Unit	1014
Title	Describe and Apply Advanced Rigging Practices
Document type	Learning resource

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Feedback is welcome and may be sent to training@bcforestsafe.org.

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Unit Introduction

What you will learn in this unit

By the end of this unit, you will be able to demonstrate knowledge of:

- Line work
- Guyline placement
- Tail hold
- Basic splicing
- Deflection
- Advanced rigging practices for Tower
- Advanced rigging practices for Grapple Yarder

Why it's important for you to learn this unit

It is always the responsibility of any person using these materials to inform him/herself about the Occupational Health and Safety Regulations related to the work being conducted. A full list of OHSR related to this unit can be found in the relevant package.

Are you ready to take this unit?

To take this unit, you need to have completed the following units:

- 1002 – Describe Forest Industry
- 1013 – Describe Rigging Components and Apply Basic Rigging Practices

Does this unit apply to you?

This unit applies to you if you are in any of the following occupations:

- Grapple yarder operator
- Hook tender
- Tower operator

Section 1014-01: Tailhold

What you need to know about this section

By the end of this section, you will be able to demonstrate knowledge of the following key point:

1.1 Choose tailhold that is in the appropriate position and strength for logging system

Key Point 1.1: Choose Tailhold that is in the Appropriate Position and Strength for Logging System

A skyline supplies lift for the rigging and a tailhold is the point of anchor of the skyline. With adequate deflection, the tailhold need not be elevated at the back end; however, this method requires adequate anchor holding power and tiebacks. When deflection is minimal, tailholds may be located well beyond the setting boundary. If more lift or deflection is required, backspars may be used. Rigging backspars requires specialized rigging, climbing gear, and training. Tailholds should be selected before workers go in and fell the timber. You should be mindful of what systems you will be using as there may be different requirements for the tailhold.

A tailhold must:

- Be in lead
- Have no obstruction
- Strong enough to support the system, tied back in necessary
- Have correct spacing for road changes (spacing is dictated by length of wood, lay of wood, and topography such as hills and steep terrain)

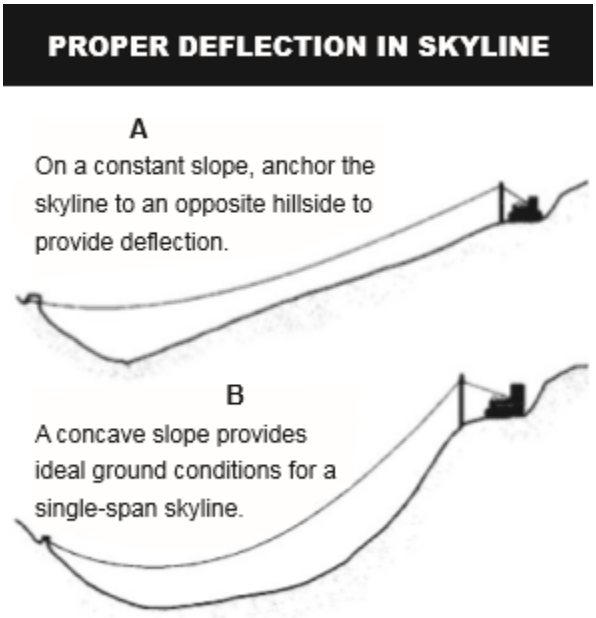
A tailhold failure can be deadly. The ability to choose a tailhold that is strong enough and in the correct position for the work to be done is essential for helping to ensure the safety of a worksite. You must be able to demonstrate that you can choose a tailhold that is both in the appropriate position, and strong enough for the logging system being used.

Deflection

Deflection is critical in logging with cable systems. Poor deflection will affect payload capacity and reduce production, and in some cases – as in going over a blind ridge to log behind that ridge – may make it impossible to tighten the lines enough to effectively get the logs off the ground. Poor deflection will also cause unnecessary breakage which devalues the logs. It can also create hang-ups which in-turn create hazards for the workers. The use of engineering controls can help lessen these hazards.

Many loggers can assess the terrain by eye. In uncertain situations, running a deflection line prior to rigging up allows a closer look at the terrain and a clear indication of how tight the lines may have to run. At this stage, the landings are already in place, and the logger will

need to assess what deflection is available and choose an appropriate yarding system.



Rigging stumps and using anchoring methods

Carefully select the anchor stump according to the species, size, and terrain. Each species of tree has a different root system and grows differently according to the soil moisture, density, and slope. The holding power of a stump increases with soil depth and density. Never assume the stumps in one setting will be the same as stumps in the next setting.

The holding power of a stump multiplies by the square of the diameter – so double the diameter gives four times the holding power. The equation is modified, however, by factors of soil and species, direction of pull, and zones and angles of the guylines. Before relying on an anchor, you should first load it to maximum and then watch the stump for movement.

Stumps are generally strongest with a side pull rather than an upward pull. On slopes, stumps have more root structure on the downhill side, and are therefore stronger on an uphill, rather than downhill, pull. Stumps on the back side of a ridge, with an upward pull, are stronger.

In the event that a single stump is not adequate, multiple stumps must be tied together or an alternative anchor type must be considered. If in doubt, use multiple anchors.

Remember that multiple anchors are only as strong as the weakest link. If one stump fails, the entire system can fail in a surge. If possible, isolate tieback stumps in multiples, so if one anchor fails, other leads will hold.

If a tree is used as a tailhold, the tree must be tied back, regardless of species or size.

Anchoring methods

Twisters

Always use a solid stump as an anchor, even if it is slightly out of lead or farther away from the spar.

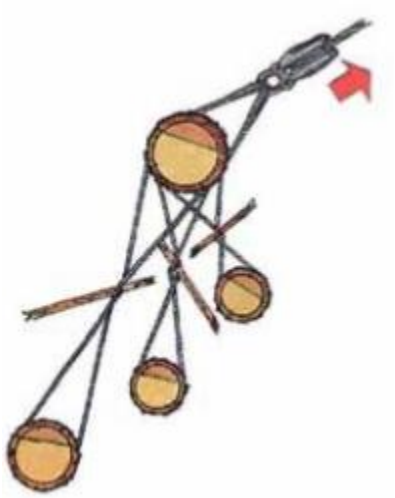
If solid stumps are not available, tie doubtful guyline anchor stumps back with one or more twisters. Alternatively, tie back to one or more stumps by wrapping the guyline end around the stump. Another possibility is to insert a Choke and Wrap. This is when the guyline wraps around the stump closest to the machine and continues to be choked around the farthest stump.

Remember the following points when securing stumps with twisters:

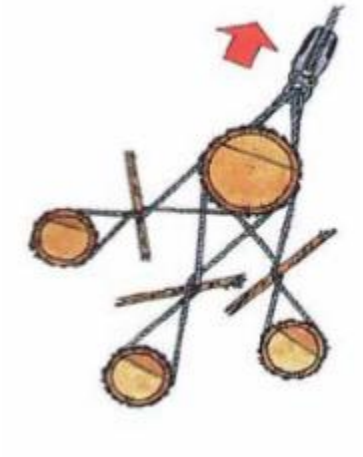
- Contact the operator when installing or removing a twister
- Ensure that a worker check system is used when only one worker is available to install twisters
- If two people do up the twister, then two people need to undo it
- Twisters need to be attached before loads are placed on the system
- Select suitable anchors in lead with the pull
- Select suitable line for the twisters
- Notch secondary anchors to prevent line slippage
- Select a good, sturdy, green limb or sapling of sufficient strength, diameter, and length for the twister stick
- If installed properly, twisters only have to be wrapped three to four times
- Longer twister lines require additional twister poles to take up the slack and prevent line damage
- Tension lines so they will almost touch
- Place the twister pole between the lines
- Rotate the twister pole uphill until tight
- Secure the pole 90 degrees to the twister lines
- Unwrap a twister when removing it. Never release a twister by cutting the twister pole with an axe or power saw

Remember, twisters don’t need to be over tightened. You should be able to pound on it with your fist without causing any visible movement in the wire.

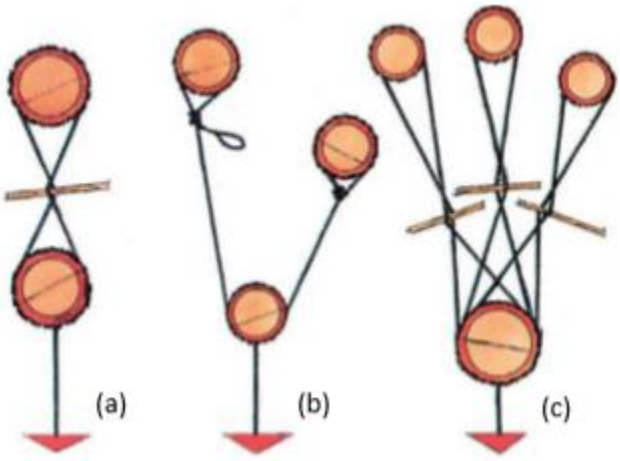
If more than one twister is required, apply as many as necessary, ensuring that they are kept in lead with the pull of the line. You may need to twist back a twister stump as well.



Twisters positioned incorrectly



Twisters positioned correctly



(a) Single twister (b) Two legs with cable clip (c) Multi-legged twister

Jill-poke supports

A jill-poke is when a log is driven into position between two anchor stumps for the purpose of increasing the stumps' stability and holding power.

Follow these four steps when using jill-poke supports to secure stumps:

1. Select a suitable secondary anchor in front of and in lead with the anchor stump.
2. Cut a flat surface on each stump facing the other.
3. Cut a suitable log slightly longer than the distance between the two faces.
4. Drive the log into position between the anchors.

A jill-poke can replace a twister

Deadweight anchors

Mobile equipment can provide additional support for securing a stump by placing the blade or track on the stump or root system.

Rigging backspars

A backspar is a tree rigged at the back end of the work area to provide lift for yarding lines, and is used primarily in skyline applications. If it is determined that a backspar is needed for the logging system to be used, then it should be identified at the same time as tailholds and before workers go in and fell the timber.

Backspar guylines

When a backspar is required, guylines must be used. Proper rigging practices for guylines also apply to backspars. A come-along may be used to tighten a backspar guyline. Use a minimum of three spikes to secure the last wrap.

A guyline secured to a stump must be wrapped at least two and a half times. The top wrap must be secured with three spikes. The number and position of spikes should be adequate to ensure that the guyline will handle the imposed stresses.

