NE-TF 1
ROPE RESCUE

Instructor Introductions

Class Introductions

Presented by NE-TF1

NE-TF 1 INSTRUCTORS

OBJECTIVES

- Knowledge of rope rescue language and terminology
- Knowledge of rope types and strengths
- Knowledge of rope software and hardware
- The ability to tie certain knots and hitches
- The ability to construct systems:
  - Anchors, Belays, Repel, Lower/Raising, Mechanical Advantage (MA), and Highlines

CARDINAL RULES

- Never, never step on the rope!
- Always have a safety check of the system before loading
- Always use the terms:
  - STOP and GO
  - Raise and lower
  - Slack and Tension
  - Belay and Repel

MODULE 1

- Positions
- Terminology
- Communication Commands
- PPE
- Crush Syndrome
- System Safety Ratio
- Ropes, Knots, Hitches
- Software and Hardware

POSITION DESCRIPTIONS

- Incident Commander – On scene commander
  - May or may not be a Technical Rescue Specialist
  - Coordinates with Rescue Supervisor and helps develop action plan (IAP)
  - Oversees overall rescue and recovery operation
  - Assigns personnel
  - Responsible for accountability and requesting additional resources

POSITION DESCRIPTIONS

Safety Officer

- Ensures safe procedures are followed
- Responsible for stopping unsafe operations
- Ensures non-essential personnel are kept out of immediate rescue area

Rescue Group Supervisor

- Responsible for immediate rescue
- Determines rescue systems to be used
- Performs secondary check of rescue system before going live

POSITION DESCRIPTIONS

Belay Attendant

- Operates the belay or safety line (first person to be asked if ready!)

Main Line Attendant

- Operating the main line (becomes haul team leader during raising ops)

Edge Attendant (Controller)

- Maintains positive communications with rescuer during all phases of the rescue, controls the lowering/raising of rescuer/victim (may be Rescue Supervisor)

POSITION DESCRIPTIONS

Rescuer(s)

- Person(s) on rope or at risk who performs according to rescue plan

Medical

- Personnel standing by for medical needs

TERMINOLOGY

- Rappel – controlled descent using friction
- Rappel Line – line used to directly lower rescuer/victim
  - Could also be the lowering line
- Haul Line – line used to raise rescuer/victim
- Belay Line – second line used as safety line for rappel line
- “Dead Man” Safety System – safety system on the belay line which allows the system to automatically lockup preventing it from moving.

TERMINOLOGY

- Bombproof (anchor) – extremely strong, stable, and secure
- "BFR"
  - A slang term used by rescuers for a very large rock, but also includes big trees, vehicles, water tanks, stairwells, and other large, immovable objects. Size it not always the controlling factor as several times a large "immovable" rock pulled loose under rescue and even rappel size loads.
  - Literal meaning is "Big F***ing Rock"
- Friction Device – device such as brake bar rack or figure 8 ring used to create friction on rope for descent
- Shock Load – load resulting from rapid change of movement
- MBS – minimum breaking strength (varies with manufacturer

COMMUNICATION COMMANDS

- "Clear the Systems" – extra members clear the system area
- "Prepare to Lower/Raise" – check lines, attendants get in position
- "On Belay" – rescuer making sure belay line system and staff are ready
  - "Belay On" – attendant response if ready
- "On Rappel" – rescuer making sure rappel line system and staff are ready
  - "Rappel On" – attendant response if ready
- Climbing and Untying should be used by the rescuer

COMMUNICATION COMMANDS

- "Off Rappel" – rescuer alerting rappel line staff that line no longer needs attending as he is off-line
  - "Off Rappel" – acknowledging rescuer
- "Off Belay" – rescuer alerting belay line staff that line no longer needs attending as he is off-line
  - "Off Belay" – attendant response if ready
- "Reset" – ensure belay line is taught and system is set

COMMUNICATION COMMANDS

- "STOP" – Attendants stop motion, respond with "STOP," and set safety device
  - Also indicated by closed and raised fist
- "Lower" ("down-rope") – begin lowering
  - Also indicated by making circular motion with index finger as it is pointing down
- "Raise" ("up-rope") – begin raising
  - Also indicated by making circular motion with index finger as it is pointing up

COMMUNICATION COMMANDS

- Other Options
  - Vertical Environment
    - “Up” (may include rope color, i.e., “up on blue”)
    - “Down” or “slack”
    - “Stop”
  - Horizontal Environment (i.e. Highline)
    - “In”
    - “Out”

PPE

- Rope Rescue Helmet
- Eye Protection (ANSI)
- Gloves
- Long Pants/Long Shirt
- Boots (No soft shoes)
- Harness (Class 1,2,&3)

- Personal Care
  - Hydration
  - Shelter
  - Warm or cool station
  - Rehab
  - Self Sufficient

