Chapter 12

Machine and rigging inspection, servicing and maintenance

In this chapter you'll find out about:

- ✓ Regular inspections for:
  - Winch-assist machine.
  - Supported machine.
  - Ropes and connectors.
  - Non-winch-assist machine anchor.
- ✓ Servicing, including annual inspections.
- ✓ Guidance to help safely undertake repairs and maintenance.

This chapter provides an overview of general inspection, servicing and maintenance for the winch, the steep slope machine (harvester, forwarder, skidder) and rigging. Irrespective of the machine's brand, the chapter highlights the important things to check. There's a significant risk for the machine operator if a system failure occurs. Also, machinery damage is often expensive and time consuming to fix.

There are three ways the machine can fail and any of the three can create significant hazards. These can be structural, mechanical, and control element failures.

Structural components don't move. Mechanical ones move, e.g. they rotate, extend, retract. Control elements are the devices and systems that cause the mechanical parts to start, stop, change speed or direction.

It is best practice for the operator to be familiar with safety critical elements and for the machine owner to oversee and support regular inspection, service and maintenance of these.

Note: The guidance does not replace the Original Equipment Manufacturers' (OEM) requirements and recommendations. If in doubt always refer to OEM manuals, guides and induction materials.

Regular Inspections

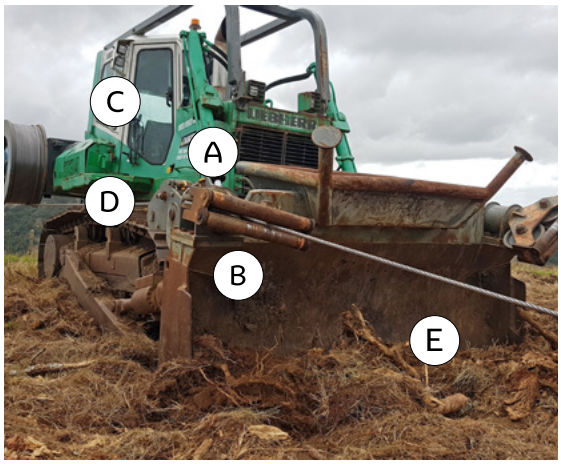
Winch-anchor machine

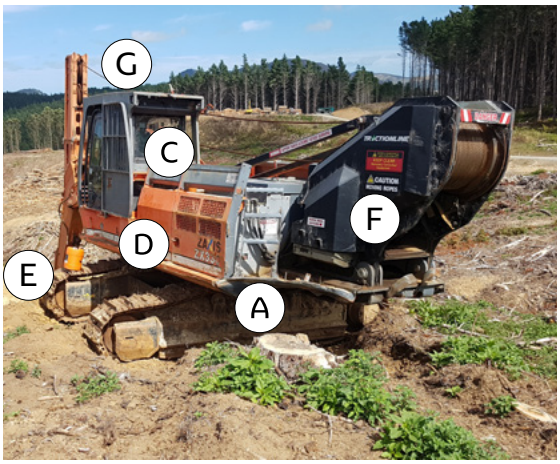
The winch machine should be checked daily. The things to check will depend on the type of WAM and the manufacturer's requirements, e.g. anchor winch or winch on the steep slope machine.

Look carefully, especially in areas that are subject to:

- Wear and tear.
- Changing forces and tensions.
- Areas that are known to need maintenance.

On the following pages, photos show examples of components that should be regularly inspected.





A No fluid leaks

B Fairlead rollers

C Electronics working

D Fuel and oil levels OK

E Anchored and braked?

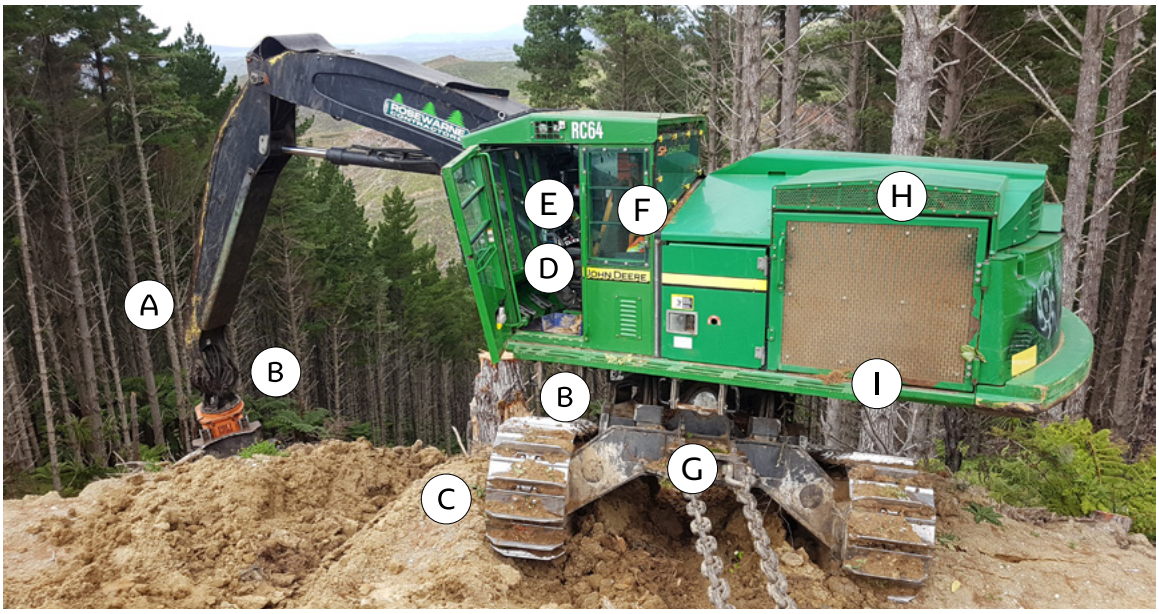
F Winch mounts/ attachment points OK

G Tower/guides/ sheaves

Also:

- No metal or hose cracks.

