may move throughout the block to ensure that there is a mix of wood available with short and long haul distances. It is also a good idea to leave an area of wood close at hand as a buffer should weather or machine breakdown slow extraction.

Clearfell — Flat terrain (up to 11°)

The tree lean and the shape of the block will define the work pattern on flat terrain. For manual felling operations, felling and extraction progresses back against the predominant tree lean. This allows trees to be felled into the open rather than into the stand. Ideally, the landing should be positioned upwind of the stand to take advantage of butt extraction.

When mechanical felling, the harvester can progressively move away from the landing to establish a felling face. Harvesters can handle tree lean much more easily than manual fallers, allowing the stem to be ideally positioned for extraction. Stems can be bunched to provide access for the extraction machine and increase extraction productivity.

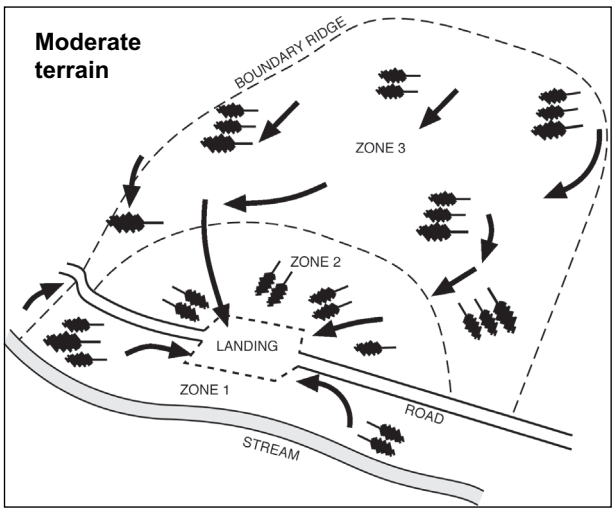
At right is an example of a work pattern for manually felled flat terrain.



Flat terrain

- A corridor can be opened to the back of the block to provide access (Zone 1). Trees should be felled for butt extraction.
- Once opened, Zone 2 can be felled in a herringbone pattern for butt extraction to the landing.
- Zone 3 can then be directionally felled at an angle to the predominant lean to allow for butt extraction.
- Zone 4 can be felled for head pull to the landing, or felled across the predominant lean for butt extraction.

On flat terrain, extraction machines will use a radiating or branch-like pattern of extraction tracks. Break-out will usually be towards the closest major access track. Some blading of the main access track may be necessary to straighten it.



Clearfell — Moderate terrain (12° to 18°)

As the slope increases, tree lean has a greater influence on the felling and extraction pattern. Also, the need for planned extraction tracks increases.

Where the landing is downslope of the stand, stems will be extracted from the bottom of the slope first. Alternatively, an alley will be cleared first to allow access to a range of felled stems.

If extracting uphill to the landing, an alley will be opened from the bottom to the top of the slope along an accessible ridge. This will form the main access to the surrounding area.

At left is an example of a work pattern for manually felled sloping terrain.

- Zone 1 is directionally felled across slope to protect the stream. The trees are felled to maximise butt extraction. Although close to the landing, this area may be left standing until later in the operation to balance woodflow when extracting Zone 3.
- Starting at the base of the slope, a portion of Zone 2 is felled for head pull to the landing.
- The upper slope (Zone 3) is directionally felled to allow butt extraction, and extracted. Felling and extraction may work off both sides of this zone to allow stems to be dropped on alternating sides of the landing. The return journey for the extraction machine will be by primary extraction tracks located in the bottom of any dry hollows or gullies orientated up-slope.

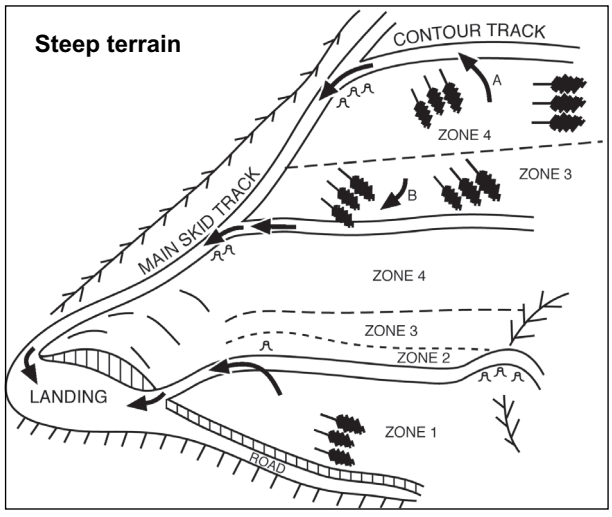
On moderate slopes, there may be a need to form tracks to access stems on side slopes. If using a cable machine, it may be easier to break-out uphill towards a contour track. This allows the winch rope to be pulled downhill for butt pull, and gives better control over the drag during break-out. For long slopes, it may be necessary to establish a main return track from which secondary extraction tracks branch off downhill.

Clearfell — Steep terrain (greater than 18°)

As the terrain steepens, the need for formed contour tracks increases. They should be located so that the machine does not have to move off the track. Their spacing should allow break-out from the track. An excavator may bunch stems to the track or rope may be pulled from a wheeled or tracked cable skidder.

Normally, $^{2}/_{3}$ of the wood is pulled down to the contour track and $^{1}/_{3}$ up.

Safety considerations are important in steeper terrain. Rub trees or stumps should be left on the downhill side of curves and where contour tracks turn on to down tracks. Turn areas should be constructed so that the machine can approach the drag backwards. Contour tracks should be wide enough to allow the machine to be orientated in the break-out direction.The track itself may not be wide enough for a wheeled machine to turn around on safely. Therefore, this should not be attempted.



At left is an example of a work pattern for manually felled steep terrain.

- Zone 1 is felled directionally to protect the access road and allow for butt extraction.
- Zone 2, alongside the contour track, is felled from the back of the strip along or parallel to the track. Most of the trees will fall on to the track for butt-first extraction to the landing.
- The trees in Zone 3 are either directionally felled to the track to allow butt extraction, or felled for head pull.
- Stems are broken-out up towards the contour track in Zone 4. The breaker-out or machine operator pulls the winch rope downhill to the stems.

Production thinning — Flat terrain (up to 11°)

Where the residual stocking rate is high and restricts machine access, an outrow system may be used. In this system an entire row of trees is removed, allowing surrounding trees to be reached from the resulting strip. Either a mechanical harvester will process logs to the outrow and a small excavator or Bell may bunch stems, or a winch rope will be pulled from a machine positioned within the outrow. If residual stocking is low, random tracking may be used as this offers better opportunities for tree selection. Bunching with a small excavator or Bell loader can increase extraction productivity.

Approaches to the landing need to be gently curving to reduce the damage to residual trees and avoid the extracted tree lengths tail-locking.

Production thinning — Moderate terrain (12° to 18°)

On short slopes the best approach is to use parallel tracks which are at right angles to the slopes. Directional felling is most important to reduce residual tree damage and aid break-out. Small tracked skidders are particularly effective for tree length extraction as they can back directly up to the stems.

For longer slopes a climbing track may be required. The machine climbs this and then descends on an extraction track passing over unpulled wood as it does so.

Landing use

The contractor and/or foreman decide on the layout of the landing. The aims are to:

- Allow the extraction machine(s) to land wood with minimal interference to other landing activities
- Provide adequate safe working area for the processing activities. This is particularly critical where manual processing is done.
- Fit the required number of log stacks, where the logs in highest demand are close to the loading area.
- Provide a truck loading area that is close to the log stacks, but separated from the processing activities so that neither activity is slowed down or placed at risk.

The contractor may decide to **de-phase** (separate) the different landing activities by using multiple landings at a time. This generally requires at least three closely spaced landings. While stems are being extracted to the first landing, processing is done at a second, and loading occurs from the third. This avoids people and machines being together on the same landing, with obvious benefits for safety.

Landings usage	Suits …	Disadvantages
Single landing	• Low rate of production. • Out of shift load outs. (cold decking) • Long haul distances (low extraction rate). • Steeper terrain (long haul cycle times). • Tracked loader sorting/fleeting.	• Interference between extraction and processing/ sorting/fleeting functions. • Load out in shift can affect other activities.
Multiple landings	• High production rate. • Day-time or out-of-shift load outs. (hot or cold decking) • Fast extraction (short cycle times). • Easy terrain. • Wheeled loader sorting/ fleeting. • Mechanised operations.	• Processing crew must be mobile or mechanised — time is lost in moving between landings. • Needs good organisation and communication within the crew. • A dedicated loader is needed for loading trucks as well as a sort and fleet loader.
Single large landing (Super skid)	• High production rates or more than one crew. • The cutting of more log grades than usual. • Manual processing (calliper log making).	• Waste build-up can be significant. • Requires a large flat area. • Expensive to construct.

Two-staging may be used to separate the extraction and processing phases. This may be done for safety reasons or because the landing site cannot be made big enough. Wheeled or tracked skidders may extract wood to a small landing or to roadside dumps. A full-stem truck may then transport stems to the processing landing, which may be 10 km or more away.

Super skid

Two-staging allows the processing landing to be placed in a more ideal position. Because it can be used for a greater volume of wood, it can be made bigger and with more attention to drainage. The greater size provides adequate working room for manual workers and machines. It also provides benefits for value recovery and log stock management.

Another option may be to load out-of-shift (**cold-deck**). This increases the efficiency of the sorting and fleeting phases, as there is no interference with loading activities. This may also increase the utilisation of the loading machine.