CLASS 1

- Class I - a pelvic harness designed for *escape*
- Must be 2” webbing

CLASS II SEAT HARNESS

- Class II: A seat harness meant for heavy-duty work by one person or in rescue situations in which another person's weight may be added
- A tied emergency seat harness ("hasty harness") may be used in a pinch.
- Webbing should be wide (at least 2 inches)
- Should not slip down when you walk around
- Do not use a Class II if you have to invert, only use a Class III

CLASS III FULL BODY HARNESS

- Preferable to seat harness:
  - When involved in a dangerous activity – Rope rescues
  - When heavy equipment is worn
  - When person is of greater weight
  - During activities when it is necessary to stay upright
  - For placement on a subject in some rescue activities

CRUSH SYNDROME

- A potential medical consequence of harness suspension trauma
- Can lead to renal failure and other life-threatening conditions
- Rescuers can reduce the potential for harness suspension pathology by repositioning and moving about in the harness to facilitate blood flow.

SYSTEM SAFETY RATIO

Can be determined once you have determined the reasonable system load ratio

Apply a multiplier of the load to make up for inaccuracies and unknowns in your system analysis

The goal is to achieve the highest system safety ratio that is reasonable to rig in the given conditions with time and equipment constraints often beyond your control.

SYSTEM SAFETY RATIO

- Experienced rope technicians know:
  - The minimum breaking strengths of the various components they are using
  - The ways those minimum strengths can be affected by the rigging methods
  - The quality of anchors
  - The force multipliers both in and on the system

NFPA GUIDELINES FOR LIFE SAFETY ROPE

- The NFPA classifies life safety rope into four categories:
  - Escape rope
  - Technical-use rope
  - General-use rope
  - Moderate elongation laid life-saving rope

ROPE TENSILE TEST STANDARDS

- The Cordage Institute's CI1801, *Low-Stretch/Static Kernmantle Life Safety Rope*, can be used for comparisons by rope manufacturers who choose to follow it.
- Certain NFPA standards also apply to rope that is used by those who adhere to that organization's standards.

MINIMUM BREAKING STRENGTH

- Breaking strength:
  - The force at which an item breaks
- No two samples of any item are going to break at exactly the same force.
- Minimum breaking strength (MBS):
  - The minimum, or lowest, strength at which equipment is reasonably likely to fail

ROPES USED IN RESCUE

Kernmantle	Kern = core • carries the load imposed on the rope and holds up to 85% of the total load on the rope mantle = sheath • gives the rescue rope its durability and resistance to abrasion
Static (low stretch) Kernmantle (used for rappelling)	Fiber bundles run parallel Stretches no more than 20%
Dynamic (high-stretch) Kernmantle (used for safety line)	Made of twisted strands Stretches as much as 60%

STRENGTHS OF LIFE SAFETY ROPE (MBS)

- Tensile or Breaking Strength
  - 7/16” – 6,000 lbs
  - 1/2” – 9,000 lbs
  - 5/8” – 13,000 lbs
- Working Strength = Tensile / 15

INSPECTION AND CARE OF ROPE

- Use manufacturer's recommendations
- Inspect by looking and feeling
- New ropes inspected and a rope log created
- Rope should be retired based on experience and good judgment, used in conjunction with education
- Store in accordance with (IAW) manufacturer’s recommendations to avoid degradation from the environment
  - Sun, heat, exhaust, acid, hot concrete
- Rope can be washed by hand, with a commercial rope washer or in a front-loading laundry machine
- Document after use and inspection

SOFTWARE

- Webbing
  - Flat or Tubular
  - Used in place of or with rope
  - 1” = 4,500 lbs MBS
  - 2” = 6,000 lbs MBS
    - (Basket/Choker)
    - Used for anchoring

SOFTWARE

- Prusik cords
  - Formed using 6 to 9mm kern mantle rope
  - Ends connected using a double fisherman knot
  - Used in place of an ascender
  - 8mm chord has an MBS of 2875 lbs.
  - A Prusik loop has a MBS of over 5000 lbs, including the knots.
  - Two three-wrap prusiks (T3WP) have a MBS of 10,000+ lbs.
  - T3WP will slip, then grab again, at approx. 3500 lbs.
  - NOT pre-tied in the USAR cache

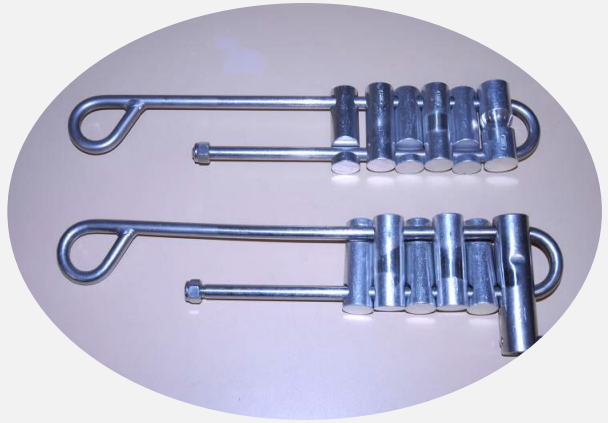
SOFTWARE

- Slings
  - Formed from nylon webbing w/ sewn in loops
  - Primarily used for lifting and moving
  - READ MBS in multiple forms, you don't was a sling as the weakest link in your system