Steep Slope Harvester (Harvester, Forwarder, Skidder)



A Boom and attachment OK

B No fluid leaks

C Track gear good

D Controls working OK

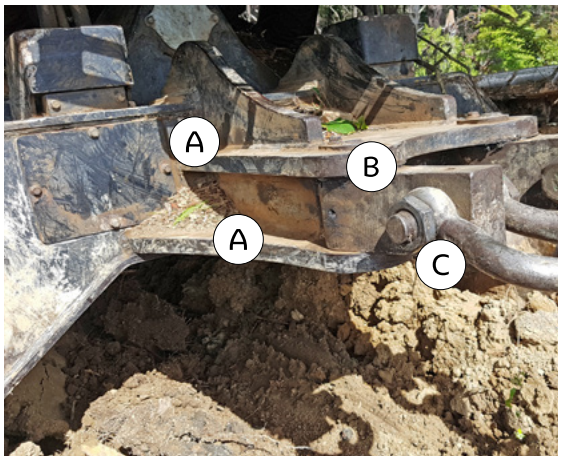
E Electronics working, e.g. radio, remote control system

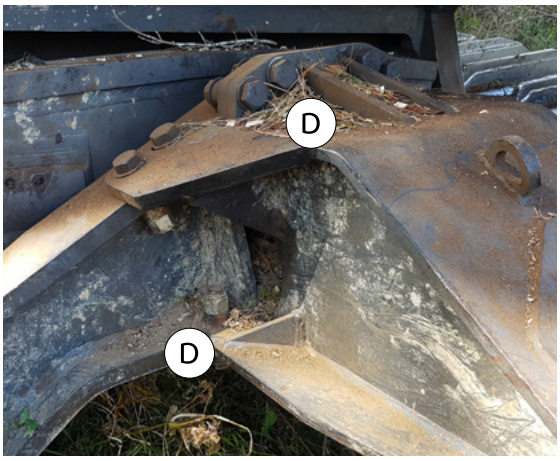
F Windscreens clean?

G Winch mounts/ attachment points OK

H Fuel, oil and water levels OK

I No guarding damage



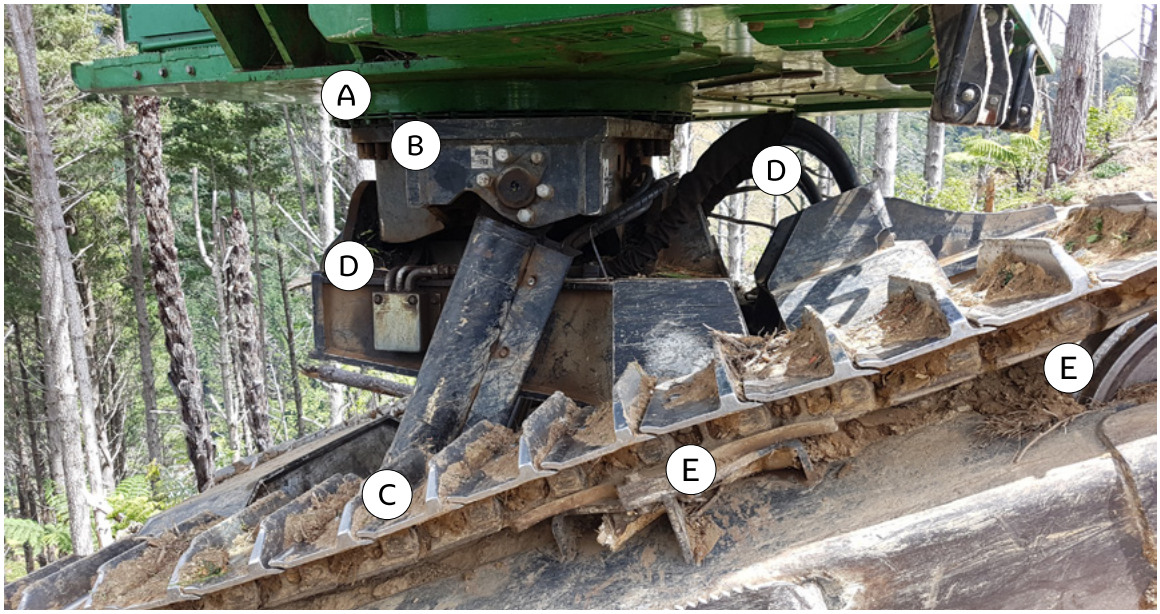


A Winch-assist attachment welds no cracks

B Pivots pins no cracks and greased

C Shackle has grommet of bolt, shackle wear OK

D All winch mounting bolts tight and not sheared off



A Slew bearing OK (noise, play, etc.)