Railway spikes should only be used with large lines and large stumps.

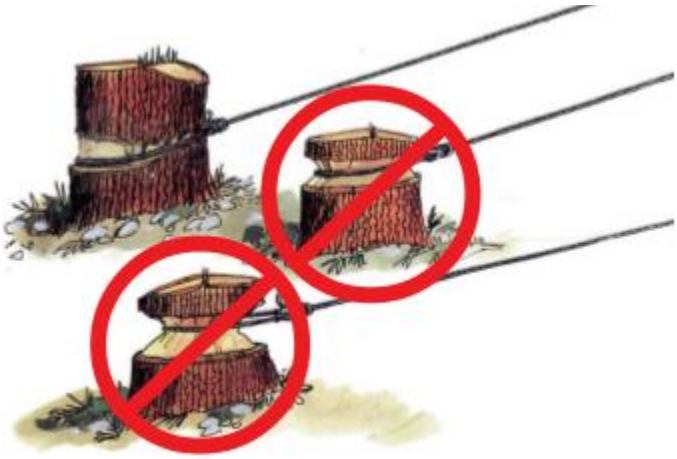
Remember this rule of thumb: a 2.5 cm (1 in.) of slack in the guyline on the stump gives 30 cm (1 ft.) of slack in the belly of the guyline.

Notching for guylines

Stumps must be notched to hold the guyline. The common way to notch a guyline stump is with an axe or power saw. Clear the area around the stump to work safely. If using a saw, wear protective gear. Depth and position are the two basic critical points when notching a guyline stump.

Stump anchors must be notched to a depth not greater than is necessary to safely secure the line to the stump. Cutting too deep reduces the diameter of the stump and effectively reduces its holding power. Deeper notching of swells, burls, and other irregularly shaped stumps is allowed so the line will be properly secured to solid wood.

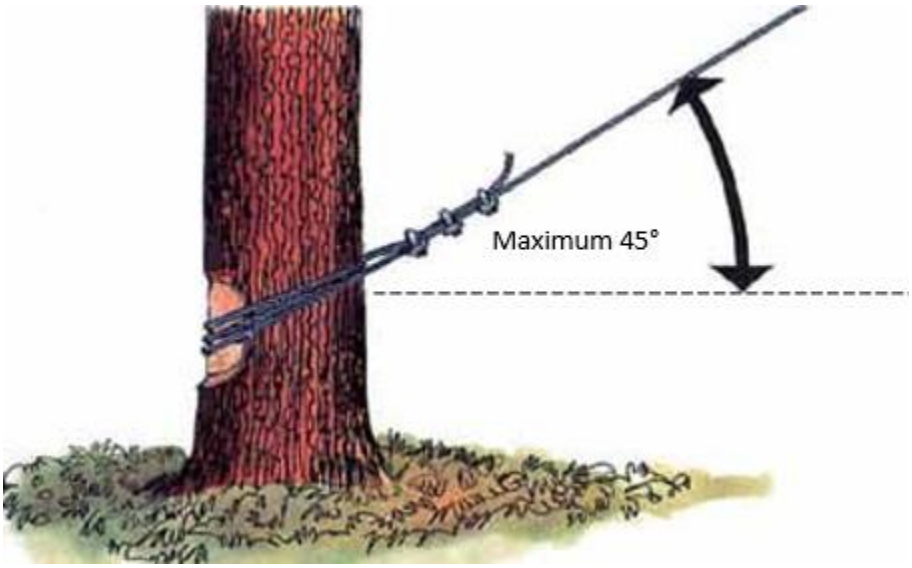
The notch must be positioned in lead with the guyline and with enough wood above the notch to prevent slabbing. The notch needs to be as low as possible, but do not cut off the roots. By placing the notch low, less leverage is exerted that could pull the stump out of the ground.



The top stump is properly notched. The notch in the middle stump is placed too high. The notch in the bottom stump is too deep.

Tightening sequence for guylines

When yarding downhill from a backspar, the two front guylines must be tightened first. When yarding uphill, the two back guylines must be tightened first. Guylines should be tensioned to support the backspar adequately, and positioned so that the inside angle is less than 45 degrees to the horizontal. When this cannot be done, additional guyline support is required.



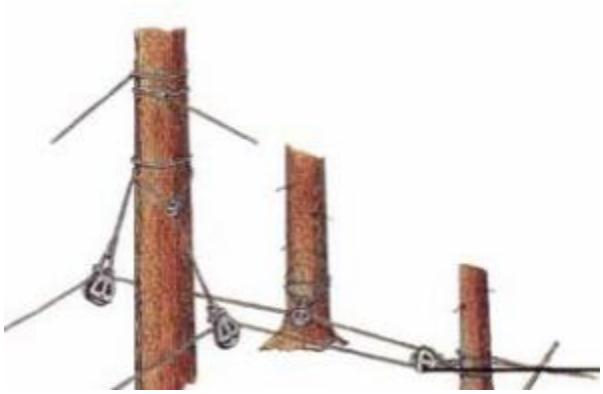
Guyline placement and moving guylines

Backspar guylines must be arranged to ensure that the stress in any direction is shared. Furthermore, the combined breaking strength of the two opposing guylines must equal or exceed the breaking strength of the skyline.

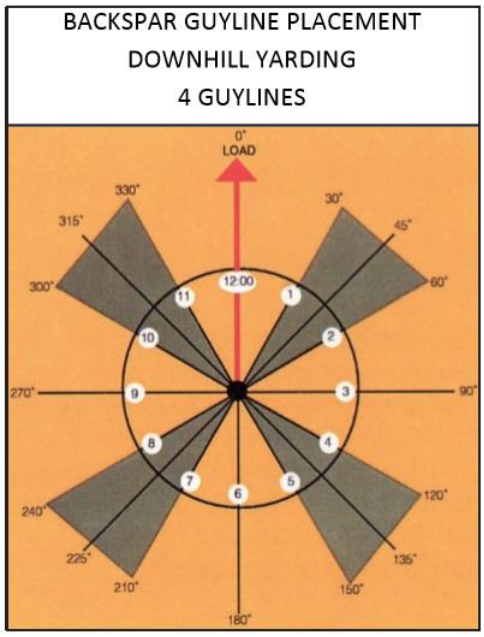
The following are three examples of guyline rigging arrangements that you may encounter on the worksite.

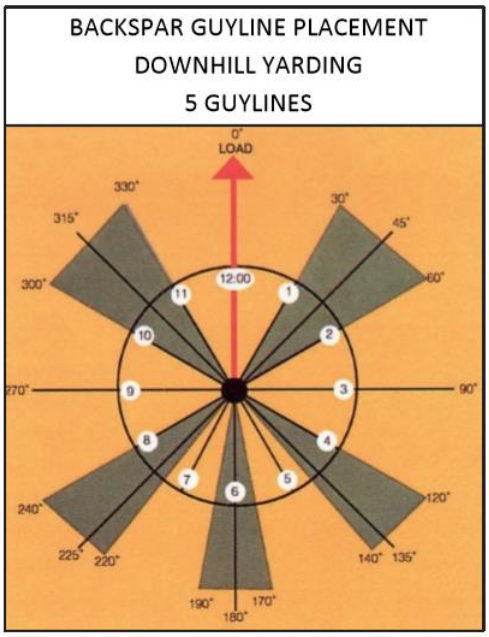
Guyline rigging arrangement example 1

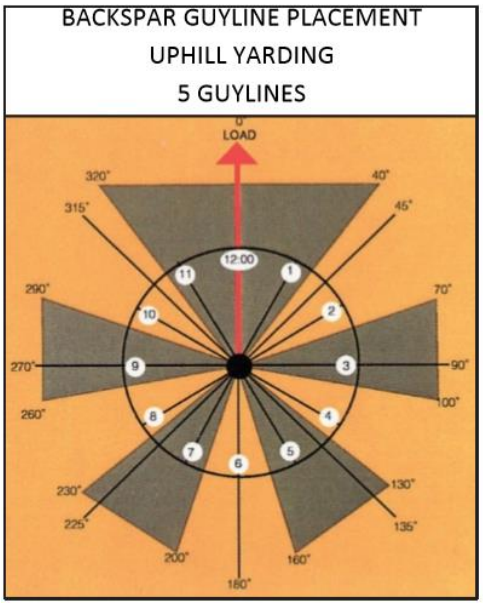
This rigging arrangement has proved to be the most practical and will exert the least stress on the backspar.

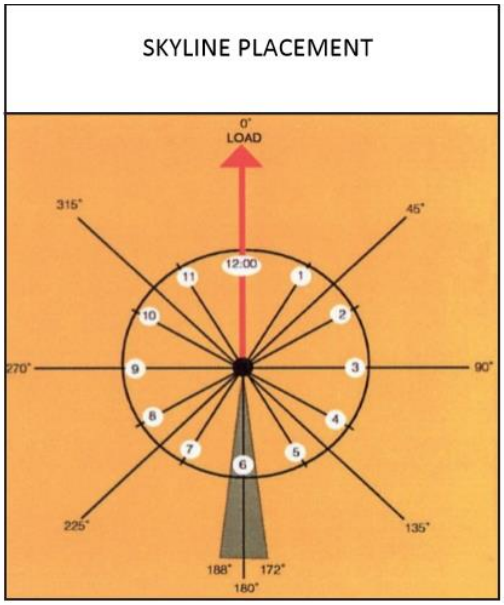


- With high-speed grapple yarders, use at least two guylines
- When only two guylines are used to equally support the backspar from the sides, the haulback tailhold block anchor location is most important. Both blocks on the backspar must be hung in the conventional manner with both eyes of the strap in the shackle or gooseneck
- Large straps choked with guyline sleeve shackles may be used to hang the blocks.
- Choker straps must be of sufficient size to support the blocks
- The guylines have to be positioned depending on the forces exerted on the tree. To lessen the load on the backspar and to provide equal loading on both sides, ensure that both the road line and back line block tailholds are placed well back
- Straps for the backspar blocks must be choked in opposite directions to prevent twisting the tree under heavy loads
- To put equal strain on each anchor, both road line and back line anchor stumps must be the same distance from the backspar
- Straps must be checked thoroughly before each use



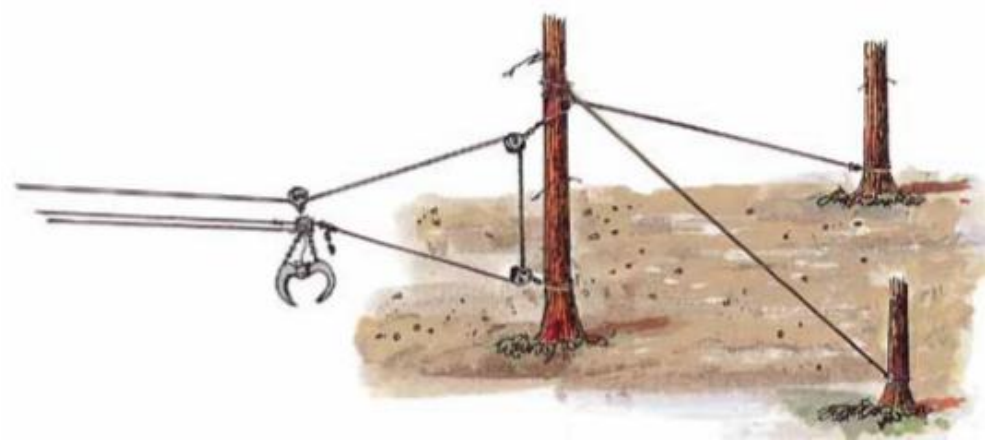






Guyline rigging arrangement example 2

This system uses one block at the top and one block at the bottom of the tree. The rigging arrangement places full loading on the guylines. The advantage of this type of backspar is ease of road changes.