HARDWARE

- Carabiners
  - Constructed of steel or aluminum
  - Used to connect rope/webbing to objects
  - Types & Strengths:
    - Steel – 6,700 lbs MBS
    - Aluminum – 5,500 lbs MBS
  - Gate always goes against body
  - Do NOT cross load or tri-load

- Figure 8 Plate (Descender)
  - Constructed of aluminum
  - Used for descent control
  - 6,000 lbs MBS
- Brake Bar Rack
  - 6,000 lbs MBS



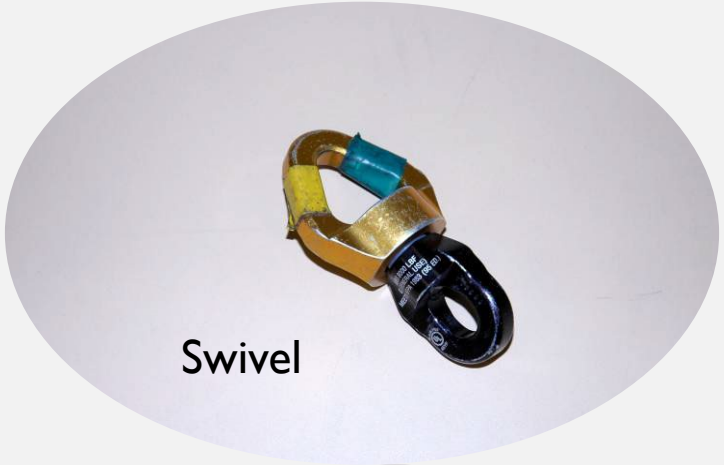
HARDWARE

- Pulleys
  - Constructed of aluminum
  - Used for mechanical advantage systems or change of directions
  - May be single,multi sheave, and or prusik minding
  - 8,000 lbs MBS

- Ascenders
  - Constructed of aluminum
  - Used for descent control and climbing
  - 5400 lbs. MBS
  - Can damage rope at pressures of 2000-3000 lbs.
  - In one test dropping a 200kg (440lb) load 10 inches, the rope was cut or severely damaged almost every time.
  - Our recommendation is to not use the Gibbs on a rope that could be subjected to high loads, or could be shock loaded.