B Turret bolts tight and none snapped

C Grousers OK

D No fluid leaks, hydraulics

E Rollers, sprockets and idlers all good?

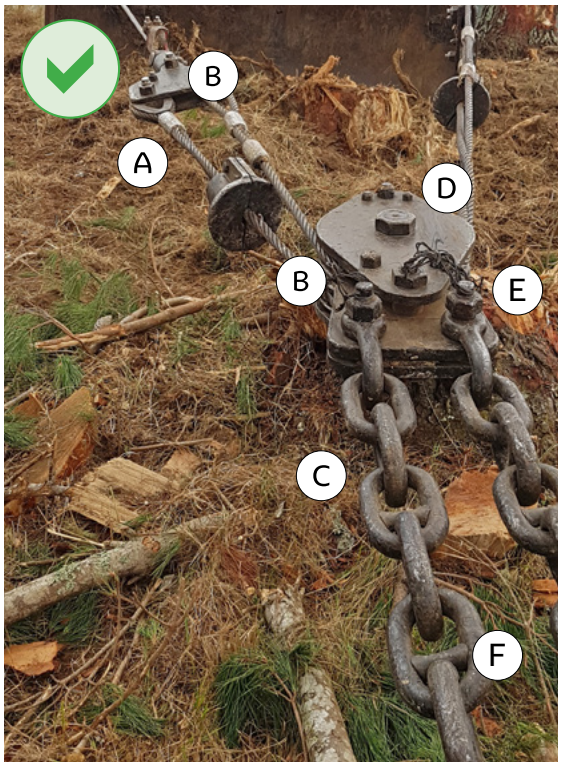
Connectors

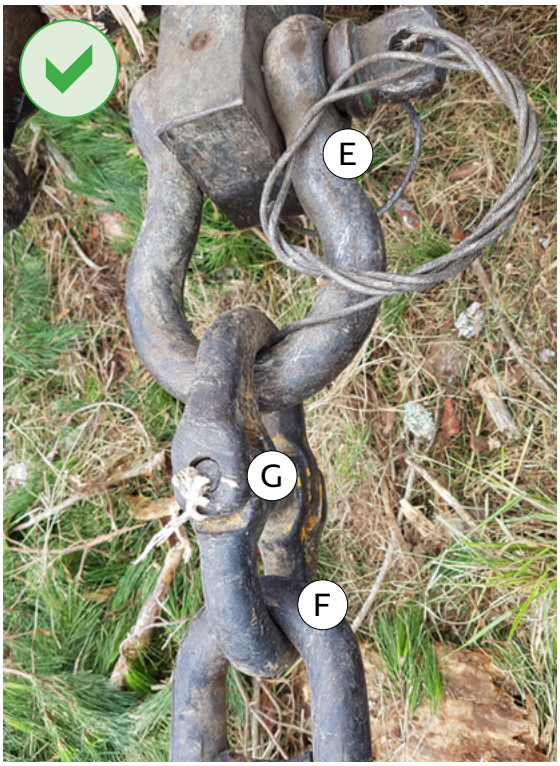
Thoroughly check the rope connection points, fasteners, chain, shackles, and hammerlocks. Rigging wears out over time. Make sure that all parts in the tether system still meet the manufacturer's tolerances. The type and amount of rope and rigging wear and tear will vary depending on the location, terrain, and soil types. Specifics around wire rope are discussed in a later section.

Daily inspect every connector and wire rope attachment point for wear or damage:

- Inspect the chain regularly for wear or damage, e.g. measure the chain's length and the links hole diameters to check for stretch using a simple gauge. Replace the chain if it appears worn, damaged, or stretched beyond the manufacturer's recommended limits.
- Inspect the wire rope connectors for surface wear, nicks, cuts, broken wires. Replace accordingly. Some types of cable, e.g. swaged, may appear fine when they are worn out, so know the wire's characteristics.
- Keep a list of all rigging components, their breaking loads and deployment date.

Stop work and check connectors and rigging if a stress event or damage occurs. Assess, and replace the component immediately, if necessary.





A Ferrules good?

B Other connectors in good condition?

C Chain bridle good?

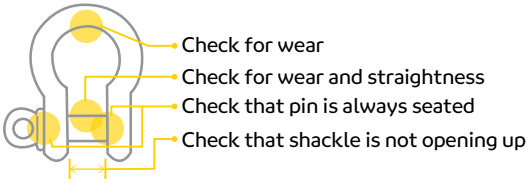
D Blocks OK

E Shackles with grommets or bolts, wear OK?

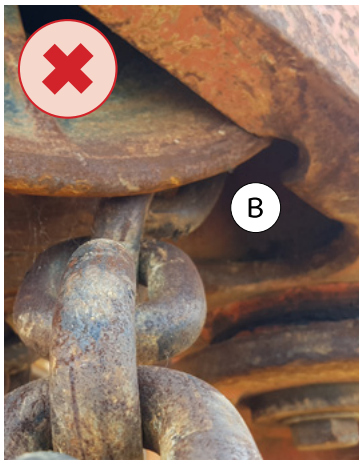
F Chain wear OK? Stretched, worn, bent or gorged out?