Layout of the landing

Extraction machine entry/offload/exit

- The landing must enable entry of the extraction machine
- Sharp turns should be avoided as machine stability can be compromised and incoming stems may be damaged
- The drag should not dislodge piles of slash or waste material — this will be a danger to skid workers
- High stumps are useful to guide the drag on entry
- A straight-through travel movement (following off-loading) is more efficient, uses less space, and is safer than reversing manoeuvres.
- It is good practice to drop the butts in one direction. This makes it easier for logmaking, sorting, and fleeting.

Stems laid out for manual processing

Delimbing, logmaking, and crosscutting

- The layout of the landing and work pattern should allow workers to face towards machines working on or entering the landing.
- Where possible, delimbing should take place off the landing.
- Logmaking will take place on stems laid out on the landing.
- The stems should be laid out with sufficient room for skiddies and logmakers to walk alongside (*left*).
- Logmakers need to see more than 180° of the stem surface to examine the tree properly for defects.
- Stems must be laid out with sufficient room for machinery to move around the butts or tops without endangering landing workers.
- There should be a maintenance area for skid workers to sharpen and maintain saws, as well as store paint, stencils, and fuel.
- Stems are usually laid out along the long axis of the rectangular skid, with entry/exit points mid way on the short sides.
- Usually, there is room for only one processing area (one set of stems) on the landing (a typical square is 40 m x 50 m, extracted stems may be 25 to 30 m long).
- The extraction machine will offload to the side opposite to that already cut up so that the sorting and fleeting are not hindered.
- If a Bell loader or small excavator is used for sorting, and some of the fleeting, two parallel processing areas might be used, and interferencewith extraction reduced.

Sorting and fleeting

- Stacks can be placed on the outside edge of the landing. Alternatively, they may be placed between the processing area and the road (where trucks are loaded).
- Room between stacks should be allowed for quality control (QC) access.
- Additional room should be allowed for stack rotation, especially if comparatively large volumes of a given grade are being cut.
- Rotation involves the relocation of stacks to bring the older logs from the back to the front where they will be loaded out first.
- Additional perimeter room will be made for accumulation of slash, waste, slovens, and other debris.

Fleeting to roadside stacks

- A wheeled loader should sweep material out to the extraction exit point, and the skidder or tractor can blade it on to the cutover and away from the skid.
- Stacks should be placed so that fleeted logs are moved the shortest possible distance. High quality stacks will be towards the butt end, and pulp and low quality material will be at the top end.
- A high-demand, high-volume product (e.g., peeler logs) should be placed where access to trucks is comparatively easy.
- Slow-moving product (pulp) should be stacked out of the way in corners.

Slash disposal

- Extraction machines fitted with blades are used to clean the skid of branches, slovens, and log waste. This is done every few cycles, sometimes on the return trip to the felling site after unhooking of the drag.
- The landing can also be cleaned at smokos or when work is finished.
- If an excavator loader is used, the skidder or tractor will clean the landing, otherwise rubber-tyred front-end loaders (RTFEL) will do this.
- The extraction machine is often in a better position to clean the landing because the RTFEL is busy fleeting and/or loading, and it doesn't take much more time for the extraction machine.

A Bell loader clearing slash from the work area

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, September 1st 2000*

  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 any conditions set by the authority before any signs warning of operations are placed and work commences.*

Note that Transit jurisdiction 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

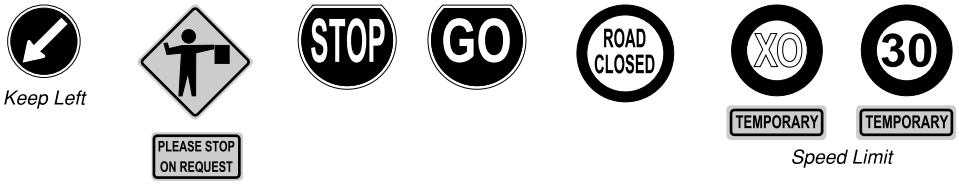
According to the Transit code, the following signs may be used.

- **Advance warning signs**

- **End of works/operation signs**

Derestriction

- **Direction and protection signs**



Keep Left

Speed Limit

Placement of signs

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

Transit requirements for sign placement relate to average annual vehicle usage.

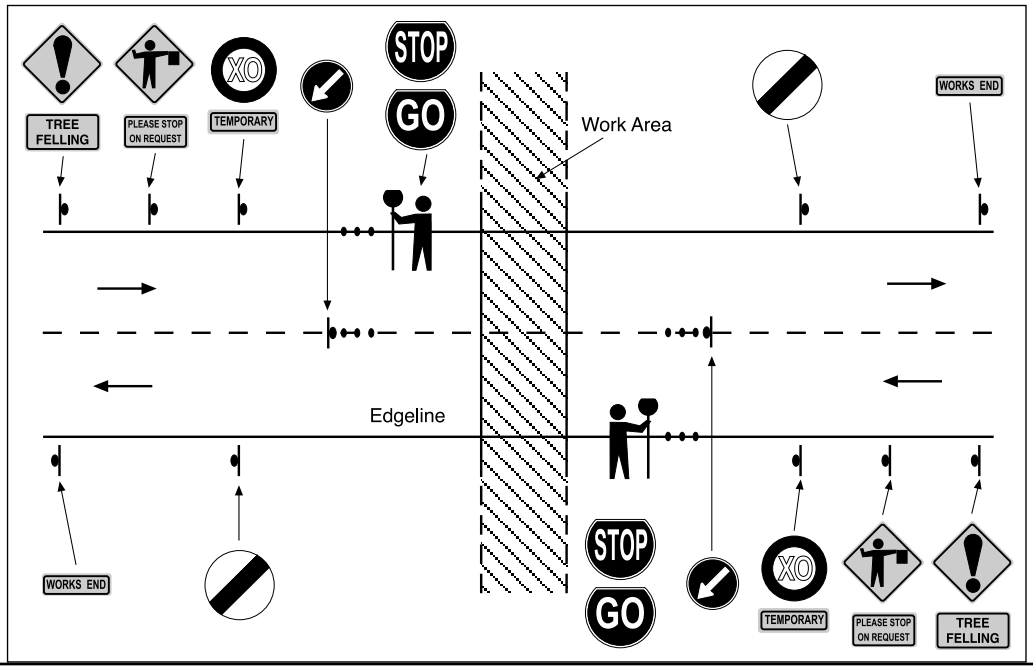
The following guidelines relate to traffic control on Level 1 roads — these are roads that carry less than 10 000 vehicles per day.

- The distances between the advance warning sign and the edge of the operational area vary with traffic speed.

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

(from *Transit code, Sept. 2000*)•

- 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 Code.



Work area safety

It is important to check the work area for hazards before you start felling or cutting. Under the Health and Safety in Employment Act 1992, you are required to avoid any activity that will harm yourself or another person in any place that you work.

Before any tree felling can commence:

- Inform all staff in the immediate area.
- Check on the distances to the nearest workers to ensure an adequate safe working distance (**two tree lengths minimum**).
- Check that there are no other persons, children, or animals in the work area.
- Do not work in adverse weather conditions such as high winds, heavy rain, or snow.
- Always ensure you have a clear work area where you have stable footing and do not have to reach or work off balance.

When felling trees:

- Ensure other people are at least two tree lengths away unless they are part of the felling operation, assisting, supervising, or involved in training.
- Ensure that other operations, machines, and operating ropes are at least two tree lengths away.
- Fallers and observers shall ensure the safety area is maintained
- Always have an escape route planned and cleared, at 45° to the side and rear of the direction of fall
- Trees shall be felled into an open area unless there is no alternative
- No tree shall be felled within two tree lengths of any road, railway or public access unless adequate provisions have been made to control traffic (signs, barriers, personnel).

If it is necessary for there to be more than one person at the tree with the faller:

- Only one person shall be making felling cuts at one time
- Only one chainsaw shall be working while the felling cuts are being made
- The person not making the felling cuts must be behind the tree being felled, in full view of the faller and able to see the top of the tree.

Further details on felling operations are contained in **Best Practice Guidelines for Tree Felling**.

Entering an operational area

Every person entering an operational area shall:

- Notify the supervisor or foreman before entering the area
- Exercise care when approaching workers engaged in any operation
- Attract the attention of the faller before going within two tree lengths of him/her.

  Do not enter the area until acknowledged or signalled to do so.

Training and supervision

Ground-based logging involves a wide range of tasks and situations. 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 new workers to the operation or task. Regardless of their training status, they should not be allowed to work unsupervised until they have demonstrated that they are unlikely to harm themselves or anyone else.

All workers must be under a documented training programme and should be aiming to pass the NZQA Units relevant to ground-based extraction.

Workers involved in ground-based extraction need to be fit, active, alert, properly trained or supervised, and appropriately equipped.

Knowledge of hazards

As part of the supervision and training programme, operators and 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 operators and 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 and workers have had them explained.

The two main hazard categories are **Health Hazards** and **Operational Hazards**.

Health hazards

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
- Have an adequae level of fitness for the task
- Do not let drugs or alcohol impair your judgement.
- Maintain an adequate level of hydration and diet
- Get adequate sleep

Health hazards

Hazard	Control
Fatigue (mental and physical)	• Build short frequent rest breaks into your day. • 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 24 hours.
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 go back to late starts.
Alcohol abuse	• Avoid drinking alcohol for at least 24 hours before carrying out any hard physical work.
Poor nutrition ***(most accidents occur between 9 and 11am 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 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.
Occupational Overuse Syndrome	• Use of correct techniques. • Be aware of muscle tension as you work; if you experience discomfort, take a break and let your muscles relax. • Regular medical examinations.

Health hazards (cont . . .)