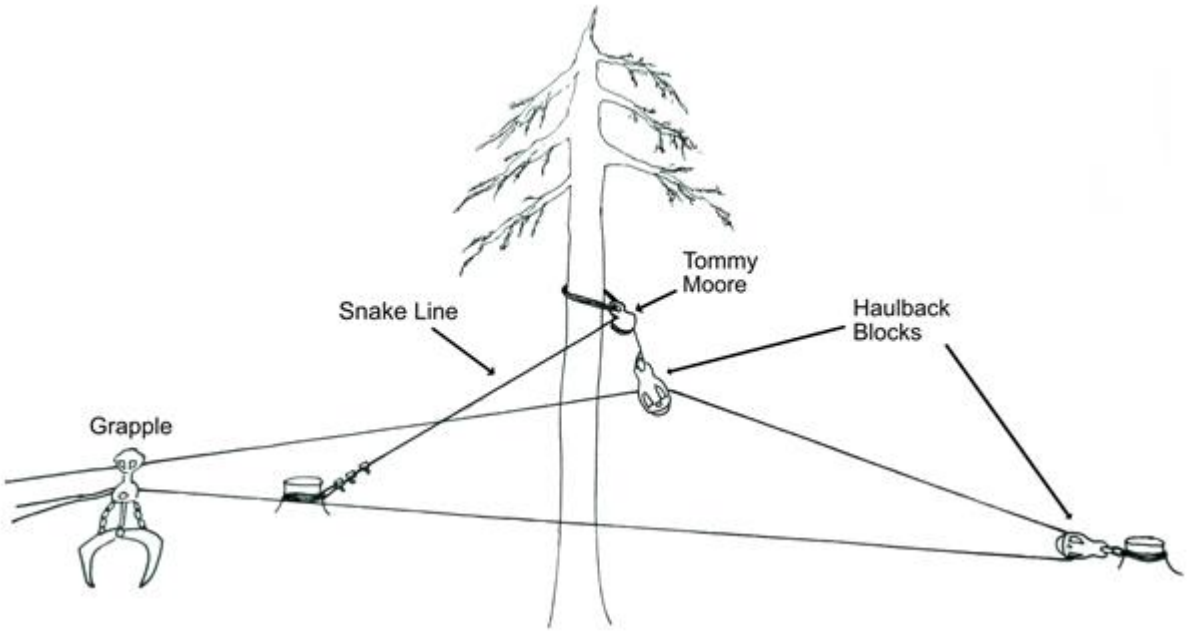


Workers using this method must consider the following:

- The top block is exposed to the greatest stress and must be hung with a suitably sized strap. Use a shackle to hang the block in the strap to prevent the block from twisting and burning the line on the shell of the block. Two guylines must be used and located directly behind the backspar with the spread between the anchors no greater than 60°
- The guyline must be rigged from opposite sides with as little bight as possible in the shackle
- The guylines must be equal to or of greater strength than the yarding lines.
- The shackle pins are inserted from the bottom and secured with an appropriately sized Molly Hogan
- The bottom block is usually hung in both eyes of the strap and set in a suitable notch. A longer, heavier strap choked with a guyline sleeve shackle may be used to allow the block to lift for clearing rocks and similar obstacles

Guyline rigging arrangement example 3

This rigging arrangement utilizes a “snake line” meaning a small block such as a Tommy Moore block is hung up the tree and the haulback block is connected to the eye of a 100’ piece of haulback with an eye in it, the bight of that line is placed in the Tommy Moore and the haul back block is pulled up to the Tommy Moore, The remaining slack is then wrapped around a stump and cable clamped to hold it in position, rigged with single haulback block in back end. The advantages are that this system is quick to set up, with minimal equipment, and the hook tender is able to do it without help. The disadvantages of this system are that it causes lift in the front end and back end of the setting, but not always in the middle.



Put knobs on

Knobs are used as stoppers on the end of a wire rope. They are also known as quick fix knobs.

The steps for attaching a knob are as follows:

1. Have the following tools and equipment ready:
    - 4lb. soft hammer
    - 10lb sledge hammer
    - Marlin spike
    - Eye protection
    - A new knob

2. Cut the line cleanly with no burrs. Be sure that the new knob is the proper size for the line.
3. Slide new knob onto line with larger end of knob facing end where knob is to be attached.
4. Insert marlin spike into end of line ½" to an inch from end at a 90-degree angle to the line, marlin spike needs to go under three continuous strands of line and above the three other strands and core.
5. Push spike in until end of spike sticks out about an inch and rotate with the lay of the line about a 1/8th of a turn.

6. Insert one wedge into space created small end first, tap slowly into place ensuring strands sit in corresponding grooves on wedge.

7. Continue tapping into place until wedge is inserted ¼" past end of strands on line.
8. Repeat last 4 steps with second wedge for other three strands, ensuring spike goes under three strands but above the core.
9. Once both wedges are tapped into place about ¼" past end of strands slide the knob up the line and hammer forcefully on bottom end of knob to tighten it onto line.
10. Knob is ready to use.

Remove knobs

The steps for removing a knob are as follows:

11. Have the following tools and equipment ready:

    - 4lb. soft hammer
    - 10lb. sledge hammer
    - Marlin spike
    - Black electricians tape
    - Eye protection

12. Remove old knob by laying it on its side on a hard surface like a steel deck or a large flat rock and hitting it hard a few times on the side of the cylinder-shaped knob.
13. With knob being held by standing on the bottom portion (where line goes into knob) and the line, strike the top corner with the 4Lb. hammer forcefully to shock the knob off the line and wedges. The line and knob might have to be rolled 90 degrees and struck again to loosen it completely.
14. Slide knob down the line clear of end of line and wedges.
15. Grab line over wedges and twist against lay of line to free wedges.
16. If that doesn't work, loosen wedges by prying them out with marlin spike.

Place loose wedges back into knob, wrap with black electricians tape and store until needed.

Choose Tailhold that is in the Appropriate Position and Strength for Logging System—Self-Quiz

1. It is recommended that the interior angle between the guyline and the horizontal plane does not exceed how many degrees?

   - ☐ 35
   - ☐ 45
   - ☐ 60

2. What equation describes the relationship between holding power of a stump and that stumps diameter?

   - ☐ The holding power multiplies by the square of the diameter
   - ☐ The holding power multiplies by twice the diameter
   - ☐ The holding power multiplies by the cube of the diameter

3. A backspar guyline that is being secured to a stump must be wrapped at least how many times?

   - ☐ 2
   - ☐ 2 1/2
   - ☐ 3

4. Poor deflection can result in reduced production.

   - ☐ True
   - ☐ False

5. Stumps are generally strongest with an uphill pull rather than a side pull.

   - ☐ True
   - ☐ False

Now check your answers on the next page.

Choose Tailhold that is in the Appropriate Position and Strength for Logging System—Quiz Answers

1. It is recommended that the interior angle between the guyline and the horizontal plane does not exceed how many degrees?

   Answer: **45**

2. What equation describes the relationship between holding power of a stump and that stumps diameter?

   Answer: **The holding power multiplies by the square of the diameter**

3. A backspar guyline that is being secured to a stump must be wrapped at least how many times?

   Answer: **2 1/2**

4. Poor deflection can result in reduced production.

   Answer: **True**

5. Stumps are generally strongest with an uphill pull rather than a side pull.

   Answer: **False (stumps are generally strongest with a side pull rather than a uphill pull)**

Section 1014-02: Advanced Rigging Practices – Grapple Yarder and Tower

What you need to know about this section

By the end of this section, you will be able to demonstrate knowledge of the following key points:

2.1 Application of rigging math required in the block (Tower and Grapple)

2.2 Elevated rigging on trees for deflection (Tower and Grapple)

2.3 Use of grapples, (Grapple)

2.4 Carriages (Tower)

2.5 Gravity systems (Tower)

2.6 North and south bend (Tower)

Key Point 2.1: Application of Rigging Math Required in the Block (Tower and Grapple)

In this section we will discuss how to apply the math that is required when in the block. This includes determining deflection, guyline placement, and load limitations.

Be sure to read all the material carefully as you will be required to demonstrate knowledge of these topics.

Deflection

Deflection increases the payload capacity of a yarding system, as illustrated in the following table.

Deflection percent	Gross Load Capacity (pounds)
4	3,000
6	5,500
8	8,500
10	11,000
12	13,500
14	16,000
16	19,000
18	22,000
20	24,500

Example: Unclamped carriage, 2,000 ft. span, 40% downslope, 1-inch EIPS skyline – 103,400 lbs. breaking strength, 34,500 lbs. safe working load; weight 1.85 lbs./ft.

Terms of Measurement to Calculate Deflection

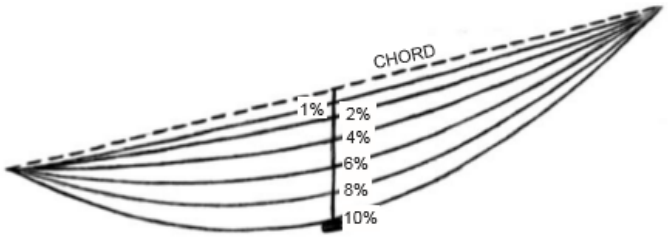
Chord = A straight line from the top of the tower to the tailhold.