G Hammerlock good?

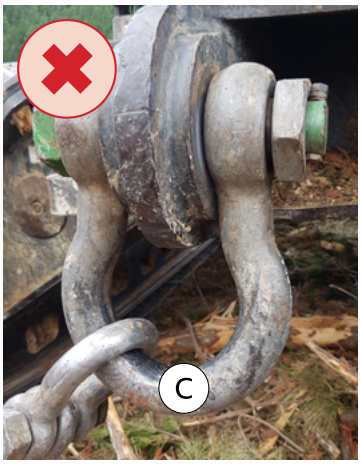
Never replace a shackle pin with a bolt. It will bend.



A Hammerlock worn by rubbing against machine. This happens when going to flatter slopes below steeper ones



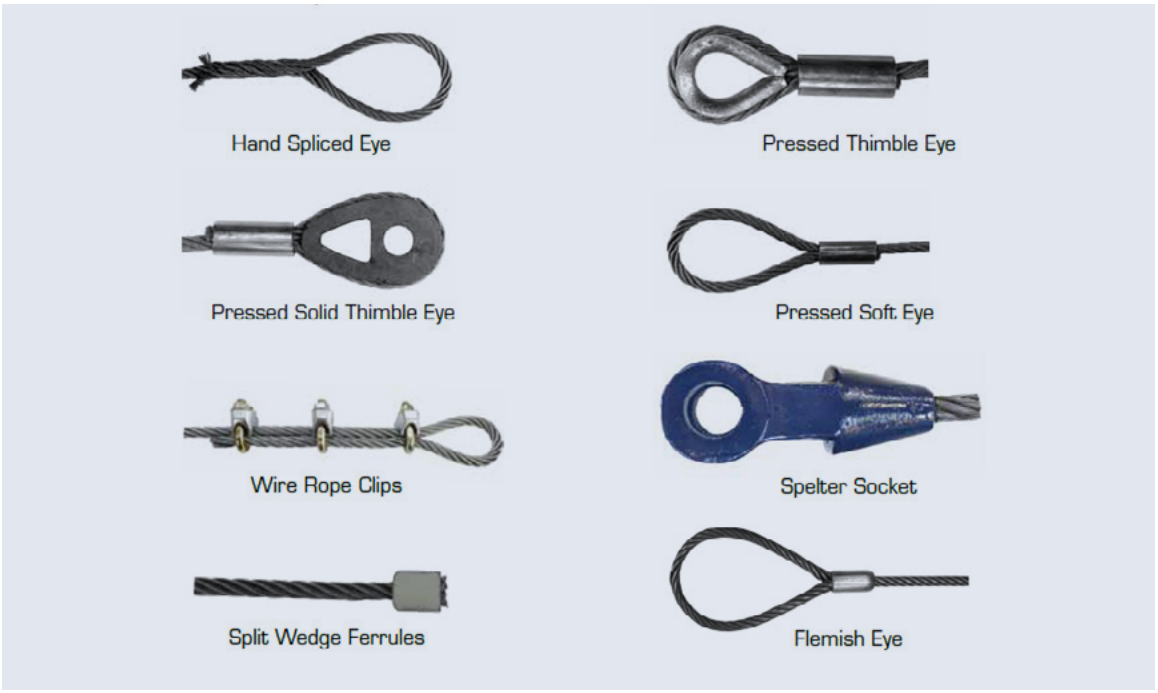
B Excavator anchor fairlead shows significant wear caused by a rope riding off the sheave



C Shackle is worn here but elsewhere too?

End Connector Inspection

Some common types of end connectors:

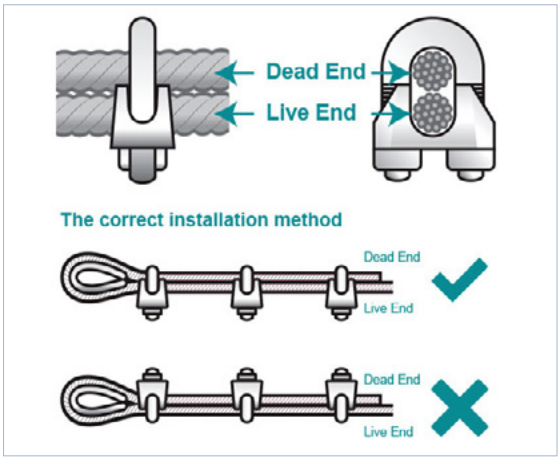


These connectors should be installed correctly and in good working condition. Make sure to inspect pressed eyes, thimbles, ferrules and other metal components for excessive abrasion and fatigue cracks. The following are best practice guidelines examples for correctly installing end connectors:

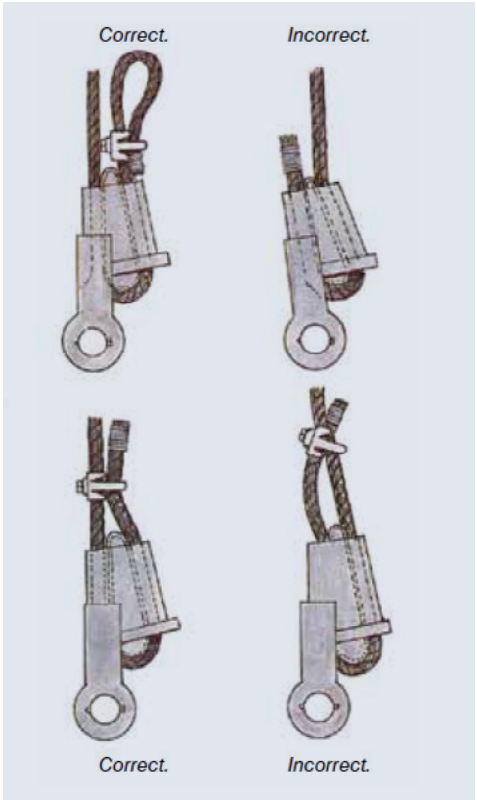
Loggers eye splice
A loggers eye splice should be tucked three times on one side and two on the other (ACOP, 2012)

Split wedge ferrules
The strands of wire rope should protrude roughly 1/4" past the top of the wedge button. Once the first load is applied, the wedge will seal firmly into the wedge button.

Wedged sockets and Cable Clips



Remember the saying "Never saddle a dead horse!"



Wire Rope Inspections

What causes wire rope failure?

Ropes can fail through abrasion, tensile overload, and temperature damage.

1. Abrasion occurs when the rope rubs an external source like a rock outcrop, a different section of the rope, or a component of the rigging.
2. Tensile overload occurs when the rope experiences an axial load that overwhelms its strength. The result may be a loss of rope strength or even rope failure.
3. Wire rope can also be damaged by exposure to extreme temperatures, which can occur when the rope rubs against trees or stumps during operations.

How to extend a rope's life

Reduce or eliminate the three points listed above that shorten a rope's life.

1. Abrasion damage

- Avoid running the rope on the ground, over rocks, or around sharp bends.
- Use a heavy-duty chain segment near the harvesting machine and in other high-wear areas.
- Move the anchor or anchor machine as needed to prevent cable contact at ground breaks.
- Before every use, inspect the wire rope for surface wear, nicks, cuts, broken wires, or changes in diameter.
- Take care when lifting/repositioning wire rope. Use mechanical attachments to grab a chain segment rather than the rope.
- Don't run over the rope with wheels or tracks.

2. Tensile overload

- Working tension affects rope life. Use a tension monitoring and recording system. Review tension log data daily, and whenever shock loading is known or suspected to have occurred.
- Avoid loading or shockloading the rope, or the weakest rigging link, above the safe working load specified by the manufacturer.
- Cease operations and replace the rope if tension ever exceeds the elastic limit. If tension exceeds the rope's endurance limit, its lifespan is reduced.

3. Temperature

- Heat affects rope strength. For IWRC wire rope, temperatures over 93°C reduces the rope's strength.
- Look for wood charring where the rope has contacted a tree or stump. Charring occurs at 120 to 150°C.

Who should inspect wire rope?

A competent person needs to inspect a rope. They consider the different types of deterioration and assess the 'combined effect' of the wear on the rope. This requires knowledge and experience.

When to inspect a rope

Use the rope manufacturer's recommendation for rope inspections and discard requirements, e.g. Some manufacturers recommend end for ending rope after 1000 hours and replacing rope after 2000 hours.

Otherwise:

- Inspect the rope's working length monthly, or at minimum of every 500 hours, unless there is a reason to do it before that.
- Use the inspection and discard criteria outlined in ISO 4309:2010.
- Inspect ropes and connectors after an incident involving visible damage to the rope or suspected shock loading above Safe Working Limit (SWL).

Check the rope thoroughly. If you are unsure about something, get a second opinion.

Joining splices should not be used to join broken or damaged winch ropes.

What to look for, and when to discard?

If significant changes in a rope's condition are seen, the rope may need replacing. If the damaged section is near the working end, it may be possible to remove the damaged section. This shortens the working length of the rope.

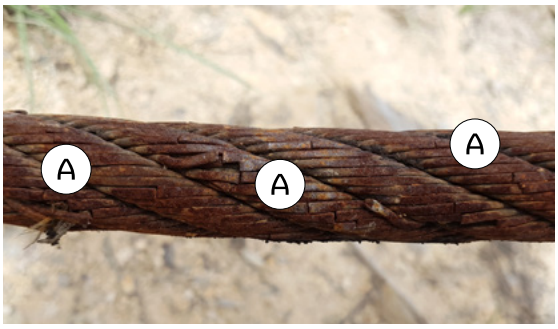
The ISO 4309-2010 document explains in detail rope inspection and when to discard. Always inspect a rope with the tension off. If you see breaks on the outside, there will be more broken on the inside.

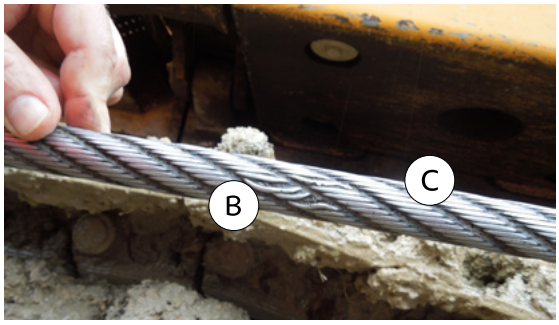
The 9 key points of ISO's discard criteria are:

1. Randomly distributed visible broken wires and valley wire breaks.
2. Local groups of visible broken wires.
3. Visible broken wires near the rope termination.
4. Local decrease in diameter (core failure).
5. Uniform decrease in diameter (wear).
6. Internal corrosion.
7. External corrosion.
8. Deformations.
9. Thermal damage.