Hazard	Control
Occupational Overuse Syndrome (cont...)	• Use stretching techniques both on and off the machine throughout the day. • Perform other tasks, off the machine, that will exercise different muscle groups. • Use micro-pauses (short breaks every 5 min or so). Take your hands off the controls and let your arms and hands totally relax for 5–10 sec.
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.
Hypothermia/chills	• Polypropylene clothing (thermal underwear) is excellent for cold, wet weather. • 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 working on maintenance or repair outside the cab.
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

Operational hazards will be specific to the type of operation being undertaken. The operational hazards listed here have been divided into:

- Machine hazards
- Extraction hazards

Operational hazards

Machine hazard	Control
Solvents	• Read safety information regarding the solvents used. • Try not to get dangerous substances on your skin. • Make sure that hands are washed before eating food. • Avoid excessive breathing in of solvent fumes, ensure there is plenty of ventilation in the work area.
Diesel fuel or hydraulic fluid under pressure *(skin penetration, eye injury)*	• Install cylinder rod support struts, or block the cylinders and equipment before working on the hydraulic system. • Cycle all hydraulic steering and other controls after shutdown to relieve system pressure, follow manufacturer's instructions. • When venting or filling the hydraulic system, loosen filler cap slowly and remove it gradually. • Use a piece of cardboard or wood when looking for leaks. • Wear a face shield or goggles for eye protection.
Footing	• Attend to footing if walking around trees and standing on ladders. Pay particular attention to wet logs and slash in old cutover areas. • Jumping from ladders should be avoided. • Boots must provide good ankle support and good grip.
Flammable substances	• Never fill the fuel tank with engine running, while smoking, or near a naked flame. • Ground the fuel funnel or nozzle against the filler neck to prevent sparking. • Do not cut or weld on fuel lines, tanks, or containers. • Remove rubbish and debris from the cab of the machine. • Make sure that oily rags and other flammable material is removed from the machine. • Check for, and repair fuel, oil, and hydraulic leaks before operating the machine. • Use non-flammable solvents for cleaning parts. • Store all flammable fluids and materials away from the work area. • Check readiness of fire extinguishers or suppression systems
Other vehicles on roads during relocation *(if mobile plant is to be driven or transported on the road)*	• Make sure all flags, lights and warning signs are in place and visible. • Use hazard-warning lights. • Use an escort vehicle if required. • Secure all accessory equipment or attachments.
Maintenance-related hazards	• Read the Manufacturer's Service Manual and the Operator's Manual. • Ensure you have the necessary skill, information, correct tools, and equipment.

Operational hazards (cont . . .)

Machine hazard	Control
Maintenance-related hazards (cont...)	• If the engine should not be started, remove the key. • Check the workspace has adequate clearances, light, and ventilation. • Wear protective clothing, overalls, gloves, and eye protection. • Keep clear of rotating components (e.g., fan blades and couplings). • Keep pockets free of objects that could fall out into machinery. • Start the engine only from the operator's seat. • Move the machine on to a level surface. • For tracked machines, block the tracks before releasing service brakes. • Stop the engine and release all hydraulic pressure. • Don't work on a running engine unless instructed by the manual. • Attach cylinder support struts, or block hydraulically operated attachments. • Place controls in neutral. • If doing maintenance on a running engine, use two people, one to sit in the operator's seat. • Don't leave guards off or access doors open when the machine is unattended. • If servicing the air conditioning system, avoid Freon gas contact. • Don't work beneath raised equipment, use jacks, wood blocks, or jack stands as stable supports.
Climbing into cabs	• Maintain three points of contact while climbing. • Face the machine when climbing or dismounting. • Be aware of the state of the ladder (e.g., ice, mud, water, oil, etc.), and clean if necessary. • Don't jump from a machine. • Don't climb off a moving machine. • Don't use either the steering wheel or any control lever when entering or leaving the cab. • The cab should be aligned with the undercarriage centreline when entering or leaving the cab.
Asbestos ***(some older machines may have components containing asbestos in friction (brake linings) and gasket materials***	• Never use compressed air for cleaning. • Avoid brushing or grinding. • Use "wet" methods for cleaning up. • Wear an approved respirator. • Avoid areas where particles may be in the air. • Shower after contact. • Store food, drink and personal belongings away from the work area.

Operational hazards (cont...)

Machine hazard	Control
Asbestos *(cont...)*	• Never eat, drink, or smoke where asbestos is in the area.
Exhaust fumes	• If it is necessary to run the engine or operate the machine in an enclosed area, be sure there is enough ventilation.
Tracks	• Wear gloves if handling recently used pins and bushings from a dry joint. • Never hit track tension springs (they could shatter explosively if under compression).
Tyres	• Follow supplier's recommendations. • Don't exceed correct tyre pressures. • Inspect tyres and wheels daily. • Don't operate on low pressures, cuts, bubbles, damaged rims, or missing lug bolts or nuts. • When adjusting tyre pressure, use a long hose with a self-adjusting chuck. Always stand behind the tread when doing this. Ensure the area to the side of the tyre is clear of others.
Electrical systems	• Disconnect the battery before working on the electrical system. • Remove the ground cable first. Connect this cable last. • When checking coolant, stop the engine and let the system cool first before removing the filler cap (if this is necessary). • Keep arcs, sparks, and naked flames away from lead-acid batteries. • Do not charge a battery or jump-start the engine if the battery is frozen.
Noise ***Typical noise levels: Car 70dB, Skidder 85–95dB, Gunshot 180dB Chainsaw 100–105dB,***	• Use hearing protection inside a cab if noise level is above 85dB. • Reduce noise exposure by keeping doors and windows shut while working.
Vibration from machine	• Avoid sudden impacts while operating 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 spinal discs. • Control breathing and relax muscles. • Keep a good posture. • Keep fit — strengthen abdominal muscles.

Operational hazards (cont . . .)

Extraction hazard	Control
Tree felling	• Keep at least two tree-lengths away from any tree felling. • The exception is for a machine giving assistance to a faller in the case of hang-ups, or assisted tree felling of edge trees.
Movement of machinery	• When hooking on, ensure that the parking brake is applied and the blade is lowered. • Do not stand behind a stationary extraction machine that does not have the blade lowered and park brake applied. • Breaker-outs should not stand downhill from any machine positioning for breakout. • Watch for unexpected side-slipping or tipping when a wheeled arch is being manoeuvred.
Wire rope	• Unprotected workers must keep well clear of any ropes when winching. • Do not stand in the bight of any rope unless the tension has been released, and the machine operator is aware of your presence. • Avoid hand injuries from sprags by wearing gloves • Remove sprags with side-cutters. • Wear protective eyewear when cutting wire rope.
Stem movement	• Make sure that stems are stable before attaching strops. • Use the extraction machine to reposition stems.
Machine instability	• Do not work on slopes beyond the capability of the machine. • Move up and down slopes, not across them. • Ensure that the angle of break-out is directly behind the machine. • Don't plan for, or winch across a side-slope. If stems are caught on a stump or an obstacle, the extra tension on the rope could make the machine unstable. • When working on slopes, attach strops from the uphill side if possible. • If moving on a track, keep as close as possible to the inside (batter slope), and avoid driving on less stable fill. • If turning an articulated machine (skidder) on a slope, turn uphill. • Extracting downhill should be carried out with the blade down (to help prevent sliding), in low gear and avoiding stumps (or the machine may become stuck).
Flying debris, branches at breakout	• Breaker-outs should stand well clear of the break-out area following hooking-on. • Be aware that branches under tension can whiplash.

Operational hazards (cont...)

Extraction hazard	Control
Underfoot conditions *(slash, vines)*	• Move slowly to ensure you have stable footing. • If possible, walk around piles of heavy slash. • The breaker-out must ensure he/she is standing in a safe position for break-out. Be aware of vines, etc., tangled around stems being extracted.
Poor communication	• Ensure that, if hand signals are used, they are well understood. • If a breaker-out is required, ensure that he/she talks to the operator beforehand about the sequence of extraction (e.g., gullies first). • The extraction machine operator should talk to the foreman or contractor, as well as fallers, about the sequence of extraction, and how contact will be made if fallers need machine assistance.
Material entering a machine cabin	• Extraction machine shall have certified OPS. • Keep the door of the machine closed while the machine is actively working (If it is not closed there is not full OPS protection).

Personal protective equipment (PPE)

The approved Code of Practice for Safety and Health in Forest Operations requires that people working in logging operations wear the following personal protective equipment:

- Hi-vis helmet (a machine operator must wear a helmet when outside the machine)
- Hi-vis shirt, vest, or jacket
- Safety footwear providing ankle support (machine operators should not wear spiked footwear)
- Protective eyewear, unless it creates a greater hazard
- Hearing protection if noise levels exceed 85dB.

Other useful equipment:

- Gloves (leather or thick cotton)
- Small First Aid kit
- Water bottle

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

Safety requirements for extraction machines

Protective Structures

There are basically four kinds of protective structure:

(1) Rollover Protective Structure (ROPS) - designed for machines with an integral chassis to protect the operator during a rollover incident. A seat-belt must be fitted and used if a ROPS is fitted. Machines with slewing cabs should have COPS rather than ROPS.

(2) Cabin Operator Protective Structure (COPS) - designed specifically for hydraulic slewing machines. A seat-belt must be fitted and used if a ROPS is fitted.

(3) Falling Object Protective Structure (FOPS) - designed to protect the operator from falling trees and logs.

(4) Operator Protection Structure (OPS) - designed to protect the operator from material that may enter the cab. Having a door open or window removed means that there is not full OPS protection.