ADDITIONAL EQUIPMENT

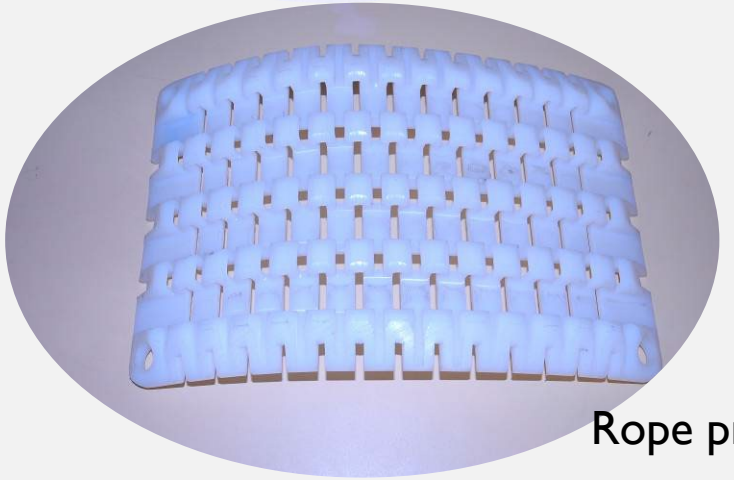
3:1 Z-rig



Swivel

Kootenay

Pick-off strap



Rope protectors

KNOTS IN THE HIGH-ANGLE ENVIRONMENT

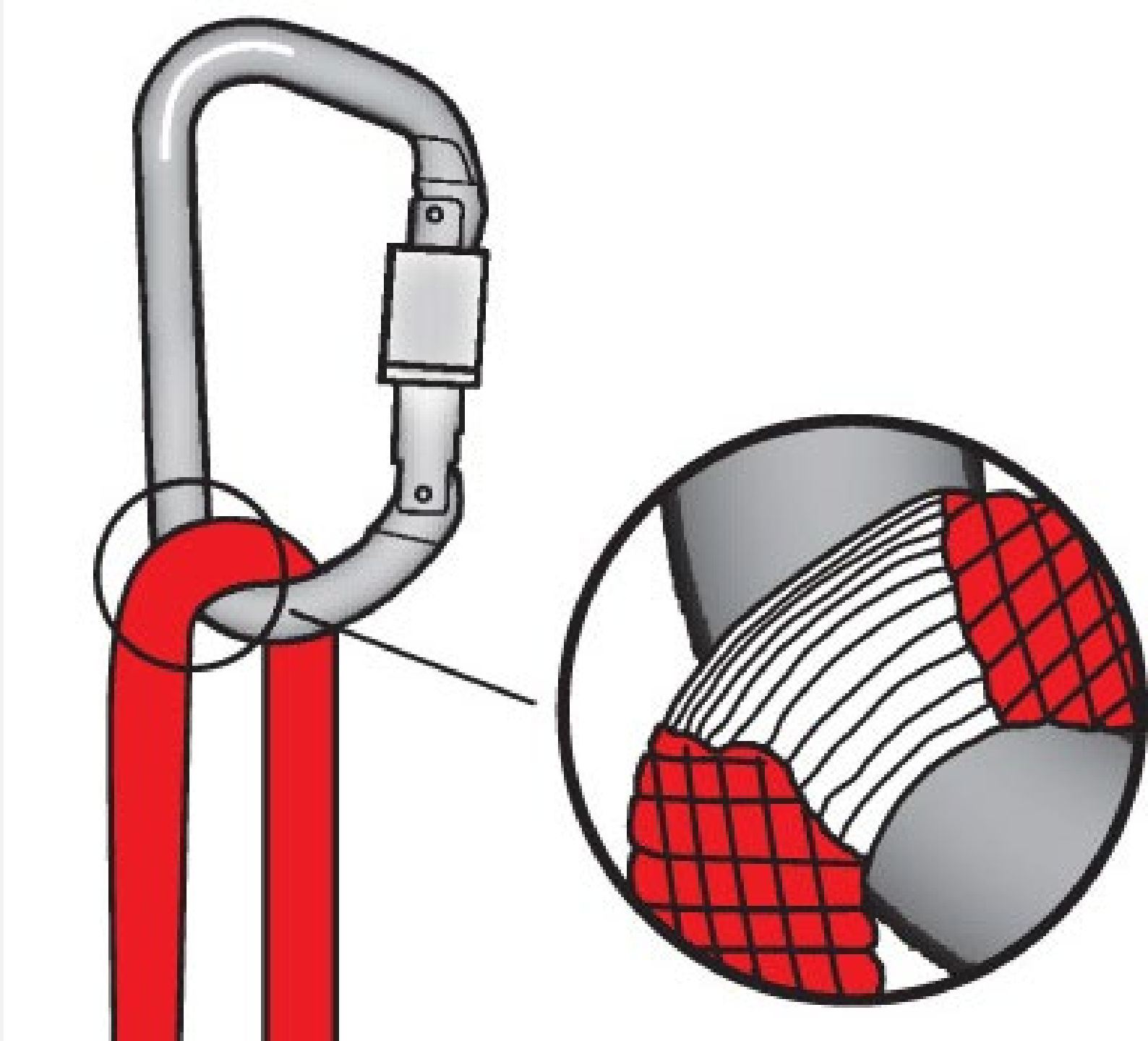
- The high-angle rope rescuer:
  - Must be able to tie knots correctly, confidently, and without hesitation
  - Must know the ways these knots are used
- You may be a danger to yourself, to a rescue subject, and to your fellow rescuers if you go into the high-angle environment without these knot skills.
- You must practice your knot-tying skills continually.
- You should own at least two lengths of rope for practice.
- Group training sessions for high-angle rescue work should begin with a review of knots.
- Every high-angle rope technician should be able to tie knots under stress.

KNOT USAGES IN THE HIGH-ANGLE ENVIRONMENT

- Anchoring
- Tying ropes together
- Tying webbing together
- Tying loops in rope and webbing
- Tying people directly into ropes
- Creating certain belay systems
- Dealing with emergency situations
- Backing up other knots
- Keeping rope ends from pulling out of equipment
- Ensuring personal safety
- Creating emergency ascenders
- Tying safety lines
- Improvising when other elements of a system fail
- Extricating yourself from unexpected difficulties

HOW KNOTS AFFECT ROPES

- Every knot diminishes the strength of rope somewhat.
  - The rope fibers on the outside of the bend carry most of the load on the rope.
  - The fibers on the inside of the bend carry very little of the load or none at all.



HOW KNOTS AFFECT ROPES

- Some knots have sharper bends, resulting in greater strength loss in a rope than occurs with knots that have more open bends.

Table 6-1 Examples of Strength Loss in Rope Tied with Typical Knots*

	Average Percentage of Original Strength	
	Bowline Knot	Figure 8 Knot
7/16-inch (11.1-mm) Static Rope	74%	78%
1/2-inch (12.7-mm) Static Rope	73%	80%

*These results are the average of four tests done with new PMI ropes 7/16 inch (11.1 mm) and 1/2 inch (12.7 mm) in diameter that were made in July 1990. Other test results may vary, depending on a number of factors such as the design of the rope, the manufacturer, and the test conditions.