Replace ropes if there are concerns. Visual inspection only shows the condition of the outer wires, only 20% of the rope's area. A marlinspike helps see more, but for only small sections.

Always consider swapping the rope out sooner than later to give it a second life in a less safety critical work area.



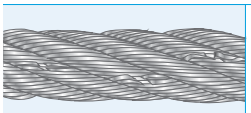
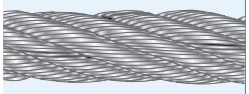


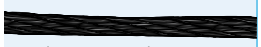
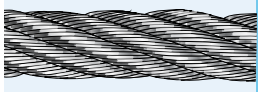
A Randomly distributed visible broken wire

B Local group of visibly broken wires

C External wear

Below are some common defects and their discard criteria as outlined in ISO 4309:

DEFECT	DISCARD CRITERIA
 Breaks: crown wire	Discard or remove section if: • 6 or more randomly occurring wire breaks are found over a lay length, or • 3 or more breaks occur in a single strand in one lay, or • 2 or more wire breaks occur at termination points.
 Breaks: valley wire	Discard or remove section if: • 2 or more valley wire breaks occur over a lay length, or • 2 or more wire breaks occur at termination points.
 Corrosion	Discard rope if wire surface is heavily pitted and slack, and corrosion cannot be wiped away. Perform internal inspection if signs of internal corrosion (such as corrosion debris exuding from between strands) are visible. Discard if internal corrosion is confirmed.

DEFECT	DISCARD CRITERIA
 Flattened portion	Flattened portions wear more quickly. Inspect them more frequently for broken wires and corrosion damage.
 Changes in rope diameter	Discard the rope or remove the section if there is an obvious localized decrease in diameter caused by failure of a core or rope centre, or by a sunken strand. When non-localized changes in diameter are found, discard the rope if the changes in diameter exceed 7.5% of nominal diameter.
 Waviness	Discard the rope or remove the section if the gap (g) between the underside of the rope and a straightedge is 1/10 of rope diameter (d) or greater.
 External wear	External wear will cause the diameter to decrease and will result in broken wires. See discard criteria for wire breaks and changes in diameter, above.

Source: FPInnovations 2017, "Wire rope integrity in winch-assisted harvesting operations"

Servicing

The following advice should be followed:

- The anchor and the steep slope harvesting machine must be serviced according to the Original Equipment Manufacturer's (OEM) specifications, recommendations or instructions.
- The machine owner is responsible for ensuring specified components are replaced in accordance with manufacturer's recommendations.
- All sensors, alarms, and controls fitted by the manufacturer must be monitored and in working condition.
- Structural repairs or modifications must be approved by the OEM or their local representative and may require inspection and approval by a certified professional engineer. This includes repair to an operator protective structure.
- The machine owner should keep servicing records.

Manufacturers recommend doing a pull test before starting work and after completing daily checks, and hitching is done. Refer to your operator manual for instructions, including tension pre-sets and instrumentation to monitor.

The inspection form below gives an example of a regular weekly or monthly check. Manufacturers will often provide their own inspection forms.

OPERATOR DAILY / MONTHLY CHECKS			
Date: _____ Machine Model: _____ Machine Hours: _____ Winch Hours: _____	Daily (8 hrs)	Monthly (160 hrs)	Notes
Independent or integrated Winch Machine			
Rollers and Sheaves (check for movement, wear, damage)	○		
Rollers and Sheaves (grease)	○		
Sheaves (check for damage cause by lead angle rub)	○		
Tension monitor (visual check that rollers are turning)	○		
Winch Mountings (visual inspection of bolts and/or weld integrity)	○		
Fairlead and Boom (wear, damage, cracks, loose bolts)		○	
Fluids – Check all oils, water and fuel levels. Check for leaks (hoses, pipes and tanks)	○		
Grease / Lubricate points (as per Manufacturer's instructions)	○		
Electronics/Software (Various prestart checks and warning features checked)	○		
Movement sensor check (attachment points and cable tightness). Pull the lanyard to active the anchor/ motion switch, the warning sign should be activated on the main screens in the machine cab	○		
Supported Machine (Harvester, Forwarder, Skidder)			
Drawbar (check for wear, cracks and that pins are in correctly)	○		
Drawbar (winch mounting bolts tight and not sheared off)	○		
Fluids – Check all oils, water and fuel levels. Check for leaks (hoses, pipes and tanks)	○		
Operator Protection (in good condition)	○		
Electronics/Software – Various prestart checks and warning features checked	○		
Fuel, oil and water levels OK	○		