Extraction machine	Protective structures required
Wheeled skidder	ROPS, FOPS, OPS
Tracked skidder	ROPS, FOPS, OPS
Excavator	COPS, FOPS, OPS
Clambunk	
• Forwarder-based	ROPS, FOPS, OPS
• Timbco (cab and crane on rotator)	COPS, FOPS, OPS
Forwarder	ROPS, FOPS, OPS

These structures must meet defined standards. The manufacturer or specified agent must approve alterations to protective structures, outside the manufacturer's specifications.

The Approved Code of Practice for Safety and Health in Forest Operations describes the requirements for these structures in Part 3, Section 4.

The protective structure requirements for extraction machines are summarised left.

Operator and plant certification

Mobile plant must have a valid warrant or certificate of fitness and operators must have a licence, where applicable.

Other safety features

Different classes of mobile plant, or makes of machine, may have safety features that ensure the operator does not come to harm in the course of his/her work duties.

Safety features may include:

- Side, front and rear screens or doors
- Guards
- Safety signs
- Horn
- Mirrors
- Fire extinguisher
- Warning lights or devices
- Lights
- First Aid kit
- Reversing or travel alarm
- Windshield wipers and washers
- Fire suppression system

Further details on safety features and operating procedures are outlined in **Best Practice Guidelines for Mobile Plant**.

Wire rope, Strops, and other accessories

Wire rope

Wire rope is used as winch rope in ground-based operations. Skidder operators and breaker-outs need to know how to use rope to operate efficiently and minimise the risk of injury.

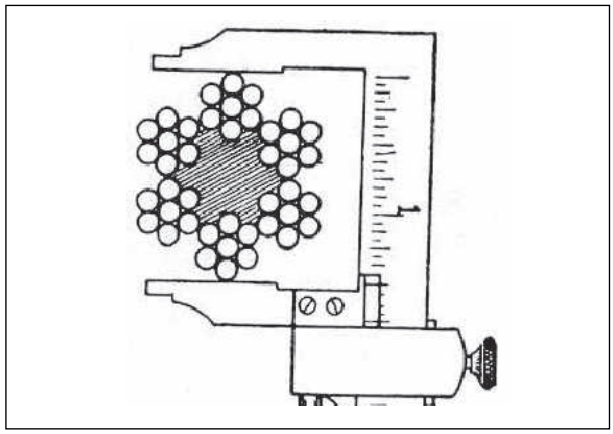
Describing rope

Wire rope is described by its:

- Diameter
- Configuration
- Rope core
- Lay.

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.



Correct way to measure rope diameter

Rope core

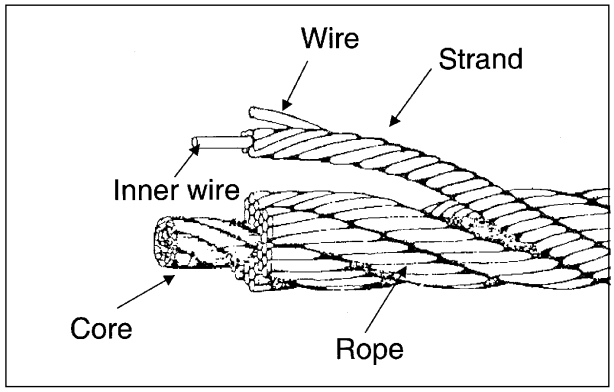
Most wire rope currently used in logging consists of a central core surrounded by six strands

The rope core has three functions:

(1) It provides a foundation for the strands so that they may work past each other without interference as the rope is bent

(2) It offers resistance to the rope crushing in on itself

(3) It acts as a reservoir for rope lubricant.



Rope components

Two types of core are:

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

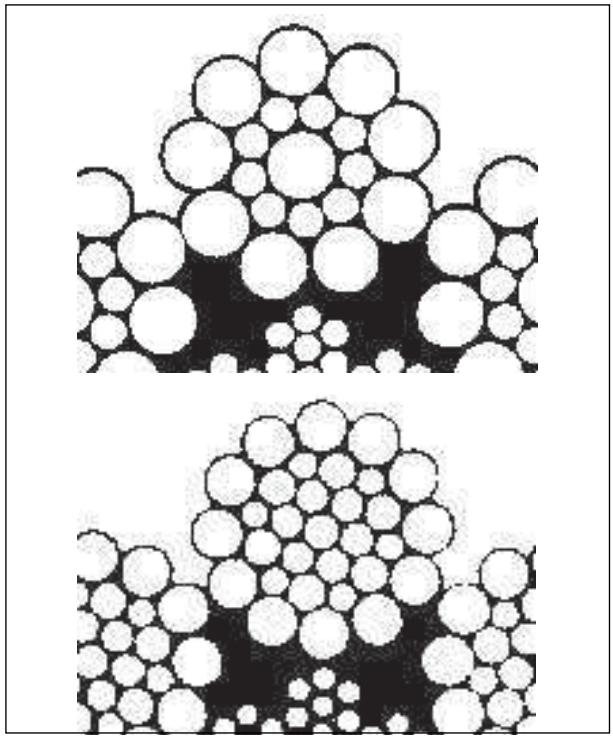
Configuration

Wire rope configuration is described by the number of:

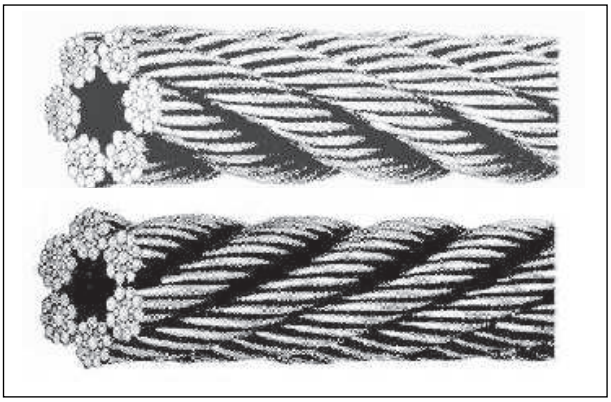
- Strands per rope
- Wires per strand.

Examples:

- 6 x 19 means a rope with six strands, each strand having 19 wires
- 6 x 31 means a rope with six strands, each strand having 31 wires.



6 x 19 rope (*upper*) and 6 x 31 rope (*lower*)



Right-hand lay (upper) and left-hand lay (lower)

Lay

Lay refers to the direction in which strands are laid in the rope. It affects the way in which rope spools on the drum.

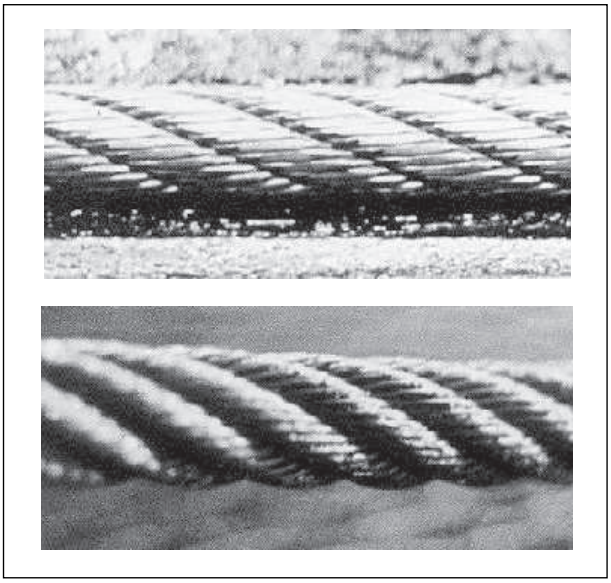
Lay is described as:

- Right-hand lay
- Left-hand lay.

Swaging

Swaging is the process of drawing formed wire rope through a set of reciprocating tapered hammers so that wires and strands are packed more closely.

Advantages of swaging	Disadvantages
• Higher breaking strength than unswaged 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, causing potential weak spots and preventing the wires from sliding against each other.



Swaged (upper) and unswaged (lower)

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

Load limits for ropes

When loaded, the behaviour of wire rope changes.

At low loadings, the rope stretches temporarily. When the load is released, the rope retracts back to its original size.

As the loadings increase, the rope stretches but does not retract back again. This is said to be beyond the elastic limit.

The loading of wire rope is usually designed around the **Safe Working Load (SWL)**. In forestry, this is defined as $^1/_3$ the Breaking Strength (BS) of the rope.

Common load limits used in forestry are given in the following Table.

Term	Percentage of breaking strength	Comment
Safe working load (SWL)	33%	A load limit obtained by dividing the BS by the factor of safety of 3. The SWL provides a margin of safety from gradual weakening of ropes through wear or age
Endurance limit	50%	If rope tension regularly exceeds the endurance limit, the life of the rope is shortened severely through fatigue.
Elastic limit	60–65%	Where applied tension is below the elastic limit, the wire can return to its original length. Exceeding the limit permanently stretches the rope that may then be damaged and have reduced BS.

Logging ropes are often subjected to either sudden (shock) or dynamic loads. For example, rope tension for a given drag weight may easily exceed rope load limits if:

- Extra force is applied to break-out a drag
- An obstacle is suddenly hit during loaded travel

Repeated shock-loading may cause:

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

To avoid shock-loading:

- Make sure there is no slack or jerk at break-out
- Apply power smoothly during break-out as strain increases
- Watch for obstacles (stumps, rocks, etc.) which may cause the drag to foul during break-out or inhaul

Handling wire rope

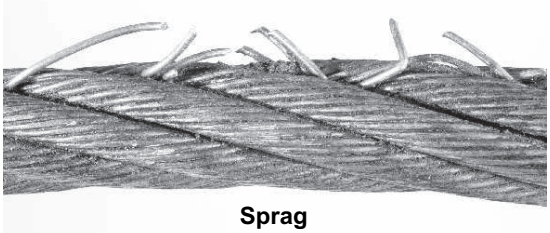
Wire rope, particularly when used, can be difficult to handle. Workers must be aware of rope characteristics, which may cause them harm when handling. These include spring, sprags, and kinks.