Span length = The horizontal distance between the tower and the tailhold.

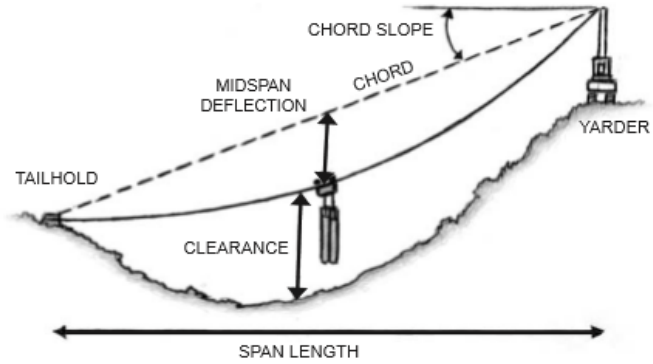
Deflection = The vertical distance between the chord and the carriage at midspan.

Deflection is typically expressed as a percentage of the span length.

$$\text{Deflection (\%)} = \frac{\text{Deflection} \times 100}{\text{Span length}}$$



Changes in deflection



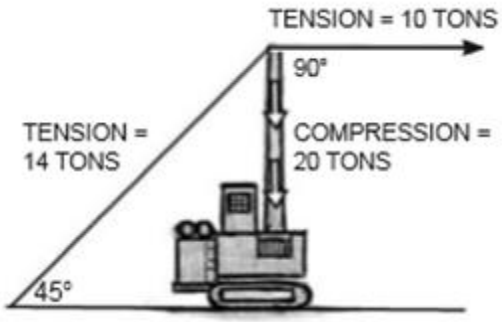
Terms used to measure deflection

Guyline placement

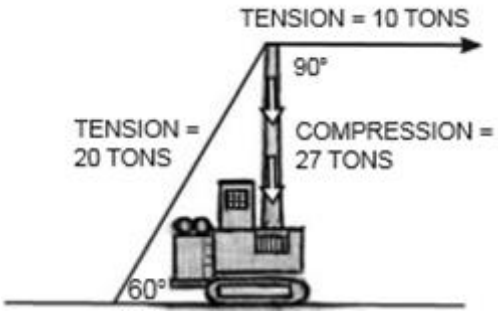
The angle of the guyline measured horizontally from the anchor point must be no greater than 50 degrees (or the manufacturer's recommendation). Angles greater than 50 degrees can place a buckling force on the tower and cause a catastrophic failure. The flatter the angle, the more effective the anchor will be. An anchor above the height of the tower will be less stable. Guylines too far above the tower will create a lifting force that could actually lift the tower off the ground. Examine upward forces on the tower to assure stability. If a suitable anchor is not available, so a guyline exceeds a 50-degree angle, then additional precautions must be taken, such as adding guylines to oppose the load, or using narrower yarding roads or lighter loads.

Guyline angles should be as flat as possible to avoid extreme tension. Greater angles produce greater tension. Tension in the guylines produces a downward force on the tower. Greater tension produces greater tower compression.

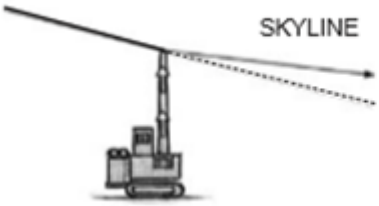
With a horizontal skyline, a load of 10 tons, and a guyline angle of 45 degrees, tension on the guyline is 14 tons and compression on the tower is 20 tons.



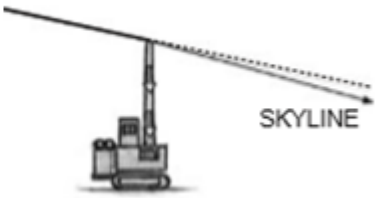
With a horizontal skyline, a load of 10 tons, and a guyline angle of 60 degrees, tension on the guyline is 20 tons and compression on the tower is 27 tons.



Placing a guyline above the tower can result in a lifting force that increases tower instability. Lift is produced if a guyline angles up from the working line. If the guyline angles down from the working line, then a downward force is produced in the tower.



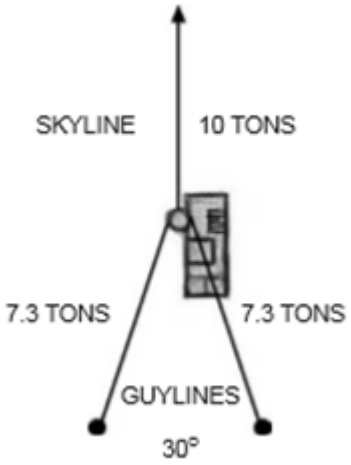
Upward force on tower



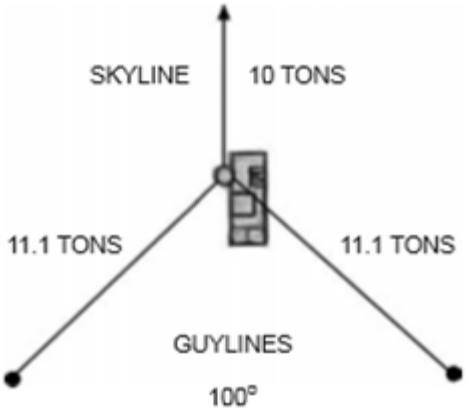
Downward force on tower

Horizontal angles in guyline placement also affect the tension in the guylines. As the angle between two guylines increases, the tension shared in those guylines increases. The figures below show results for different guyline configurations, with a 10-ton load on a horizontal skyline, and guylines set at 45 degrees.

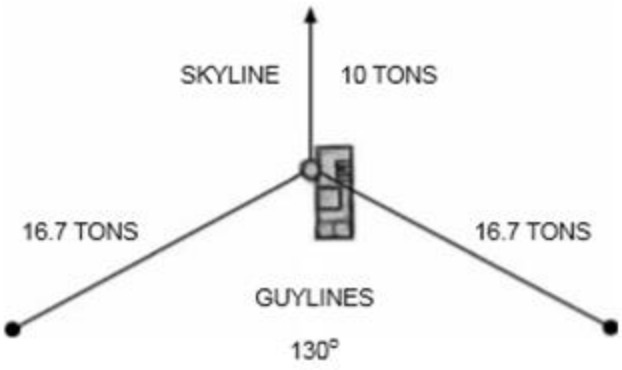
The tension on two guylines equally spaced at an angle of 30 degrees will be 7.3 tons.



The tension on two guylines equally spaced at an angle of 100 degrees will be 11.1 tons



The tension on two guylines equally spaced at an angle of 130 degrees will be 16.7 tons.

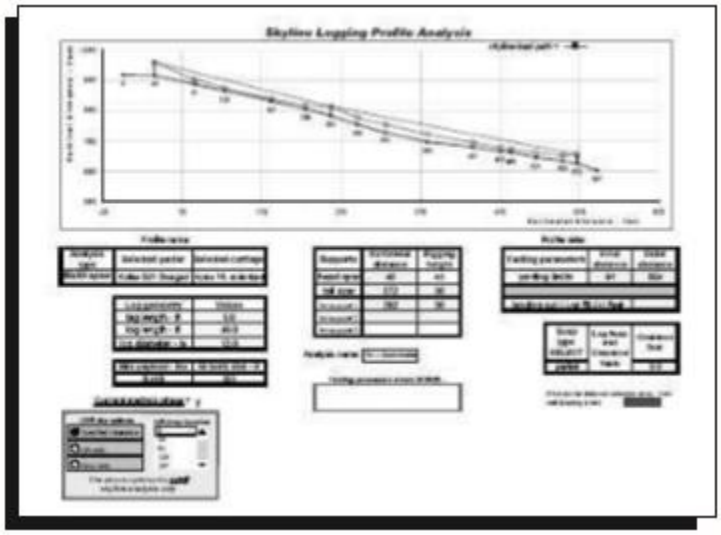


Load

There are several ways to analyze the payload for any given tower, landing, and terrain combination. Analyze the worst payload scenario for each landing to determine how much wood can be safely carried on the skyline. If suitable payload is not available with a tailhold down low on a unit, consider finding a tailhold up the back side, or use a tailtree to raise the line and give more deflection.

The payload analysis screen shown here from the computer program SkylineXL works on input for equipment and terrain to estimate an appropriate payload. Using a computer program is the easiest way to calculate payload. Adjust the estimate by additional variables related to the particular situation for environment, equipment, and human factors.

A tension meter attached to the skyline at the tail hold will tell the operator what every turn weighs and allow them to set a standard tension on the cable for yarding.



Application of Rigging Math Required in the Block (Tower and Grapple)—Self-Quiz

1. As the angle between two guylines increases, how is the shared tension in those guylines affected?

   - ☐ It increases
   - ☐ It decreases
   - ☐ It stays the same

2. Deflection is typically expressed as a percentage of what?

   - ☐ Chord
   - ☐ Span length
   - ☐ Payload

3. Lift is produced if a guyline angles down from the working line.

   - ☐ True
   - ☐ False

Now check your answers on the next page.

Application of Rigging Math Required in the Block (Tower and Grapple)—Quiz Answers

1. As the angle between two guylines increases, how is the shared tension in those guylines affected?

   Answer: **It increases**

2. Deflection is typically expressed as a percentage of what?

   Answer: **Span length**

3. Lift is produced if a guyline angles down from the working line.

   Answer: **False (lift is produced if a guyline angles up from the working line)**

Key Point 2.2: Elevated Rigging on Trees for Deflection (Tower and Grapple)

There are some situations when you may be required to use additional elevated rigging in order to get the required amount of deflection to safely yard logs. In this section you will learn about the different types of elevated tree rigging that you may encounter out on the job site. Read the material carefully as you will be expected to demonstrate knowledge of this topic.

Elevated support

Backspars used for grapple yarders should be a sound tree supported with guylines and good anchors. Backspars are not normally subject to heavy stresses if properly positioned tailholds are used.

When a grapple yarder is operating, workers must not be within one and a half tree lengths of a backspar that is not guyed or that is guyed but not topped.