KEY KNOT POINTS

- It is good practice to back up knots with a backup (safety) knot.
  - An overhand knot is often used for this purpose.
  - The double overhand knot is more secure.
- The backup should be tied as close as possible to the knot it is backing up
- Don’t leave big clip-in loops in knots if large loops are not needed.
- After a knot has been tied, it should be:
  - Dressed (the strands aligned and uncrossed)
  - Compacted (all ends pulled down so that the knot is compact)
- Be certain to dress knots correctly for the intended forces.
- Choose the correct knot for the load application.

KNOT-TYING TERMINOLOGY

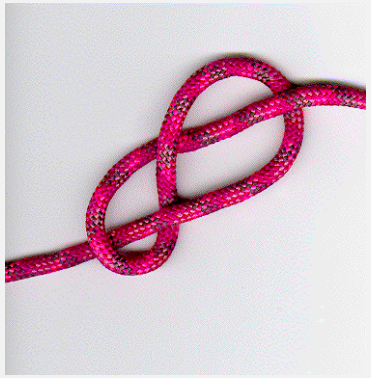
- *Bight*: A U-shaped section of rope with parallel sides
- *Hitch*: A knot that attaches to or wraps around an object or rope in such a way that when the object or rope is removed, the knot falls apart
- *Loop*: A portion of rope formed into a circle with the ends crossing one another
- *Running end*: The portion of rope used for lowering or hauling or that will touch the bottom when rappelling
- *Standing part*: The portion of rope between the running end and the working end
- *Turn*: A single pass of a rope behind an object
- *Working end*: The end of the rope that is used to tie and form the knot

COMMON KNOT NAMES

KNOT NAME	ALTERNATE NAME
Girth Hitch	Larks foot
Double figure 8 loop	Canadian 8, Double loop 8
Butterfly	Lineman's knot
Grapevine knot	Double fisherman's
Ring Bend	Water knot

KNOT THEORY
INHERENTLY TIGHT AND NOT INHERENTLY TIGHT

- Inherently Tight
  - Figure 8 Family
  - Double Fisherman's
  - Butterfly
  - Water Knot (?)



- Inherently Not Tight
  - Clove Hitch
  - Bowline Family
  - Square Knot
  - Granny Knot (square knot done wrong)

FIGURE 8 FAMILY

- Simple Figure 8 (for Rope)
  - Used as a stopper knot for certain types of security
- Figure 8 on a Bight (for Rope)
  - A bight is simply the loop formed when the rope is doubled back on itself.
  - A figure 8 on a bight is used as a secure loop in a rope for clipping in hardware.

- Figure 8 Follow-Through
  - Used to create a loop at the end of a rope when a figure 8 on a bight cannot be tied
  - Always begin with the tying of a simple figure 8 knot well back from the end of the rope.
  - After the simple figure 8 has been tied:
    - Pass the end of the rope around the anchor point, then follow back through, parallel to the first knot
    - Follow every contour of the first knot with both rope ends going in the same direction

FIGURE 8 FAMILY

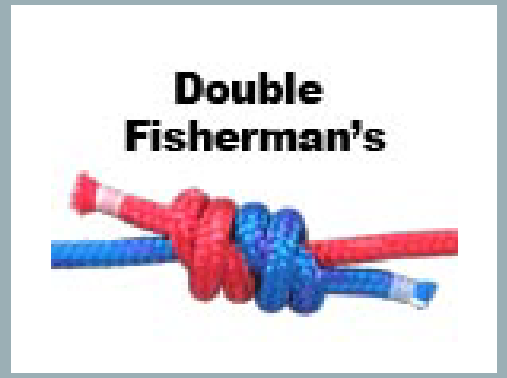
- Inline Figure 8 (Inline Figure 8 Loop)
  - Used to create a loop in the middle of the rope
  - Also used to create handholds for a haul line and to create an additional anchor point
  - This knot should be loaded in only one direction; otherwise it can capsize and fail.
- Double Figure 8 Loop (Canadian 8/Double loop 8)
  - Used to equalize a load on two anchors

FIGURE 8 FAMILY

- Figure 8 Bend (for Rope)
  - Used to join two ropes or the two ends of one rope in order to:
    - Connect two pieces of rope
    - Create a loop of rope by joining the two ends of one rope
  - Tips for tying:
  - First, try tying this knot using two ropes of different colors.
  - Then follow the contour of the first knot exactly, with the rope ends approaching from opposite directions.

OTHER ROPE RESCUE KNOTS

- Clove Hitch
  - Used to secure a rope to an object
    - Around an object
    - Over an object
- Double Fisherman's
  - Used to create a prusik cord
- Butterfly Knot
  - Two directional knot
  - Can be tied wrong and is prone to slipping
- Water Knot
  - Used to join two ends of webbing



MODULE 2

- Anchoring
- Belay systems
- Ascending Rope

ANCHORING

Anchors are the most critical and difficult part of rope rescue systems to learn and implement. Extreme caution must be used in selecting and establishing your anchors.