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

A sprag is a broken wire that has formed in 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).



Sprag

Kinks

A kink develops when a loop is allowed to form in a slack line and the line is then pulled 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 may require cutting to remove a length of worn or damaged rope.

The recommended rope cutting tools are:

- Grinder
- Impact cutter
- Long-handle cutter
- Hydraulic cutter.

Safety equipment

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

- Protective eyewear
- Gloves

Transferring rope

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

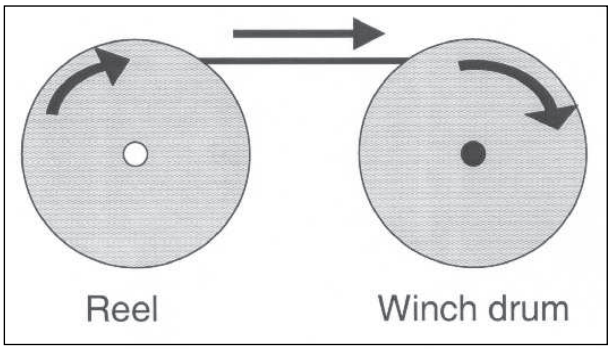
When transferring rope from reel to drum it is important to brake the reel to avoid over-run.

Also, the rope should be wound:

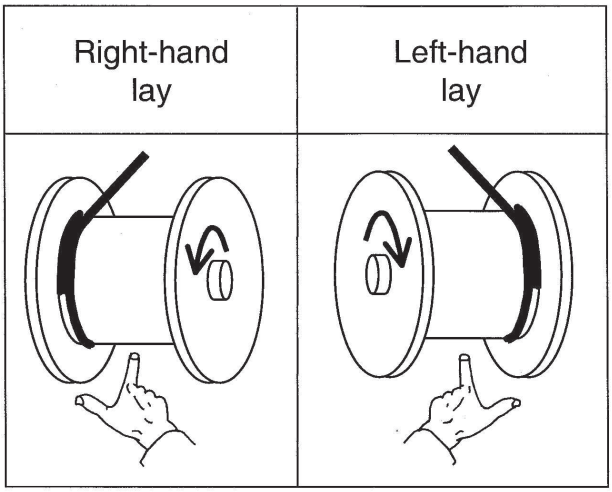
- At the correct tension to ensure even spooling on the drum (this is done after installation but before use).
- So that it bends in the same direction as when it was stored on the reel. This is achieved by running it from the top of reel to top of drum.

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

The following steps should be followed to spool the rope on to the winch drum.



Spooling from the top of the reel to the top of the winch drum



A simple method for correctly winding right- and left-hand lay rope on to a winch drum

(1) A ferrule is attached to one end, and an eye splice constructed at the other.

(2) The toggle (chain links and “A” stopper) for the strop rings is connected to the spliced end.

(3) The rope is uncoiled and pulled straight behind the bare winch drum.

(4) One strop is connected to the mainline and a small log hooked up to provide tension on the rope.

(5) The ferrule end is inserted into the receiving notch in the drum flange. Winch ropes are generally right hand lay. They should be attached to the right hand side of the winch drum (as viewed from behind).

(6) The strop can be connected to a stump and the handbrake released on the machine so that the machine’s own weight and brakes provide tension during spooling. The operator should use this method of installation - it is illegal for another person to be “riding” on the machine during the spooling process.

or

The operator slowly winds in the drum while a helper guides the first coils using a long, strong piece of wood.

(7) The first layer of the rope is slowly and tightly wound on to the drum.

(8) The rope should be “broken in” slowly and carefully, during the first few cycles.

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

The following rope defects mean the rope (or section) should be discarded.

- Broken wires, when over a length of eight diameters the total number of visible broken wires exceeds 10% of the total number of wires.

  For example:
  26-mm-diameter rope, 6 x 19 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.

- Broken wires near fittings
- Severe surface wear and inter-strand nicking
- Drum crushing
- Bird caging
- Kinking

Purchasing wire rope

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

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.

Winch ropes are typically 30 m to 50 m long (depending on rope diameter and intended use).

In clearfell operations, mainrope diameter may be 22 mm non-swaged and 19 mm swaged. Swaged rope is used because it is more crush resistant and also lasts longer.

For thinning operations, mainrope diameters are typically 19 mm non-swaged or 16 mm swaged.

When ordering wire rope, the supplier needs to know:

- Length (m)
- Diameter (mm)
- Tensile grade (strength) (180 or 200)
- Construction (e.g., 6 x 19 RHOL
- Core (IWRC or FC)

Strops

Strops or chokers are used to attach stems to main or winch rope. Strops consist of either wire rope and choker hook, or chain and hook.

Chain strops

Many ground-based operations use chain strops in preference to wire rope strops because they usually last longer, and are more suitable for head pulling.

Chain comes in two grades: Grade 80 and Grade 100. The grade relates to the tensile strength of the steel. Grade 100 is more brittle than Grade 80. Both have similar breaking strengths for the same diameter.

Most contractors favour Grade 100, as it is easy to repair using a hammerlock.

Chain sizes range from 8 mm for thinning operations to 13 mm for clearfell.

Chain strop

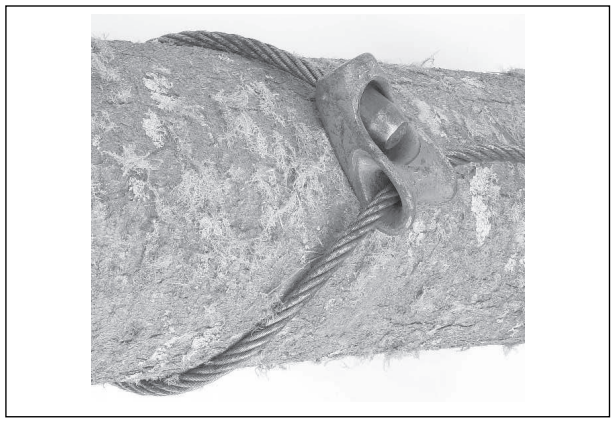
Wire rope strops

Wire rope strops are cheaper than chain strops.

Rope sizes range from 12 mm for thinning operations, to 19 mm for clearfell.

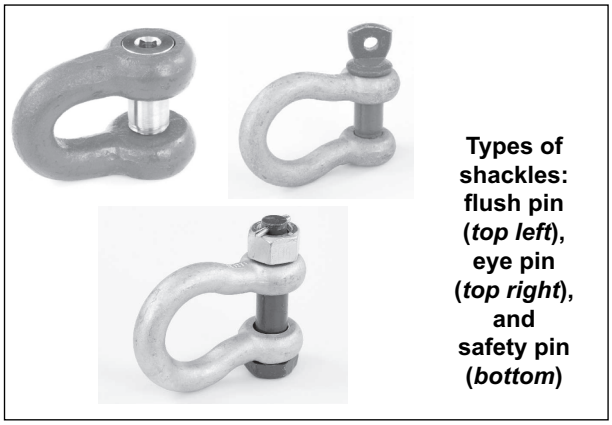
If a wire rope strop breaks, the whole strop is replaced.

6 x 31 (unswaged) is probably the best construction for strops. This is because they must be flexible to allow quick hooking and unhooking, and kinks to be hammered out.



Wire rope strop

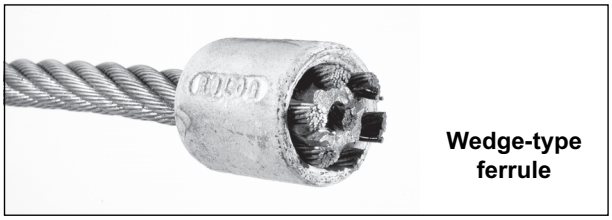
Strops should have a lower breaking strength than the winch rope so that if a hang-up occurs and the lines come under excessive tension the strops will break first



Types of shackles: flush pin (*top left*), eye pin (*top right*), and safety pin (*bottom*)

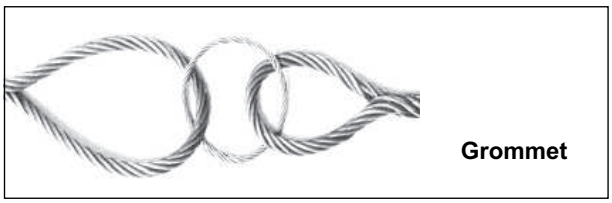
Marlin spikes

Swaged ferrule



Wedge-type ferrule

Hammerlock



Grommet

Shackles

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

Marlin Spike

The Marlin spike is used to open the strands while splicing rope.

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 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.

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. Ferrules are found in a variety of applications in cable logging.

They may be used with choker hooks or when attaching lines to winch drums

Hammerlocks

Hammerlocks are used to join lengths of chain.

Grommet

The (Molly) 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.

Extraction procedures

Bunching with an excavator

The aims of a bunching operation are to:

- Reduce the drag accumulation or loading time
- Position the stems were they can be accessed by the extraction machine
- Move the wood closer to the landing.

The general bunching procedure is as follows:

(1) Ensure that bunching operations are clear of other machines and personnel involved in the harvesting operation.

(2) Move to the front and side of the work area (work direction is from the front to the rear).

(3) If a short unmerchantable piece is available, position it to lift the butts of the bunch for easier grappling.