Important factors in rigging backspars include the following:

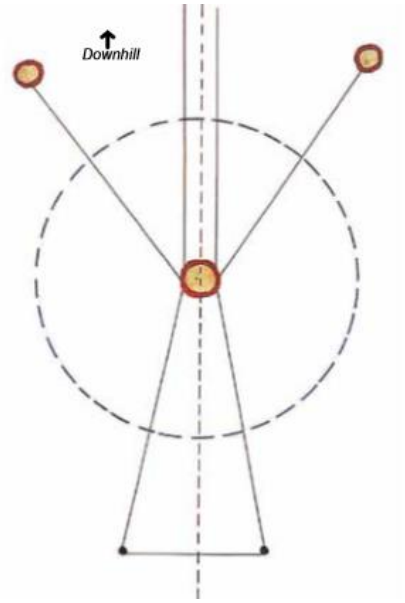
- Only use sound, sturdy, and well-rooted trees
- Rig trees no higher than necessary to provide the required lift

The following diagrams illustrate the most common type of elevated rigging.

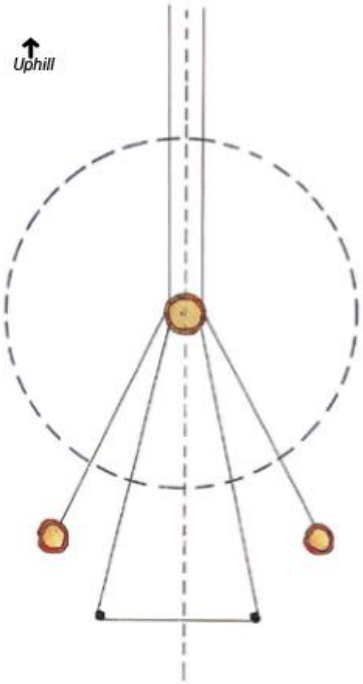
Some points to consider:

- With high-speed grapple yarders, always use at least two guylines
- When only two guylines are used to equally support the backspar from the sides, the haulback tailhold block anchor location is most important
- Both blocks on the backspar must be hung in the conventional manner with both eyes of the strap in the shackles or gooseneck unless choker straps are used
- Large straps choked with guyline sleeve shackles may be used to hang the blocks
- Choker straps must be of sufficient size to support the blocks
- The guylines have to be positioned depending on the forces exerted on the tree

- To lessen the load on the backspar and to provide equal loading on both sides, ensure that both the road line and back lone block tailholds are placed well back
- Straps for the backspar blocks must be choked in opposite directions to prevent twisting the tree under heavy loads
- To put equal strain on each anchor, both road line and back line anchor stumps must be the same distance from the backspar
- Straps must be checked thoroughly before each use



Typical downhill yarding – guylines in front of tree



Typical uphill yarding – guylines behind tree

Lift tree

Using a lift tree to elevate a tailhold or intermediate support may be useful in situations where the terrain limits skyline deflection and reduces the payload. Lift trees also increase rigging clearance, allow turns over a blind ridge, and increase haul distances.

The most common elevated support is a tailtree used to elevate the skyline and provide better deflection. Intermediate tailtrees are used to raise the skyline in a central part of the span.

Critical factors to apply to any lift tree include the following:

- Use only sound, sturdy, well-rooted trees, straight up to the point of attachment. Species of high strength are preferable, such as fir, spruce, or hemlock. It may be necessary to compromise on the location of the tailtree to obtain a sturdy tree and anchors
- Straps or chokers used to hang or support blocks, jacks, tree shoes, or rigging in tail and intermediate trees must be an adequate size
- Before rigging a tree, determine the forces exerted on the tree. Set the rigging no higher than needed. More leverage is imposed on the tree at higher levels and will require added support. It is seldom necessary to rig higher than 45 feet
- Setting a higher skyline anchor will make a flatter angle to the support tree and reduce stress on the tree
- Use caution if a steel sheave block is used to support a skyline. Over time, the sheave can create a weak point in the skyline. If the road being logged is long or will be hanging with the skyline in the same position in the block for an extended period, use skyline extensions to lengthen or shorten the skyline, and move the bearing point
- The rigging crew must be in the clear before lines are tensioned. A safe distance is at least 1½ tree lengths from the base of the tree

Elevated Rigging on Trees for Deflection (Tower and Grapple)—Self-Quiz

1. If a backspar is not topped, workers must stay at least how many tree lengths away?

   ☐ Half

   ☐ One

   ☐ Two

2. Choking straps for the backspar block in the same direction helps prevent the tree from twisting.

   ☐ True

   ☐ False

3. Setting a higher skyline anchor will help reduce stress on the tree.

   ☐ True

   ☐ False

Now check your answers on the next page.

Elevated Rigging on Trees for Deflection (Tower and Grapple)—Quiz Answers

1. If a backspar is not topped, workers must stay at least how many tree lengths away?

   Answer: **One**

2. Choking straps for the backspar block in the same direction helps prevent the tree from twisting.

   Answer: **False (straps should be choked in opposite directions)**

3. Setting a higher skyline anchor will help reduce stress on the tree.

   Answer: **True**

Key Point 2.3: Use of Grapples (Grapple)

The movement of the grapple is no different than any other load suspended from two points. When you slack the front end (the mainline), the grapple travels toward the tailhold. When you slack the back end point of suspension (the haulback), the grapple moves toward the yarder. When both lines are slackened at the same rate, the grapple drops almost straight down. The distance that the grapple moves forward or back depends on how high it is suspended above the log.

Often the grapple will rotate and miss the log as it is being slacked down. If the grapple misses the log, the spotter will ask the operator to tightline. The spotter will wait until the grapple is over the log and then request a slack.

IMPORTANT!

Remember to use appropriate verbal signals consistently.

Changing a closing line

Yarding grapple

The closing line on a grapple yarder may need to be changed if it becomes damaged or worn. To change a closing line, complete the following steps:

1. Bring grapple into the landing and lay it down on a flat surface with the sheaves and anchor on the top side.
2. Ensure legs are flat and won't move when a worker is close to them.
3. Slack carriage down so there is slack in the leg chains and room between the bottom of the carriage and the donut above the center pin on the legs.
4. Shut off machine and lock it out.
5. Have all tools and equipment such as:

    - New closing line
    - Marlin spike
    - 4lb. soft hammer
    - 10lb. sledge hammer
    - Eye protection
    - Cut-off saw

6. Remove all debris from T-bar holes, carriage sheaves, leg sheaves and anchor point.

Note: A T-bar is also called 3-way slider, has two 1 and ¼" holes at the top and a large oval shaped opening at the bottom, approx. 2" by 4", roughly triangular in shape.

7. Cut old closing line into as many pieces as it takes to remove from the grapple and carriage.
8. Remove all closing line and remove quick-fix knobs from old closing line.
9. Keep knobs for later use and place old closing line pieces in scrap line pile.
10. Place and tighten quick-fix knob on one end of new closing line.
11. Feed opposite end of closing line without a knob on it through the T-bar at the end of the mainline. Continue feeding new closing line through appropriate hole on front of carriage.
12. Feed line down through donut on bottom of carriage and then through top side of donut above center pin on grapple legs.
13. Pull all slack through ensuring there are no wraps or kinks and the line is running in right spots and knob attached at the beginning is now seated against T-bar.
14. Continue feeding new closing line under sheave on center pin then through leg sheave (or sheaves) and back into hole at anchor point on grapple leg.
15. Pull all slack through the anchor point and ensure all the slack is pulled through at all the other sheaves on the grapple and carriage.

Note: There should be sufficient slack to attach last knob on the end of the closing line sticking through the anchor point. If not, use a pry bar or spike as a pry and try and close the legs of the grapple until enough slack is available to attach the last knob.

16. Tighten last knob with sledge hammer or pull it back hard into the anchor a few times.
17. Ensure all parts of the closing line are in correct positions and anchor is seated properly.
18. Have operator do an open and close cycle with grapple to ensure closing line is proper length.
19. Replace tools in proper spots and make sure another new closing line is ready to go.
20. Tell rigging crew grapple is ready to go, continue logging.

Changing an opening line

To change a closing line, complete the following steps:

1. Have all the equipment and tools ready such as:
    - New opening line
    - Knobs
    - Shackles
    - Marlin spike
    - 4lb. hammer
    - 10lb hammer
    - Eye protection
    - Cut off saw
2. Bring grapple into landing and lay it down.
3. Pull slack from machine on slack-puller line to reach T-bar.
4. Ensure machine is shut down and locked-out.
5. Cut and remove old opening line.
6. Remove knobs, shackle and place old line in scrap line pile.
7. Attach knob to one end of new opening line.
8. Insert other end (without a knob) through second hole on T-bar beside the closing line knob and pull all the slack through, seating the knob against the T-bar.
9. Continue threading new line through the top of the opening line sheave in the carriage.
10. Pull line all the way through and insert through the bottom of the opening line sheave on the carriage, pulling all the line through again.
11. Thread line through roller on the bottom of the T-bar, ensure the lines are straight and no kinks or wraps are present.
12. Attach end of opening line to slack-puller either by Double D (knobs) or run-over shackle.

Note: If new opening line has an eye to attach to slack-puller then process is reversed and new opening line (cut end, leave eye on ground) is threaded through roller on bottom of T-bar, through bottom of opening line sheave in carriage, through top of opening line sheave in

carriage then back through second hole in T-bar and attached with a quick fix knob.

Use of Grapples (Grapple)—Self-Quiz

1. When you slack the back end of suspension the grapple moves toward the tailhold.

   ☐ True

   ☐ False

2. The old closing line is removed from the grapple and carriage by cutting it into pieces.

   ☐ True

   ☐ False

3. You have to lock out the grapple before changing opening or closing lines.

   ☐ True

   ☐ False

Now check your answers on the next page.

Use of Grapples (Grapple)—Quiz Answers

1. When you slack the back end of suspension the grapple moves toward the tailhold.

   Answer: **False (The grapple moves toward the yarder when the back end is slacked)**

2. The old closing line is removed from the grapple and carriage by cutting it into pieces.

   Answer: **True**

3. You have to lock out the grapple before changing opening or closing lines.

   Answer: **True**

Key Point 2.4: Carriages (Tower)

A carriage is the wheeled, load carrying device that runs on the skyline and is used for hauling the logs. In this section you will learn about several carriage systems as well as the many different types of carriages and the purposes that they all serve. Be sure to read the material thoroughly as you will be expected to demonstrate knowledge of this topic.