The first consideration that must be calculated is the location of the victim or the "vector" in which the load is to be lowered or raised from.

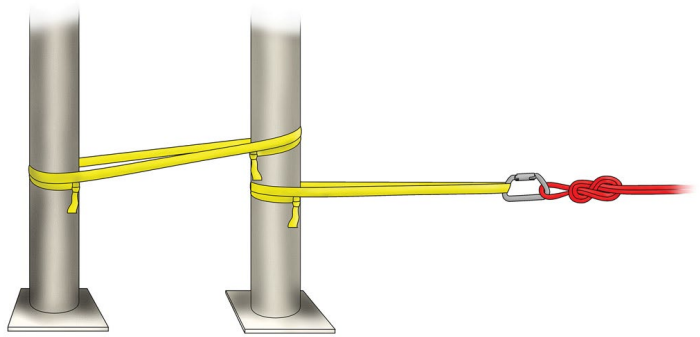
All anchors must be "bombproof." All anchors must meet or exceed the 15:1 safety margin established by the NFPA.

Even "bombproof" anchors should have a backup.

½" rope and rescue carabiners have a MBS of 9000 lbs.

An anchor should be at least that strong.

A system should never fail at the anchor.

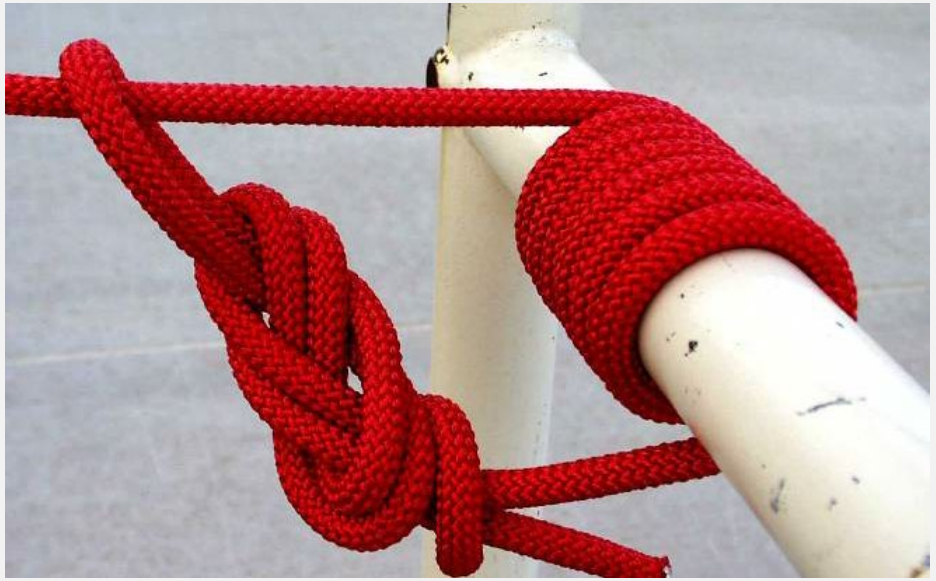


ANCHORING

- The “strongest” anchor should be the safety rope line, allowing for a failed main and thereby shock loading the safety anchor point.
- The main anchor needs to have room for a raising system and a location for haulers to pull too. Therefore, it is usually placed back from the edge and still in line with the safety anchor.
- Guardrails, vehicles, trees, large rocks, etc are commonly used as BFTS or BFR’s. Do not use trailer hitches or tow hooks as anchor points off vehicles. The point of attachment would not be *closed*. Slack could cause the system to detach. Use main frames or axles for stable points of attachment.

ANCHORING

- Use knots which minimize strength loss (figure 8 on a bight, Canadian 8)
- Better yet, take the knot out of the anchor ("tensionless" anchor, wrap-3-pull-2)
- In-line anchors are better than side-by-side anchors.
- Self-equalizing anchors rarely completely equalize.
- Failure of one anchor shock loads the system, and alters the position of the main line.
- The angle of the anchors should be as small as possible.