(4) If within the excavator's capacity, grapple and slew two stems at a time.

(5) Ensure that the butts of the bunch are in-line for efficient hook-on (some bunching systems working from steep terrain present tip first).

Stems bunched for the skidder

(6) Stems should be parallel and not crossed.

(7) Continue bunching, ensuring that the bunch size is suited to the grapple capacity (if appropriate) and terrain conditions.

(8) Work across the intended extraction direction until a line of bunches is completed.

(9) Move behind the line of completed bunches and repeat the process.

(10) Stems bunches should ideally be separated from piece bunches.

Signalling with your hands

Hand signals may be used between an extraction machine operator and a breaker-out or skid worker.

If more than one breaker-out is used, only one person should be giving the hand signals.

Any person can give the stop signal in an emergency.

Predict machine movement and allow time for the operator to react.

To the right are recommended hand signals for ground-based operations:

Emergency

Stop and hold any moving rope or machine

Position strops here

Use blade

Winch in

Move machine ahead

A stem is stropped

Slacken rope

Selecting the drag and Positioning the machine

Drag selection

Where stems have not been bunched, each drag must be planned.

This involves:

- Identifying where the stems are to come from
- Deciding where the machine is to be positioned to hook them on or accumulate them
- Determining if the stems need to be bladed to a more favourable position.

Machine positioned for hook-on (note blade in the down position)

Base your selection decision on the following:

Position

Choose the top trees (last ones felled) or clear of other trees or stems, logs, and branches.

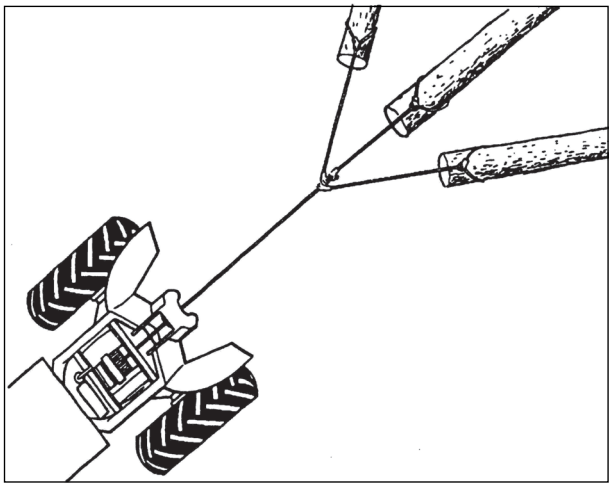
Location

Trees or stems should be aligned with the general extraction direction and within reach of the winch rope.

Size

Select a combination of trees, stems, or pieces to make up an optimal drag (as big as possible without overloading the machine or ropes).

To reduce the time taken to hook-on, you can blade the drag stems closer together. Be careful to avoid damaging the stems with the blade.



Pull the winch rope out directly behind the machine

Positioning the machine

Position a cable machine so that:

- The winch rope is spooled out directly behind the machine
- The machine is pointed down slope
- The strops can reach the stems without having to cause kinks in the winch rope.

If the stems are too far apart, blade them closer together (this is faster than having to hook-on some stems and reposition the machine to complete the drag).

To reduce stem damage, avoid using corners or edges of blade.

The breaker-out should use hand signals to direct the machine operator.

If breaking-out uphill, park the machine against a stump and at an angle to the break-out direction to ensure the machine cannot run back over the breaker-out/operator.

Hooking-on a drag

Separate breaker-out — cable machine

If a breaker-out is present, he/she should stand where the fairlead is to be positioned as the machine approaches.

Remember to move to a safe position as the machine reverses into position. This will be to the side of the stems, **where the machine operator can clearly see you**.

Be aware of any risk of material moving or swinging towards you as the machine approaches.

Do not stand downhill of a machine that is positioning for hook-on.

Watch for side-slipping of the machine or wheeled arch during machine positioning.

Do not approach the machine until it has stopped moving and the blade is down, and the operator is aware of your presence.

Pull the winch rope off so that the strops can reach the stems.

Machine operator as breaker-out

Once the machine is positioned:

- Engage the park brake
- Lock the transmission shifter in neutral
- Lower the blade until the front of the machine begins to lift.

Disengage winch clutch to allow the rope to be pulled off (tractors may “power-off” the winch rope).

Take care when climbing down from the machine. Look for clear footing.

Pull the winch rope off so that the strops can reach the stems.

Attaching the strops

If stems are layered, hook-on those on top first, freeing stems underneath for following drags and reducing breakage.

Hook-on the furthest-away stems first.

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.

Leave the tail end strop/s uncommitted if additional winch rope pulling is necessary after machine re-positioning.

Using wire rope strops

(1) Put the ferrule into the choker hook with the keyhole facing in towards the stem. This makes it easier to unhook it at the landing.

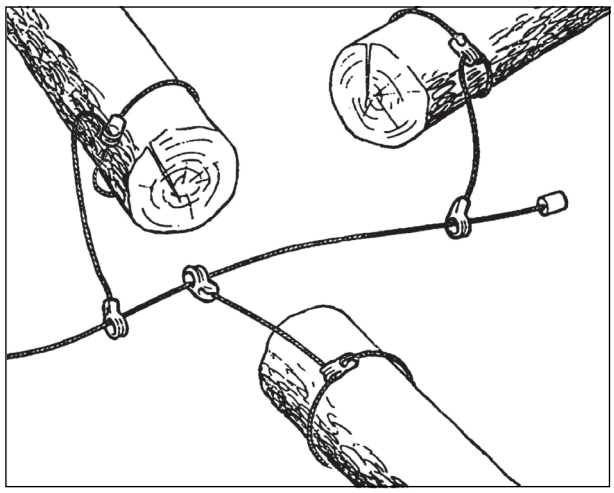
(2) Hold on to the choker hook while wrapping the strop around the log. If breaking-out downhill, the hook could slide out of reach.

(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.

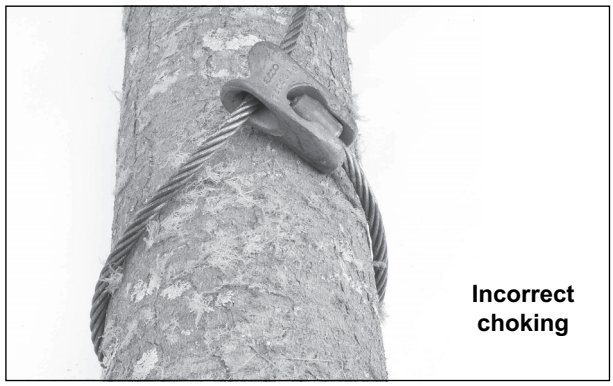
(5) Position the strop at least $1^1/_2$ butt diameters from the end of the stem (butt ends are preferred). If this is not possible, re-strop once the stem has been winched clear.

(6) Walk back to the next strop in sequence and hook-on the stem in sequence.

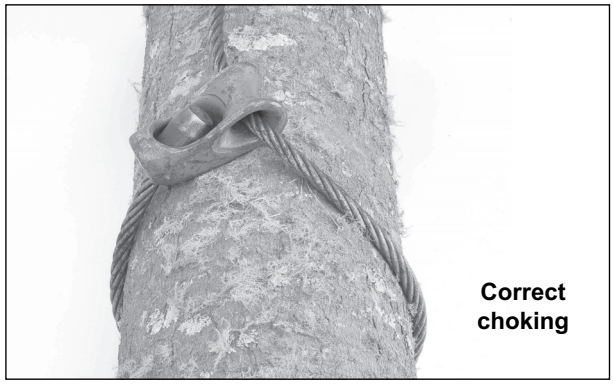


Winch rope position

Pass the strop over the stem, then back under to hook-on

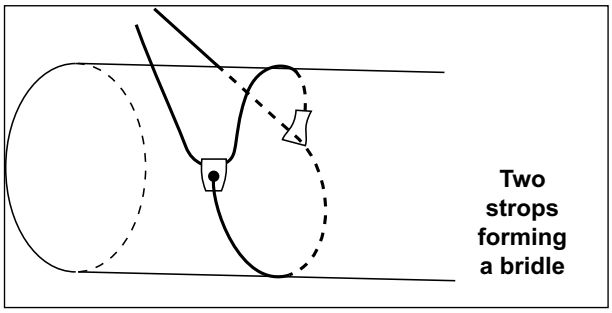


Incorrect choking

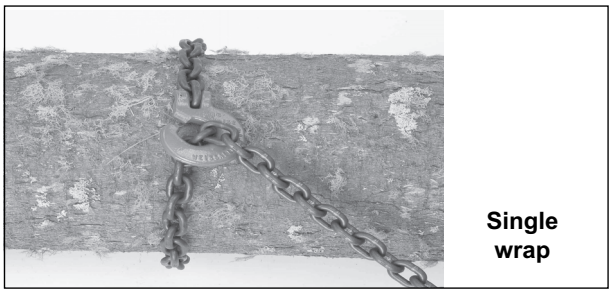


Correct choking

Double strop

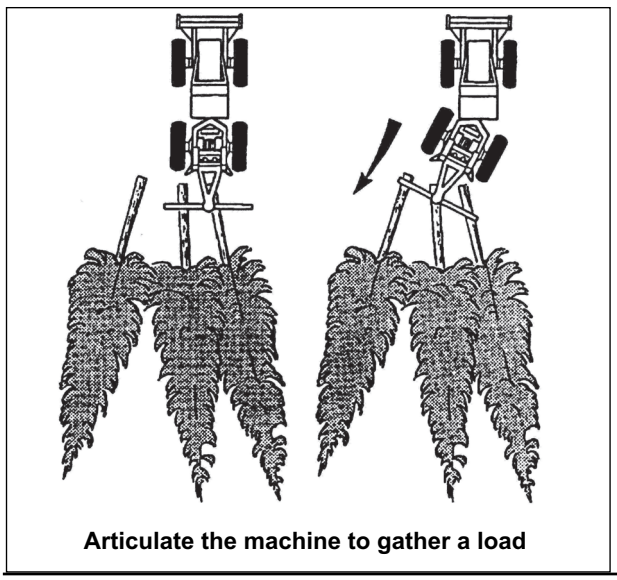


Two strops forming a bridle



Single wrap

Double wrap



Articulate the machine to gather a load

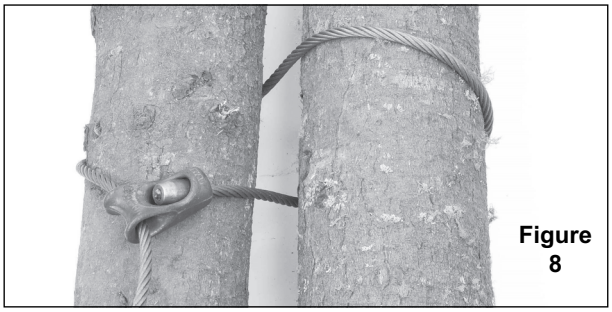


Figure 8

Alternative ways of connecting a wire rope strop are:

- Double strop (two stems per strop) — used on small stems.
- Double strop, with cross-over between stems (Figure 8) – used on small stems or head pulls to stop the stems for sliding out.

Avoid crossing strops over themselves as this causes rope damage

- Use two strops to form a bridle if individual strops will not go around a stem.

Using chain strops

Connect the chain hook so the open side is away from the direction of pull.

Pull the chain tight before connecting.

If head pulling, double wrap the chain. This reduces the risk of breaking the stem.

Position the strop at least $1^1/_2$ butt diameters from the end of the stem (butt ends are preferred) If this is not possible, re-strop once the stem has been winched clear.

Using a grapple machine

Grapple skidders and tractors can be used in bunched or unbunched wood.

If using a conventional grapple with unbunched wood, stems will need to be accumulated.

This may involve:

- Blading the butts closer together
- Using the articulating motion to grab outer stems (skidder only)
- Accumulating a drag over successive machine movements
- Lifting butts and pushing back.

Grapple the stems about 1 m from the butt end.

Once the drag has been accumulated, secure or grapple stems (lift and crowd). This brings the weight close to the back wheels to improve traction.

Breaking-out

Separate breaker-out

(1) Breaker-out moves to a safe, visible position. A guide is to stand above and behind the longest stem being broken out. Do not stand to the side of the drag during break-out. If the butt of a stem gets stuck behind a stump, the head of the tree can swing sideways towards you.

(2) Ensure that all other workers are clear before giving the winch-in signal.

(3) Breaker-out gives machine operator signal to winch (the machine may reposition first to correctly spool-on the mainrope).

(4) Watch carefully for stems hanging up, breaking, or becoming unstropped during break-out.

(5) Face the drag and watch until it has been winched clear of the break-out zone.

(6) Machine moves off as soon as drag is winched in.

Machine operator as breaker-out

(1) Once hook-on is completed, climb back into the cab.

(2) Put your seat-belt on.

(3) Check that the winch rope is still directly out behind the machine. If not, you should adjust the machine angle to suit.

(4) Engage the winch to pull stems clear. You may want to drive forward slightly to give yourself more winch rope to wind in.

(5) When the drag comes free, winch the drag right up to the butt pan to keep butts off the ground.

(6) Move off towards the landing.

Travelling loaded

Move towards the landing on the most direct route. Where possible, travel on previously used skid trails.

Raise the blade to its full height when travelling.

Match your speed to the terrain, the direction of travel, and the load.

If on a slope, move directly up or down the hill — avoid travelling across the slope.

Do not exceed the recommended slope limit for the extraction machine.

Care is needed when turning a loaded machine. If the turn is too sharp, the machine can be pulled over sideways.

Avoid turning uphill when positioned on a side slope.

Be aware of the load and how it is tracking near standing trees, people, and other machines.

The following steps can be taken if you lose traction during the travel in.

Travelling loaded, blade up and butts off the ground

Cable machine

(1) Release the winch to drop the drag.

(2) Move forward to a more stable position.

(3) Engage the winch and pull the drag to the back of the machine.

Grapple machine

A grapple skidder can crab forward by articulating the machine from side to side.

If this is not possible or successful, drop one stem and continue towards the landing with the smaller drag.

Slow down when driving on to the landing

Take care climbing off the machine

Dropping the drag

Driving on to the landing

Reduce speed as you approach and drive on to the landing.

Ideally, the drag will be lined up behind the machine as you enter the landing. In some cases, rub trees or high stumps may be left to help the drag turn into the correct position.

Check the position of people, machines, or wood on the landing.

Be aware of the position of waste or branches on the landing surface. These may flick up when run over.

If it is unsafe to enter the landing, wait at the entry point until the way is cleared and you are signalled to enter.

As you drive on to the landing you are aiming to drop the drag next to stems already landed. Be aware of people standing near the already landed stems — as you pass by you may cause them to roll or swing sideways.

Avoid straddling stems or logs on the landing with your machine as they can be forced forward, posing a hazard for landing workers.

Dropping the drag

Assisted Unhook for Cable Machines

(1) Signal the machine to stop.
(2) Signal lower rope.
(3) Do not approach or start to unhook the strops until the drag is grounded, the winch rope slacked, and the operator aware of your actions.
(4) Landing worker moves in and unhooks the drag.
(5) If one stem or more remains hooked on, signal stem still stropped.
(6) Move machine forward required distance.
(7) Stem is winched free.
(8) Signal the machine to stop winching and lower.
(9) Unhook the stem.
(10) Signal winch in.
(11) Machine moves off.

Unassisted unhook for cable machines

(1) Position drag for release.
(2) Engage the park brake.
(3) Lock the transmission shifter in neutral.
(4) Lower the blade.
(5) Climb down from machine.
(6) Release choker or chain hooks.
(7) Carefully climb back into the machine.
(8) Engage winch to take in slack.
(9) Prepare to move off if safe.

Grapple machine release

A grapple machine may approach the drop zone and simply drop the drag without stopping. Alternatively, the stems may be laid out for processing by manoeuvring the machine before dropping the load.

(1) Approach the drop point slowly.

(2) As the desired butt position is reached articulate the machine (if possible) so you are facing back towards the drop point.

(3) Reverse and drop the drag where desired.

(4) Position drag parallel to existing stems or where desired.

Skid work

The extraction machine may be used to push stems closer together or pile them up for handling by another machine.

Care should be taken when pushing stems to ensure that:

- Stem damage is avoided
- The stems being pushed and the stems in the pile do not pose a risk to workers or other machines.
- Check that there are no machines or people behind you before you reverse.

Waste material should not be allowed to accumulate on the landing to the point that it impedes the movements of workers and machinery. Such material must be regularly cleared to provide a clean site.

Extraction machines are often used to clear processing waste and slash from the landing. Often this material is pushed into piles around the outside of the landing.

When clearing the landing, the machine operator should consider the following:

- Push waste into areas where there is no risk to workers or machines
- Check the position of other machines, stems, stacks, and landing workers before manoeuvring
- Avoid pushing soil or aggregate from the landing surface. If too much of a hollow is formed, water may pond during wet weather.

Forwarder extraction

Driving uphill

- A forwarder can drive up steeper slopes when unloaded than when loaded.
- The Approved Code of Practice for Safety and Health in Forest Operations states that, as a guide, the maximum operating slope for a forwarder is 18° (30%) unless otherwise specified by the manufacturer.
- If the wheels start slipping, use steering, reduce rpm, or reverse to find a better route.

Driving downhill

- If the slope is steep, do not load any logs above the screens upper edge.
- Pick a low gear. Steering is easier if the engine speed is higher than if it is idling.
- Apply the brakes when necessary to slow the downhill speed.
- Loads will be less than when operating on flat ground.

Driving across slope

- Only experienced operators should drive across a slope. The potential risk of rolling the forwarder is higher than in other driving situations.
- When the ground is even, a forwarder can travel across 10–15% slopes.
- If possible, spread slash on the lower side of the track to provide a base for the downhill wheels.
- Ensure the load is even, or even slightly higher on the uphill side.
- Drive smoothly. A sudden sideways movement may move the load and cause imbalance.
- Watch for stumps and hollows that may upset the stability of the forwarder.
- Turning uphill from a cross-slope track increases the risk of rolling the machine.
- If you feel the machine starting to roll, turn the front frame downhill.

- It may be necessary to use the loading crane as a counter-balance by moving it to the uphill side of the load.
- Be aware that side-slipping may result in the forwarder hitting the trees on the downhill side of the track. Try to drive on the uphill side of the track to compensate.

Aligning logs by "pencilling"

Loading and unloading

Loading

- Try to load from as flat a position as possible. Ensure the machine is not tilted to the side.
- Position the machine so the logs are by, or just behind, where the loading crane is mounted.
- The logs should be within easy reach of the crane.
- Ensure there is adequate room to manoeuvre the logs and the loading crane.
- Grasp the middle of the logs to be loaded.
- If the log ends are not aligned, align them by pulling them into the gate. Ensure the grapple is slightly open when doing this. Alternatively, align them by grasping them off centre and allowing the logs to swing into the vertical position. Loosen the grapple slightly to allow the logs to stand on the ground. This is termed pencilling.
- Load evenly, starting in the centre, then filling the sides as the load height increases.
- Make sure the log ends are aligned in the stanchions (this makes it easier to make tidy stacks).
- If the logs are at maximum reach of the crane, grasp them and pull them closer to the machine before re-grasping to load.
- Once you have finished loading, leave the grapple firmly down on the rear of the load.