Carriage systems

The following are the carriage systems discussed in this key point:

- Scab skyline (running skyline)
- Shotgun system on a live system
- Live skyline and carriage with haulback attached
- Skyline tension
- Uphill and downhill yarding

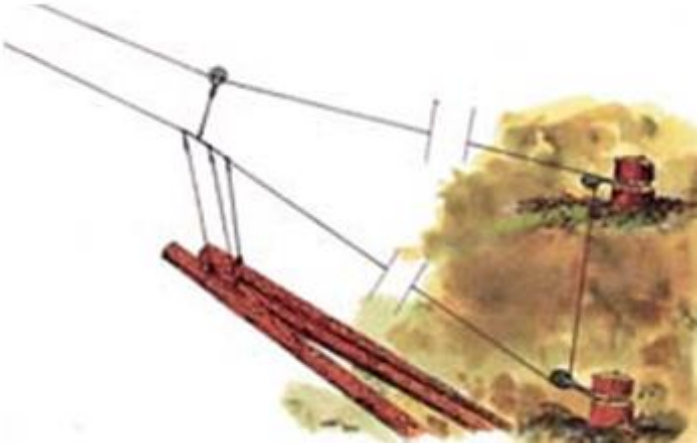
Scab skyline (running skyline)

A scab line system involves the use of a rider block on the haulback, connected to the butt rigging with a short strap or chain.

There must be adequate deflection to use this system. A rule of thumb: If you can see at least two-thirds of the home tower from the back end, you have enough deflection.

It is recommended that two blocks be used at the back end. This reduces the amount of stress that would be placed on one stump, specifically in a downhill situation where the haulback brake is used to control the turn. Using two blocks also reduces line wear caused by line wrap. The scab line system increases lift and gives better control on sidehill yarding.

When a single block is used, there is a full block purchase on the tailhold.



Two block system

Dos and don’ts when using scab skylines

Dos

- Use a sufficient amount of tag between the scab block and the butt rigging
- Use two corner blocks
- Ensure that the scab block is fitted with a proper line guard
- Make the rigging crew aware of the increased travel of the rigging when slack is given when using this system
- Stop the rigging until the lines are free, if line wrap occurs
- Secure the rigging when changing roads, to prevent any inadvertent movement
- Consider leaving the turn hooked up when changing roads

Don’ts

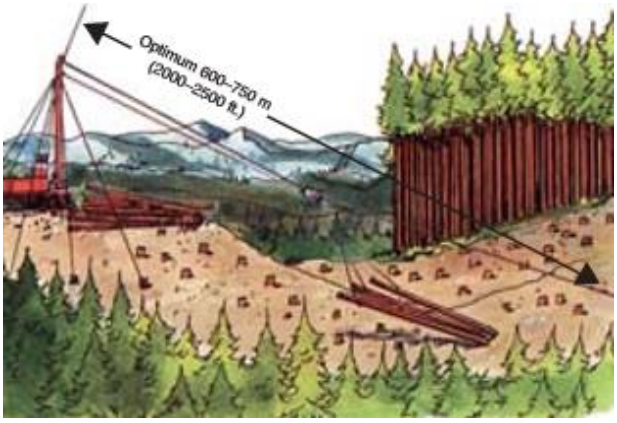
- Don’t run the rigging back near the tailhold stumps if the stumps are more than a few feet apart
- Don’t allow the chokers to flip over the lines and foul the scab block; clear the chokers immediately, or they will burn the haulback

Shotgun system on a live system

This is an uphill yarding configuration where gravity outhauls the carriage. In order to have the carriage closer to the ground, the skyline should be slackened.

One of the most hazardous work areas is directly under the skyline and carriage.

As with any yarding system, planning and setting layout are important. The crucial elements in shotgun yarding are chord slope and maintaining a recommended minimum of 10 percent deflection.



Steel tower built for shotgun

Advantages

- The only power required for this type of yarding is during the inhaul mode because gravity assists on the outhaul. Fuel costs are substantially reduced with this system
- Depending on the slope of the skyline and amount of deflection, yarding cycle time is faster than it is with powered outhaul
- Rig-up time is reduced because there are no haulback or blocks to be set
- Damage to logs is reduced
- With the ability to adjust the skyline tension, deflection can be increased for heavy loads

Disadvantages

- With insufficient lift at the back end or backspar, chokers and/or rigging will be in ground lead, creating additional hazards

Live skyline and carriage with haulback attached

With this system, the yarder operator controls the skyline tension. The haulback is attached to the carriage for outhaul, and to hold the carriage when stopped. This configuration is used for downhill yarding as well as uphill yarding.

This illustration shows the bight area

Advantages

- It is not restricted to only uphill yarding
- It allows the carriage to be spotted at any location
- It provides more control of logs being yarded
- It allows the bight of the haulback to be kept to a minimum
- It allows north bend and south bend configurations to be used

Disadvantages

This system increases hazards in the following areas:

- Bight created by the haulback and the blocks
- Inside area contained by a fall block, haulback, and mainline
- Anywhere under the haulback, mainline, and skyline
- Area within reach of any backspar or lift tree that could be pulled over

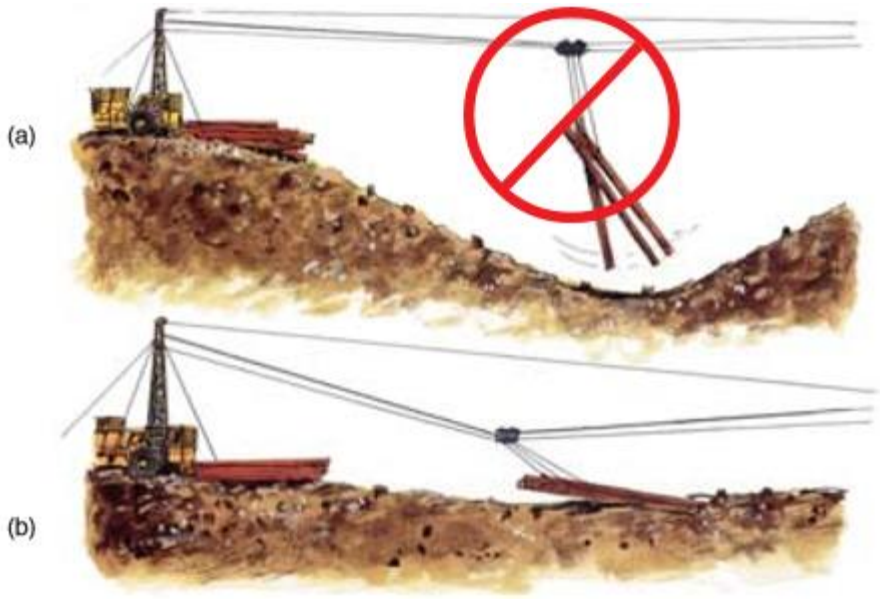
It also creates difficulty as the carriage approaches the back end, because:

- An extra bight is placed on the skyline tree jack
- A guylines stresses change
- Haulback corner blocks may have additional bight and stresses

Skyline tension

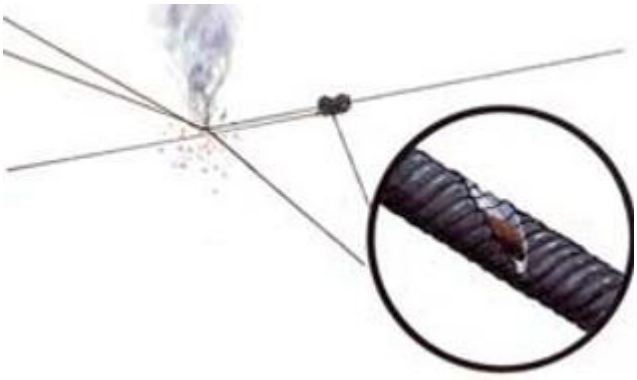
For any skyline application, there should be adequate skyline slope and deflection on the outhaul to clear the carriage and chokers off the ground. Planning for skyline yarding should determine that deflection is adequate for full or partial suspension. Deflection lines should be calculated to ensure that the desired yarding method will be possible.

Excessive wire rope wear and stretching occurs when using less than 8 percent deflection. The minimum recommended deflection is 10 percent. When this cannot be attained, consideration should be given to rigging a backspar or the use of intermediate supports



a) Unsafe – inadequate sag for uneven ground b) Safe

Only machines designed specifically or modified for shotgun logging must be used. Some equipment is designed with the skyline fairlead, with the pulling or skidding line below. This configuration prevents lines from wrapping and cutting off.



Use of wrong machinery will cause lines to wrap and burn

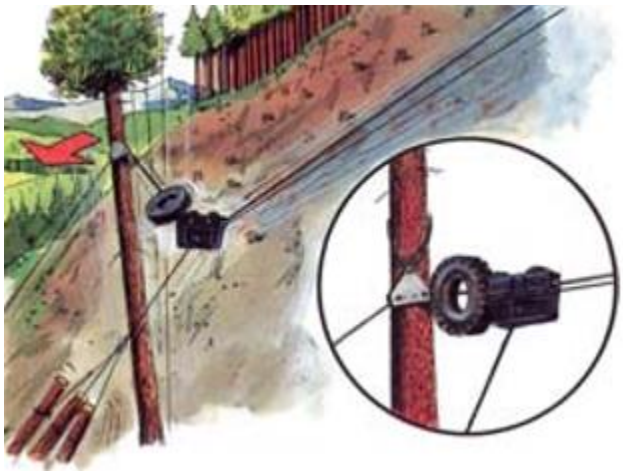
Uphill and downhill yarding

Uphill yarding

During uphill yarding, the two back guys take the critical loading. The front guys stabilize the tree when yarding logs from behind the backspar; the carriage will be brought back as far as possible. As the mainline/skidding line tightens, excessive bight occurs in the skyline at the jack.

When the carriage stops at the backspar, the bight of the mainline/skidding line is brought back to the tailblock located behind the tree. The turn is then set. Before the inhaul action is initiated on the mainline/skidding line, the carriage should be moved ahead to prevent excessive purchase on the skyline and stress on the backspar. Guyline placement is critical. A bumper should be places between the skyline jack and carriage.

Yarding logs from behind a backspar changes the direction of stress, and additional factors must be considered.