ANCHOR TIES

Tensionless (min. of 3 wraps, highline, maintains full rope strength)

Redundant wrap (provides 2 anchor points with 1 piece of webbing)

Wrap 3 pull 2

Wrap 2 pull 1

Basket (Easiest)

Figure 8 follow through

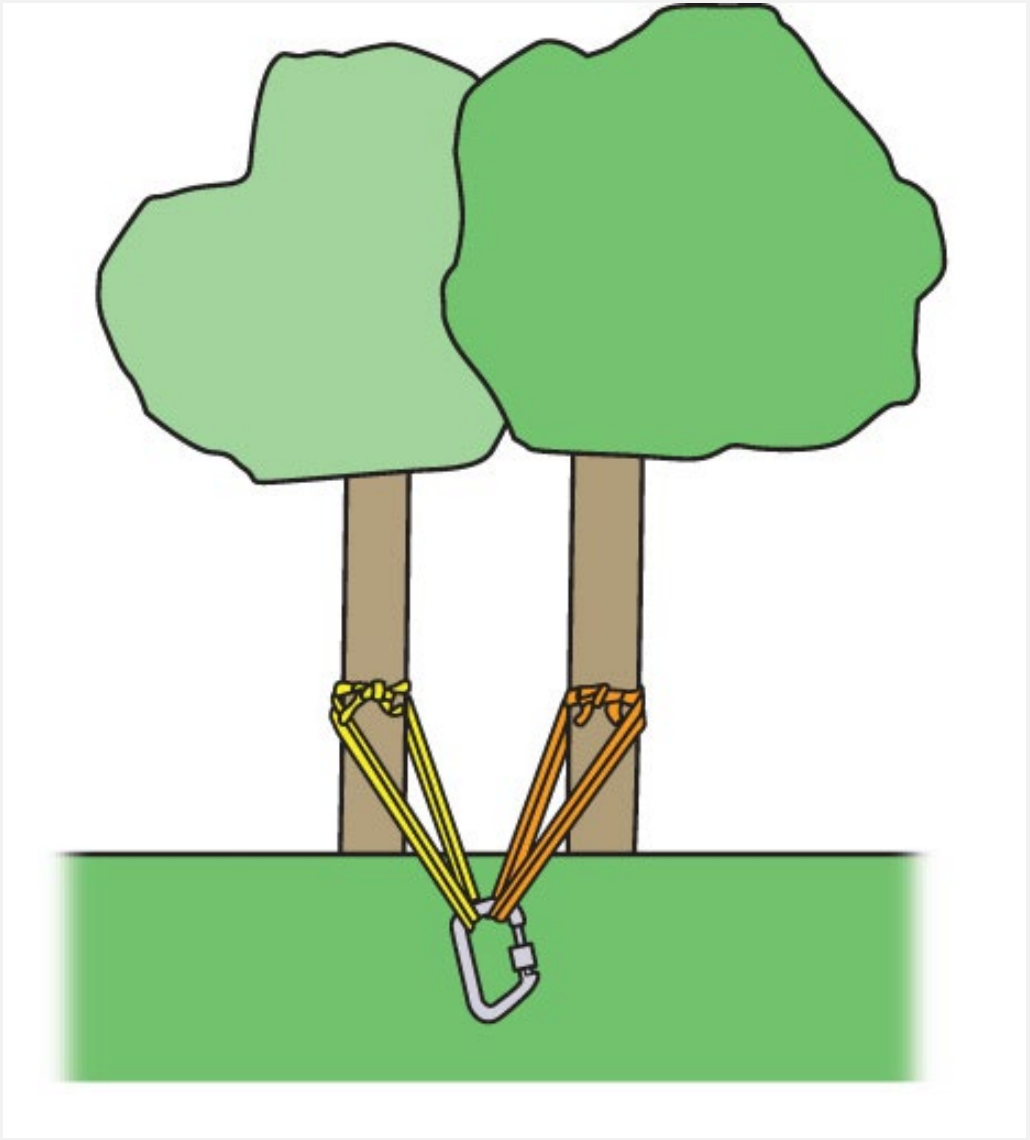
Canadian 8 (Offset)

Rigging slings do not provide adequate strength

No girth hitches or choker hitches

LOAD SHARING ANCHOR

- May be a solution if anchor points are at all questionable or are inconveniently placed
- The point where you clip the two lines together with the carabiners is known as a master attachment point.



LOAD-DISTRIBUTING/SELF EQUALIZING

- No anchor system can be made completely "self-equalizing."
- LDAs are not for casual use in rescue.
- These systems should be used only when there are no other options (e.g., load-sharing or extending anchors)
- Keep the angles small.
- Design the systems so that as little drop as possible would occur should any anchor fail.

BELAY SYSTEMS

- Main safety component
- System should "catch" automatically (whistle test)
- Must have a load releasing hitch
- A belay that is both apart from the main lowering system and on a separate anchor
- Two separate lowering lines that back up one another
- The systems should be rigged so that these two elements:
  - Do not interfere with each other
  - Become entangled
- However, they should be close enough together to prevent a dangerous pendulum should the main line fail and the belay be forced to catch the load.