Unloading on the landing

Unloading

As for loading, plus:

- Watch for landing workers when unloading on to stacks.
- Ensure logs are stable before leaving the stack.
- Watch for landing workers and the truck driver when unloading directly on to a truck. The forwarder operator must ensure that the driver remains in a safe position during the loading operation.

Glossary of terms

Arch (Logging arch). Refers to a towed arch supported by wheels or tracks.

Bell loader A three-wheeled loading and sorting machine. It has two differentially-driven steering and traction wheels and a third non-steerable jockey wheel. The Bell loader has a short boom and rotating grapple.

Bight An angle between two parts of a rope running round a block or obstruction (e.g., a stump). To be "in a bight" is to be in a dangerous position.

Bind Used loosely to describe some difficulty or obstruction.

(1) Of a saw cut: pressure causing the kerf to close up and jam the saw.

(2) Of an operating rope: rope being held out of line by a log, stump, or other obstruction.

(3) Log(s) lying in such a position that they cannot easily be extracted.

Bottleneck A term describing a critical part of the harvesting process, where reduced activity or capacity can affect the total output.

Breaker-out The title of the worker who scouts for the next drag and hooks on stems.

Breaking-out The work activity of the breaker-out for cable skidders and tractors; the combined process of hooking-on and winching or accumulating a drag and getting it moving (dislodging the drag from other felled trees) to a travel speed for extraction.

Bridle A stropping technique where two wire rope strops are used to connect to a stem where a single strop is too short.

Butt The large end of a felled stem or tree.

Cable skidder An articulated, four-wheel-drive machine for towing felled trees. The towing and attachment of the trees is by winch and strops (chokers).

Choker *see* Strop.

Clambunk skidder A 6- or 8-wheeled articulated skidder fitted with a loading crane and a vertically mounted grapple (clam).

Clearfell A term describing the non-selective harvesting of all standing trees.

Cold deck Normally refers to where stems or logs are loaded out-of-shift (before the logging crew arrives, or after they leave).

Contour track An extraction track which is orientated (near) parallel with the contour. Often used on slopes exceeding 18°.

COPS Cabin Operator Protective Structure. A self-contained protective capsule designed to protect operators working in excavators on steep terrain.

Cutover A term for the logged area after felling and extraction.

Cycle *see* Extraction cycle

Dehydration Insufficient water for normal body function.

De-phase A term describing the change of logging system from a strictly linear process to one where some parts can operate independently of others (e.g., multiskid operations).

Double stropping The encirclement of two stems by one strop.

Drag Also known as a haul. A group of stems or trees collectively attached to a machine for extraction.

Excavator A tracked, turntable-mounted, boom-equipped machine primarily designed for digging and transferring soil or rock. Configured as a log or stem loader (using a grapple) for harvesting operations, or as a base or carrier for felling or harvester heads.

Glossary of terms (cont . . .)

Extraction cycle The total time taken to acquire, extract, and offload one drag and return to the felling site.

Extraction direction The direction in which the extraction machine is expected to extract drags or loads to the landing.

Extraction track Part of a network of tracks given repeated use during the extraction process. May be used only in the travel-loaded phase (e.g., skidder with drag).

Fairlead Free-spinning roller(s) that guides a winch rope on and off the winch drum.

Feller-buncher A general term for a felling machine. The machine is usually tracked, and equipped with any type of felling or harvesting head.

Feller-director A term used to describe a kind of felling head. The head uses a hydraulically operated chainsaw to fell the tree while it is held by the head's grapple. The movement of the boom influences felling direction.

Ferrule A fitting that is either pressed, wedged, or filled with white metal and affixed to the end of a wire rope.

Fleeting The process of moving sorted logs to a stack.

Flexible track skidder A specialist logging tractor, equipped with torsion-bar mounted road wheels rather than track rollers, giving the tracks flexibility. Made for Logging by Kootenay Manufacturing Corporation (KMC).

FOPS Falling Object Protective Structure, designed to prevent falling objects from injuring the operator when working in standing trees.

Forwarder A wheeled, articulated, self-loading carrier for logs. Often used in conjunction with a harvester.

Grapple skidder An articulated, four-wheel-drive machine for towing felled trees. The towing and attachment of the trees is by a hydraulically operated grapple.

Harvest plan A document detailing the timing and nature of a number of harvesting operations in a given area, i.e., logging systems to be used, timing, skid or landing locations, haul directions, environmental and safety considerations, etc.

Harvester A machine, usually tracked, equipped with a harvester head. The harvester may function as a full-time feller-delimber-buncher, a processor, or a full harvester.

Harvester head A head attachment for a boom, with felling, delimbing, and bucking functions. Trees are cut with a hydraulically operated chainsaw, delimbed by grapple/knives, and driven through the knives by toothed rollers. Most harvester heads are fitted with a computerised length and diameter measurement system.

Harvester-processor A harvester operating as a processor. That is, it may or may not delimb, but it will cut the stem into logs.

Head (of a tree) The top or tip of the felled tree.

Health hazard An occurrence, condition, or situation, often arising off-site, that could adversely affect the general health of a worker.

Hot deck Normally refers to loaing during the hours of work from the skids being processed on.

IWRC Independent Wire Rope Core.

Job prescription The document provided by the forest owner or manager to a selected contractor detailing all the requirements and conditions associated with a particular operation.

Kink

(1) Of rope: a short deviation or change of rope straightness.

(2) Of a tree or log: a short deviation or change from an ideal of straightness of form.

Glossary of terms (cont . . .)

Knuckle-boom	A hydraulically articulated boom with a terminal attachment, often a loading grapple capable of continuous rotation.
Lay	Describes the direction in which strands of a wire rope are wound around the core.
Log grade	A classification of logs for purposes of sale. A grade differs from other grades on the basis of length, small-end diameter, large-end diameter, allowable defects, and other characteristics.
Logging operations	The forestry processes and activities of felling, extraction, processing, and loading.
Marlin spike	A steel hand-tool tapered to a point, that is used to separate the strands of a wire rope for splicing.
Molly grommet	Short length of wire strand that is wound to form a loop. Used to secure shackle pins and temporarily join eye splices.
Occupational Overuse Syndrome (OOS)	Describes work-related disorders of the musculo-skeletal system.
Operational (extraction) plan	The plan formulated by the contractor or foreman that specifies how the job is to be done, by whom and when. Normally a short-term plan that will be modified as the job proceeds.
Operational hazard	An occurrence, condition, or situation arising on-site that could adversely affect the health of a worker through physical injury.
OPS	Operator Protection Structure designed to prevent objects entering the cab and injuring the operator.
Piece size	The size of a tree which has been felled. Normally, the size to the first break at approximately $^2/_3$ total tree height.
Pre-stropping	Where the strops are connected to the stems for the next drag while the previous drag is being extracted.
Production thinning	The selective harvesting of a proportion of standing trees. Poorer specimens are taken, usually according to spacing criteria.
Quality control (QC)	The activity and process of branding logs, and checking log lengths, diameters and other specifications.
RHOL	Right Hand Ordinary Lay.
ROPS	Roll Over Protective Structure. To be fitted to any mobile plant operated anywhere except on level ground. Excavators are exempt and require COPS.
Runoff	Surface water that runs off a hillside or down a track.
Safe Working Load (SWL)	A calculated operating load that can be applied to a wire rope or chain. In forestry this is $^1/_3$ of the breaking strength. Working within the SWL ensures that the rope will not wear rapidly or fail.
Shackle	A U-shaped metal connector with a removable pin or threaded bolt through its ends.
Shock-loading	The sudden loading of a rope or structure which exceeds the safe working load. Can result in premature wear or failure of the rope, chain, or structure.
Shovel logging	An extraction system using an excavator-loader. Stems are successively swung and deposited in rows or bunches from the felling site, to a destination, usually a road. A single swing movement can be termed bunching, usually for grapple skidder extraction.
Solvents	Liquid chemicals such as mineral turpentine used for cleaning tools, or branding templates that have been used with oil-based paints.

Glossary of terms (cont . . .)

Sorting	The process of segregating and accumulating logs of the same grade.
Spool	To wind cable smoothly on to a winch drum.
Sprag	A broken wire which protrudes from worn or damaged rope.
Stem	A tree which has been prepared for extraction by felling and possible delimbing. Distinct from a log, which is cut from a stem.
Strand	A component of wire rope consisting of individual wires wound spirally together.
Strop	Short length of wire rope or chain fitted with hooks, which forms a noose around stems to be extracted.
Super skid	A large more-permanent landing which often collects wood from more than one extraction operation.
Tensile grade	The tensile strength of the steel used to form the wires of a rope.
Tensile grade	The tensile strength of the steel used to form the wires of a rope.
Towed arch	A towed two-wheeled structure of “A” frame configuration, fitted with a fairlead. For use with tractors without an integral arch and fairlead.
Tree size	The size of the tree (up to the minimum small-end diameter) as it stands.
Two-staging	Where full tree lengths are transported from an extraction landing to a separate processing landing/area.
Wheeled loader	A four-wheeled, articulated machine equipped with loading forks.
Wheeled skidder	An articulated, four-wheel-drive machine for towing felled trees.
Winch rope	A rope fitted to a winch on a skidder or tractor.
Wire core	The central core of a wire rope with strands wound around it.