Location of bumper to prevent the carriage from damaging the backspar and the backspar jack

Downhill yarding

During downhill yarding, the two front guylines take the critical loading. The backspar guys stabilize the backspar. In both situations, caution should be exercised to prevent damage to guylines, jack strap, and backspar.

Downhill yarding

Types of carriages

A carriage is a wheeled, load carrying device which travels freely on sheaves running on a wire rope (skyline) and is used for hauling logs. There are many different types of carriages.

The following are the types of carriages:

- Shotgun carriage
- Shotgun carriage with a skyline lock
- Shotgun carriage with a mechanical stop
- Slack skyline carriage
- Mechanical slack-pulling carriage on a running skyline
- Radio-controlled motor-driven slack-pulling carriage equipped with a skyline lock
- Radio-controlled motor-driven self-contained yarding carriage
- Radio-controlled self-propelled carriage

Shotgun carriage

- Simplest of the skyline carriages
- Used in uphill yarding on a slack skyline
- Chokers are attached to the bottom of the carriage
- Reach is limited by the length of the chokers
- Gravity pulls the carriage and mainline down the hill

Shotgun carriages with multiple chokers attached

Shotgun carriage with a skyline lock

- Gravity pulls the carriage and mainline down the hill
- The operator radio-controls or mechanically cycles the skyline lock when the carriage is in the landing, and the carriage operator/rigging slinger controls it when the chokers are being set
- The carriage is also equipped with a mainline lock that locks the mainline once the hook hits the carriage
- The hook on the end of the mainline is pulled by hand to the pre-set chokers

- An accumulator powers the skyline lock or clamp; the accumulator is charged by gears that are turned by the carriage sheaves on the inhaul and outhaul
- This carriage can be moved up or down the skyline once the turn is set to attain better lead when skidding the turn to the skyline corridor
- All shotgun carriages, except motorized ones, require the operator to slack the skyline to land the logs

Shotgun system with skyline lock

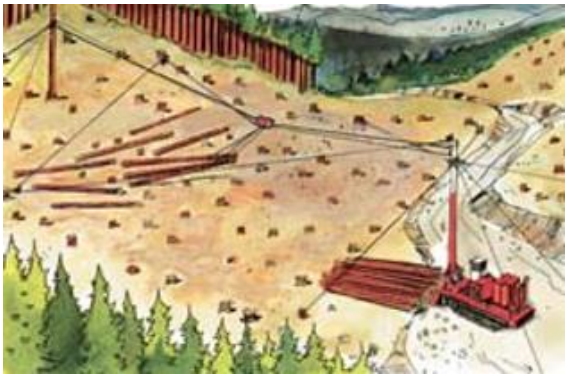
Shotgun carriage with a mechanical stop

- Gravity pulls the carriage and mainline down the hill
- The mechanical stop holds the carriage from running down the skyline
- The mechanical stop is positioned on the skyline by hand, using wrenches and bolts; it can therefore only be used effectively on slack skylines
- The carriage has a mechanical cam lock system on the mainline to prevent the chokers and logs from jamming in the carriage
- The skyline and carriage are slacked to land the logs

Mechanical stop holding a shotgun carriage

Slack skyline carriage

- The haulback controls the slackline carriage on the outhaul
- The chokers are attached to the butt rigging, which is hooked to the bottom of the carriage
- The slackline carriage can be used for uphill, downhill, or crosshill yarding; it may require the use of a backspar with four guylines to provide the required lift
- The skyline and carriage are lowered to land the logs
- The carriage provides positive operator control for downhill yarding and landing of the logs
- The carriage takes away some operator control in downhill yarding when rigged with a north bend system to increase road width



Slack skyline carriage

Mechanical slack-pulling carriage on a running skyline

- The haulback controls the carriage on the outhaul and holds it in place when lifting the turn
- This carriage can be used on a running, fixed, or slack skyline
- This carriage may require the use of a backspar with four guylines to provide the required lift
- The yarder operator controls all line and carriage movement
- Mechanical slack-pulling carriages can be used for uphill, downhill, and crosshill yarding
- This carriage provides positive operator control for landing the logs
- This carriage releases and pulls in tong line in the same method that a grapple uses to open and close
- If desired, this carriage can quickly and easily be put onto a grapple yarder

Mechanical slack-pulling carriage

Radio-controlled motor-driven slack-pulling carriage equipped with a skyline lock

- The motorized slack-pulling carriage is best suited for uphill yarding
- Gravity takes the carriage and mainline down the skyline
- The landing worker normally controls the carriage motor and skyline lock in the landing and the carriage operator/rigging slinger controls them when the chokers are being set. The yarding operator has backup controls for safety
- The logs are yarded to the carriage, using the power of the yarder mainline winch; the carriage motor is used for pulling slack when setting chokers
- For crosshill or downhill yarding, the halfback is attached for controlling the carriage on the inhaul and pulling the carriage out on the outhaul phase of the cycle
- An accumulator system charges the skyline lock on the outhaul and the lock is radio-controlled

Radio-controlled carriage - no haulback

Radio-controlled motor-driven self-contained yarding carriage

- The motor and winch in the carriage yards the logs to the carriage
- Some of these carriages can carry 230 meters (750 feet) of dropline
- The carriage operator/rigging slinger controls the carriage winch by radio when the chokers are being set and the logs are being yarded to the carriage
- This carriage can be used for uphill, downhill, and crosshill yarding; the haulback is used to control the carriage during downhill or crosshill yarding
- Gravity pulls the mainline and carriage downhill during uphill yarding
- These carriages do not require a skyline lock
- These carriages can also be used to lower turns to a landing on the mainline brake, instead of pulling them up-hill to a landing if the terrain will allow it

Radio-controlled carriage with haulback attached

Radio-controlled self-propelled carriage

- Radio-controlled self-propelled carriage can be used in uphill, downhill, and crosshill yarding
- The carriage contains its own winch and dropline cable
- The carriage propels itself along the skyline using the winch motor; no mainline or haulback is required
- The skyline may be rigged so that it may be slacked down under full load in the event of motor problems on the carriage
- The unit is radio-controlled and works best with full log suspension

Radio-controlled self-propelled carriage – no haulback

Carriages (Tower)—Self-Quiz

1. A slack skyline carriage is only suited for uphill yarding.

   ☐ True

   ☐ False

2. The shotgun carriage is the simplest of the skyline carriages.

   ☐ True

   ☐ False

3. A radio-controlled motor-driven self-contained yarding carriage does not require a skyline lock.

   ☐ True

   ☐ False

4. A mechanical slack pulling carriage on a running skyline contains its own winch and dropline cable.

   ☐ True

   ☐ False

Now check your answers on the next page.

Carriages (Tower)—Quiz Answers

5. A slack skyline carriage is only suited for uphill yarding.

   Answer: **False (This type of carriage is suited for uphill, downhill, and crosshill yarding)**

6. The shotgun carriage is the simplest of the skyline carriages.

   Answer: **True**

7. A radio-controlled motor-driven self-contained yarding carriage does not require a skyline lock.

   Answer: **True**

8. A mechanical slack pulling carriage on a running skyline contains its own winch and dropline cable.

   Answer: **False**

Key Point 2.5: Gravity Systems (Tower)

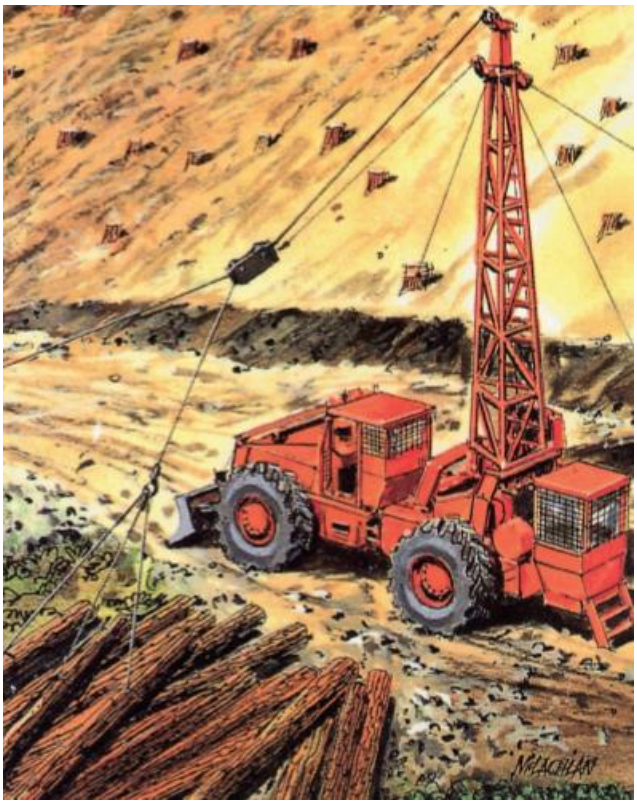
In certain situations, you may be able to use what is known as a gravity or shotgun yarding system. A gravity or shotgun system is useful because instead of requiring an outhaul system, the carriage and mainline are out-hauled by gravity.

In this section you will learn about more about what gravity systems are, as well as their advantages and disadvantages. Read the material carefully as you will need to be able to demonstrate knowledge of this topic.

Shotgun system on a skyline

The shotgun system is a simple, two-drum cable logging system for uphill yarding.

The mainline of the yarder is used as a slack skyline. The haulback is used as a mainline. The haulback is attached to a simple carriage that rides up and down on the skyline. Gravity pulls the carriage and mainline down the hill. The chokers are suspended from the bottom of the shotgun carriage. When the haulback is used as the mainline, it should be clear of the skyline at all times. In order to prevent them from crossing or rubbing together, a Dutchman block may be needed to hold the skidding line (haulback) away from the skyline (mainline) as the haulback fairlead is at the top of the boom or pipe and the mainline fairlead is lower and the mainline drum is closer to the tower or pipe.



The shotgun system uses the haulback as a mainline and the mainline as the skyline. A high-lead yarder must be designed for shotgun logging.

A shotgun system does not require an outhaul system. The carriage and mainline are outhauled by gravity. After the turn is unhooked in the landing, the operator tightens up the skyline, ensuring it is held securely by the brake. The operator then releases the mainline brake, and the carriage travels down the skyline. When the rigging crew signals “stop,” the operator applies the mainline brake and slacks the skyline until a “stop” signal is given. When the turn reaches the landing, the operator disengages the skyline brake and slacks the skyline to land the turn. The cycle is then repeated.