OPERATOR DAILY / MONTHLY CHECKS Date: _____ Machine Model: _____ Machine Hours: _____ Winch Hours: _____	Daily (8 hrs)	Monthly (160 hrs)	Notes
Slew bearing OK (noise, play etc.)		O	
Turret bolts tight and none snapped)		O	
Emergency exits functioning		O	
Ropes and Connectors			
Hammerlocks (check for wear and cracks and check that pins are in correctly)	O		
Shackles (visually check for cracks or galling on pins and grease)	O		
Wedge Socket (visually check pins for wear, cracks, and galling – change if necessary)	O		
Wedge socket (suggest cutting 50cm off rope as internal defects difficult to identify, refit, clip)		O	
Stud Link Chain (visually check for cracks, bad nicks or cracks or damage from grapples or hot saw chains – change if any major defects	O		
Rope (check for wear around connectors)	O		
Rope (zero the rope distance counter)	O		
Rope (visual inspection of working length)		O	
Other End Connectors (check for wear and tear)	O		
Non-WAM Anchors			
Deadman (4m deep, 5m long and > 50cm diameter, in-lead)	O		
Stumps (fresh, >50cm or multiple stumps, strong soils, not excessively worn by rope or socketing due to tension)	O		
Stumps (movement monitor device if any potential concerns)	O		
Mobile Anchor (sufficient size/weight, blade in the ground, in-lead, (device employed to monitor movement)	O		

Note: For further guidance on non-winch-assist machine anchor types refer to the Cable Logging BPG and section 14.3 of the ACOP.

safetree.New Zealand/resources/best-practice-guidelines

Check your anchor, machine and rigging thoroughly. Don't take shortcuts and 'tick the boxes' with maintenance or service checks.

Annual Inspections

- All mobile plant with an integrated or attached winch system should have an initial annual inspection.
- The inspection can be in isolation or as part of warranty or a service agreement provided by the OEM.
- After the initial inspection, a documented inspection should be carried out every two years.
- If the OEM specifies components requiring more frequent calibration or checking, their requirement and recommended interval should be followed.
- A competent person familiar with the plant and systems should do inspections. A competent person could be:
  - The OEM or their local representative.
  - A qualified technician approved by your service agent.
  - A person with suitable product knowledge, e.g has specific PLC programming and technical knowledge.
  - A chartered professional engineer.
- The inspection should cover:
  - All mechanical aspects, e.g. winch mounting, brakes, sheaves, rollers and bearing condition.
  - Function tests of systems, e.g. the movement sensor, hydraulic and communication systems.
  - Alert systems, e.g. engine oil pressure, high temps, low hydraulic level).
- Use an inspection checklist provided by the OEM due to differences in machines and operating systems.
- The machine owner should provide previous servicing and inspection records to the person conducting the inspection.
- The machine owner should get a copy of the inspection result, including any recommended corrective actions.

Second-hand plant

If purchasing second-hand plant:

- Ensure that the machine's structural, mechanical, and control elements meet the same standards expected of new equipment.
- A competent persons should inspect the machine to assess that all safety and operational features are working as designed by the OEM.
- Once the inspection is completed, it is recommended future inspections meet the service and annual inspection requirements within this guide.
- Ask for servicing and inspection records, operating manuals and induction materials.

All secondhand bases converted to a WAM should undergo a "pre inspection" to ensure all safety and operational functions work as the OEM intended. Visually inspect and check:

- Hydraulic hoses and components.
- Mounting points and critical welds.
- Hydraulic bypass test on all cylinders.
- Leak tests on all cylinders.
- Measure play in all pins and bushings.
- ROPS, OPS, FOPS.

Second-hand plant generally changes hands on an "as is basis". This does not prevent the buyer or seller entering into an agreement regarding future warranties.

Repairs and Maintenance

Repair and maintenance need careful management otherwise there are serious risks including severe injuries.

Repairs and maintenance shouldn't need to be done on slope, only remedial work.

It is always best if you can safely get the machine to level ground with nearest access possible for maintenance vehicles.

Major and minor repairs

Repairs should be identified as major or minor. A major repair must be done otherwise a part of the winch-assist system will fail. Minor repairs are important to fix, however, the problem will not directly cause a machine failure. Major work should be approved by the OEM or their local representative. Major changes are always major repairs and need signing off by a chartered professional engineer. Minor work is non-structural and does not change or alter any part of the winch system, e.g. replacing a damaged sheave.

Use a lockout system

The guide recommends using a lockout system that prevents machines or their energy sources from being accidentally turned on. Lockout is essential for operators and mechanics to safely and confidently work on machines.

Common steps include:

- Shut down machinery and ensure that a responsible person removes and maintains possession of the ignition/ master key.
- Apply brakes, swing locks, etc.
- Place the transmission in the manufacturer's specified park position.
- Lower to the ground or secure each moving element like the booms, grapple, bucket, saws, to prevent a release of stored energy.
- Engage hydraulic safety locks when applicable.
- Relieve pressure on hydraulic or air systems by bleeding tanks or lines.
- Place lockout device.

Before the lockout device(s) are removed and the machinery started, check that the site is safe.

If the steep slope harvesting machine is being worked on down the slope, then the winch-assisted system needs to be locked out to eliminate the risk from the anchor machine. Make sure trees or debris on the uphill side of the machine are stable.

Energy is a hazard and comes in many forms. It could be electrical, pneumatic, hydraulic, mechanical and stored energy like heat. Isolate or remove all energy before starting maintenance.