Some of the advantages of the shotgun system on a live skyline are that it:

- Is fast on the outhaul portion of the yarding cycle
- Achieves significant fuel savings with the use of gravity for the outhaul portion of the yarding cycle
- Reduces product damage
- Reduces rig-up and road change time
- Creates no haulback bight
- Permits 100 percent suspension if deflection is adequate
- Allows for longer yarding distances with adequate deflection

Some of the disadvantages of the shotgun system on a live skyline are that it:

- Can only be used for uphill yarding where adequate deflection and chord slope exists

- Limits the width of the yarding road to the length of the chokers
- Requires specialized skill for payload calculation long yarding

Rigging up a gravity skyline system

To rig a gravity skyline system, complete the following steps:

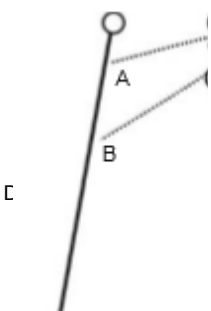
1. Run strawline (dotted line).

2. Hook one end of strawline to skyline.
3. Ahead on strawline to pull skyline past tailhold.

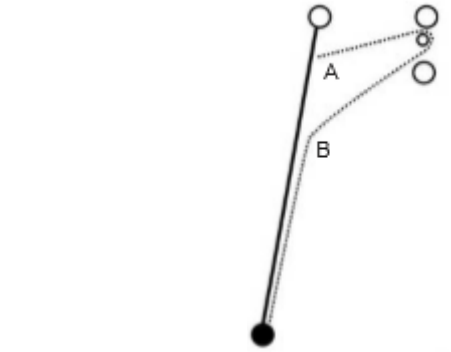
4. Disconnect strawline and hook skyline to tailhold.
5. Tighten skyline.
6. Pull strawline to landing.

Changing roads with a gravity skyline system

To change roads with a gravity skyline system, complete the following steps:

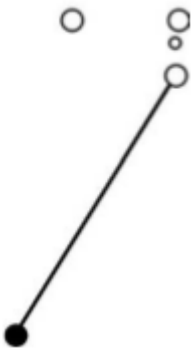


7. Layout section(s) of strawline as shown.
8. Hook strawline to carriage on landing.



9. Use carriage to pull strawline from landing to point B.
10. Hook strawline to strawline extentions at point B.
11. Take carriage back to landing.
12. Drop skyline.
13. Kick skyline loose of stump and pull skyline to point A.

14. Hook strawline section(s) to skyline at point A.
15. Go ahead on strawline to pull skyline past new tailhold.
16. Disconnect strawline and hook skyline to tailhold.



17. Tighten skyline.
18. Pull strawline to landing.

Gravity Systems (Tower)—Self-Quiz

1. A gravity system on a live skyline can permit 100% suspension if deflection is adequate.

   ☐ True

   ☐ False

2. The last step in a road change for a gravity system on a live skyline is to tighten the skyline.

   ☐ True

   ☐ False

Now check your answers on the next page.

Gravity Systems (Tower)—Quiz Answers

1. A gravity system on a live skyline can permit 100 percent suspension if deflection is adequate.

   Answer: **True**

2. The last step in a road change for a gravity system on a live skyline is to tighten the skyline.

   Answer: **False (The final step is to pull the strawline to the landing)**

Key Point 2.6: North/South Bend (Tower)

Side blocking uses a standing or a live skyline, a mainline, and a haulback to pull the skidding line (mainline) and buttrigging out to the turn. The system is used to expand the logging road without changing roads and is good for picking up small corners or areas between roads.

The mainline passes through the sheave of the fall block and continues up to the non-motorized carriage on the sky line. The gooseneck of the fall block is then attached to the front of the butt rigging. Connection to the skyline carriage allows full or partial suspension. A simple non-motorized carriage is typically used.

The two simple side blocking systems (north bend and south bend) are easy to set up from a high-lead system. The south bend differs only by adding a sheave below the carriage where the mainline passes to provide additional lift.

You need to be able to demonstrate knowledge of both the north and south bend systems.

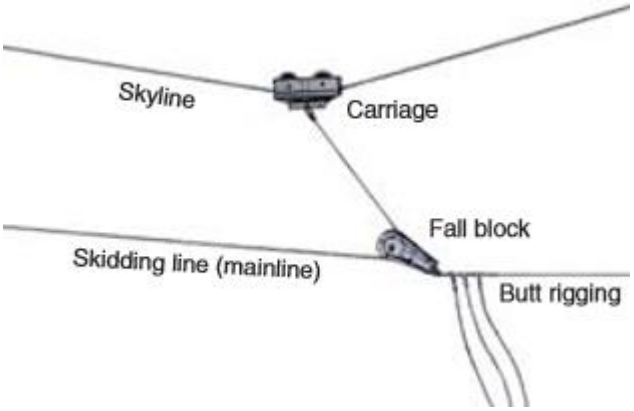
North bend

The north bend is a yarding system where the mainline passes through a fall block, then connects to the carriage; allows side blocking and extra block purchase for lift.

Northbend

The north bend skyline system is primarily used when one-end suspension of the log is required. During the yarding process, the haulback can be tensioned and the turn can be lifted; if adequate

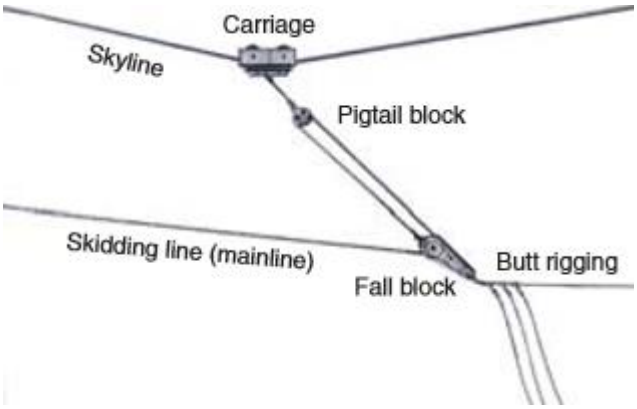
deflection and clearance are available, the turn can be fully suspended. North bend systems work well in an uphill yarding mode or on a level or moderate downhill slope.



Parts of a north bend-rigged skyline carriage system.

South bend

The south bend skyline system is mainly used in downhill yarding. The rigging is primarily the same as a north bend except that an additional block – the pigtail – is used. The mainline is passed through the fall block, up and around the pigtail sheave, and down to the carriage, where it is anchored. This manner of rigging applies an additional 2 and a half block purchase on the carriage, providing more lift during downhill yarding.



Parts of a south bend-rigged skyline carriage system.

Working in the bight

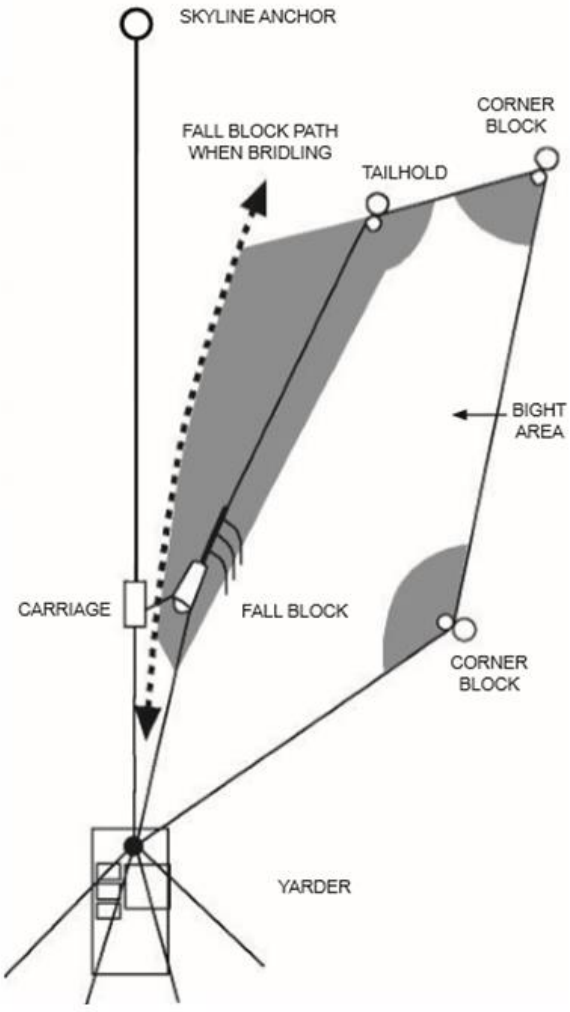
In side block and fall block systems, the skyline being pulled to the side is not as much of a concern as the huge bight area created by the side blocking. The angles and extra line in the system can make it confusing for the ground crew to figure out where to get in the clear. Also, the sideways arc in the rigging during outhaul can make spotting the rigging more difficult for the rigging slinger. The carriage may need to be stopped some distance before the hook-on point and slowly advanced to judge the final position.

The arc in the path of the carriage depends on the type of lateral yarding system. Usually, there is no side pull until the rigging reaches the logging area, which makes it difficult to judge the path away from the normal road line. During inhaul, the tension on the haulback may be used differently according to the load, and the arc of the rigging will move on a different path.

With any of the lateral yarding systems, you must use extra caution to limit exposure to the bight. Get in the clear farther from the turn to account for the extra line lengths that produce a much larger hazard area. When working near the haulback tailblock, move well clear in case a block fails.

IMPORTANT!

Always be aware of your surrounds and always be in the clear.



Potential bight areas when side blocking (shaded)

North/South Bend (Tower)—Self-Quiz

1. When using a north or south bend, the sideways arc in the rigging during outhaul can make spotting the rigging more difficult for the rigging slinger.

   ☐ True

   ☐ False

2. A north bend configuration is best suited for steeper, downhill yarding.

   ☐ True

   ☐ False

3. How much extra block purchase is provided by a south bend configuration?

   ☐ One block

   ☐ Two blocks

   ☐ Two and a half blocks

Now check your answers on the next page.

North/South Bend (Tower)—Quiz Answers

1. When using a north or south bend, the sideways arc in the rigging during outhaul can make spotting the rigging more difficult for the rigging slinger.

   Answer: **True**

2. A north bend configuration is well suited for steeper, downhill yarding.

   Answer: **False (A north bend is well suited for uphill yarding, or a level or moderate downhill)**

3. How much extra block purchase is provided by a south bend configuration?

   Answer: **Two and a half blocks**