Only work on the machine if it is stable, has zero energy, and it's locked out.

Repairing machines on unlevel ground
Sometimes machines cannot be repaired on level ground. Have a procedure or system to ensure the machine's stability before shutting down for remedial work or repair. This will create a consistent and safe approach to repairs.

This should include:

- Ensuring all parts of the machine have zero energy before starting work.
- Having the winch wire anchored.
- Putting the blade down (where applicable) or the boom/arm lowered with all attachments on the ground in a safe state.
- No lose debris upslope of the machine that could come down.
- Operator or mechanic safety, e.g. access to a harness if working on top of machine, or suitable guarding / fall protection installed.

The following accidents have occurred doing R&M on harvesting machinery:

- Arm became trapped in processor.
- Technician crushed and fatality injured during repairs to a logging processor head.
- Hose blew off just missing my head.
- Slips, trips and falls off cabs, tracks, and other machine parts.
- Crushed fingers.

Six key safety considerations for machinery repairs
The following table is a guide to safely work on machines.

	Six key safety considerations for machinery repairs	Responsibility
PREVENTION CONTROLS	**SKILLS and COMPETENCY and TOOLS and RESOURCES**	
	Worker has the skill set and experience to do this job correctly and safely.	Operator
	Correct tools and operator manuals are available.	Foreman, Operator
	PPE (e.g. gloves, eyewear) is available and worn.	Operator
	A suitably experienced person available to assist (if required).	Foreman
	External Service providers have received site access instructions (i.e. R/T Instruction or meet at gate) and contractor provides site induction.	Foreman, 3rd party
	TIME PRESSURE	
	If there likely to be a production impact, advise the foreman. This may need to be escalated to the forest owner/manager.	Operator, Foreman
	If the machine will be out of commission for an extended period, the foreman will ensure that any temporary manual work is planned, organised and undertaken by competent persons. Risks will be assessed and supervision provided (if necessary).	Foreman
	When testing a repair, keep body parts clear of nip / crush points. If multiple workers are assisting, every worker must be crystal clear about their role in the diagnostics / live check.	Operator, Mechanic
	WORK AREA	
	Raised objects must be appropriately supported. Ensure that no raised object can fall and crush any person assisting with or in the vicinity of the RandM task.	Operator
	Assess the work area for Falling objects. Ensure that no overhead hazard can fall on and injure any person assisting with or in the vicinity of the RandM task.	Operator
	Check that the machine is free of trip, slip, fall hazards.	Operator, Mechanic
	(Hydraulic fluid, diesel and oil leakage increase the chances of slipping on or falling from mobile plant or into moving parts).	Operator
	If there is a chance that another machine / vehicle will come into the work zone, Isolate (tape off) the work area.	Operator
	If the machine has broken down in an area difficult to access and repair, can it be recovered to a safer location before the repair is undertaken? Foreman is involved in any decision involving the recovery of a machine.	Foreman
	Weather conditions – if poor light, visibility fog, rain, dust, heat will affect your ability to complete the task safely, then delay the work until conditions are suitable.	Operator

	Six key safety considerations for machinery repairs	Responsibility
PREVENTION CONTROLS	**MOBILE PLANT AND EQUIPMENT PREPARATION**	
	If more than one person is involved in the task, 1 PERSON will take charge. That person will ensure each person clearly understands what is expected of them.	Operator
	The person doing the work knows how to engage the machine's lock-out / de-energise / disable features. Lockout prevents a machines or its energy sources being accidentally turned on. Lockout is essential for operators and mechanics to safely and confidently work on machines.	Operator, Mechanic
	Stored energy is released before starting the job (tension or fluid pressure). A sudden or unexpected release of hydraulic fluid release onto the body can result in severe injury including blood poisoning.	Operator
	Clothing or hair is not at risk of getting entangled.	Operator
	Important: Modern mobile plant may have as many as 5 energy systems to consider before starting RandM work (e.g. hydraulic, pneumatic (air), mechanical, electrical (incl computer) and heat. And always respect gravity!	
	SPECIFIC RISKS	
	Hot Work (e.g. welding, gas work) MUST be managed to prevent fire. Fire season requirements (including notification) are to be followed.	Operator, Foreman
	Smoking is an ignition source. No smoking while refueling or around petrol, diesel, or oil.	Operator
	Manual handling – if components or liquids > 25kg are being handled, share the load, break the load into small units or use another mechanical device to lift or assist.	Operator
	PREVENTATIVE MAINTENANCE	
	Daily Checks and Servicing are undertaken in accordance with manufacturer and company requirements.	Foreman, Worker, 3rd Party
RECOVERY	**WORKING ALONE**	
	If a worker is working alone, an effective call-in arrangement must in place. (e.g. includes weekend or after-hours work).	Foreman, Worker
	FIRST AID and EMERGENCY RESPONSE	
	Minor injuries (e.g. cuts / puncture wounds) must be treated with appropriate first aid to prevent infection.	First Aider, Worker
	In the event of an accident follow your emergency procedures. Review Emergency Procedures after an event (as part of the accident investigation).	Foreman, Worker

If Prevention Controls fail, it is critical that effective Recovery Controls are available to manage issues. Recovery controls are the things that manage an accident.