BELAY SYSTEMS

- Belayers must use belay devices that allow them to hold the weight of the rescue load plus any force from shock loading.
- Devices for belaying rescue loads include, but are not limited to:
  - The 540° Rescue Belay (Traverse Rescue)
  - The MPD (multi-purpose device) (CMC Rescue)
  - The Quadra (heightec)
  - The I'D S (Petzl)
  - Belay systems such as the tandem Prusik belay

ASCENDING ROPE

Builds confidence in rope rescue

Used for emergency escaper while on rope (jammed decent device)

Always done while using a belay system

1 long and 1 short prussik will be used (Ascenders can be used but pose problems)

Prussik can either be 2 or 3 wrap

Require more use of your legs and feet and less use of your arms and hands

MODULE 3

- Rappelling
- Friction Devices
- Rappel Pickoffs
- Lowering
- Lowering Pickoffs

RAPPELLING

- The controlled descent of a rope using the friction of the rope through a descender as the means of control
- A necessary skill for operating safely in the vertical environment
- Learning safe, controlled rappelling skills is a step toward developing vertical competency.
- Rappelling stance

- An important sign of a person's competence in rappelling
- Includes the ability to:
  - Control the descent with minimal physical effort.
  - Rappel in a controlled manner so that the rope is not damaged by heat build-up in the rappel device and anchors are not damaged by shock loading.
  - Stop the rappel at any time.
  - Tie off securely and operate with hands free of the rope and rappel device.
  - Operate in any body position (including inverted).

GETTING OVER THE EDGE

Usually, the most difficult part of a rappel is getting over the edge.

However, getting over the edge of a wall or cliff frequently presents a physical challenge as well.

Several techniques can help you get started over the edge (e.g., the Butt Thrust and Knees Over Edge.)

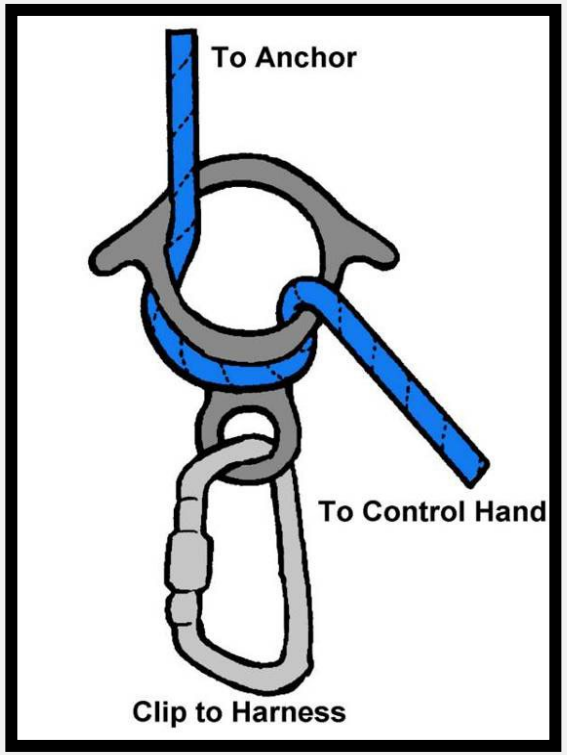
You never attempt any these techniques for the first time without a top belay.

CLEARING THE DESCENDER

- As you clear the edge on a rappel, the descender must also clear.
- Otherwise, the descender may become jammed.
- When you are backing over the edge in a rappel, always:
  - Observe the position of the descender
  - Make sure it is going to clear the edge

FIGURE 8 DECENDERS

- Involves preparation, attaching the figure 8, starting the rappel, locking off, and unlocking
- Must be practiced first on level ground, then on a slope, and finally on a vertical face under the guidance of a qualified instructor
- A top belay must be used when on a steep or vertical face.
- May be referred as a rescue 8



THE BRAKE BAR RACK

Advantages:

- Offers greater friction, and therefore greater control
- Allows the friction level to be changed after the rappel has begun
- Longer drops can be rappelled more comfortably than with most other descenders

Disadvantages:

- Somewhat more complex so it takes a bit longer to attach to the rope
- Somewhat bulkier and heavier than some other descenders
- Can be incorrectly rigged by an inexperienced person

EXTRICATING JAMMED RAPPEL DEVICES

- Rappel devices are notorious for snagging loose material and becoming jammed.
- The rappeller may become stranded and may require a rescue.
- Possible problems include:
  - T-shirts and other loose clothing
  - Hair
  - Body parts (e.g., loose flesh on an underarm)
- Avoid using a knife to extricate yourself from a jammed rappel device.
  - It is very difficult to use a knife in such situations without damaging the rope or cutting it completely.
  - It is also difficult to use a knife to remove hair jammed in a descender without inflicting a scalp wound.
- One way out of such a situation is to take your weight off the descender by using an ascender or Prusik hitch above the descender.

PREVENTING A RAPPEL OFF THE END OF A ROPE

- You may face the danger of rappelling off the end of a rope.
  - Usually occurs when you cannot see the bottom of the drop before you begin the rappel
- One form of insurance against rappelling off the end of a rope is to use a stopper knot.
- This gives you something to stand in while you figure out what to do next.

PICKOFF TECHNIQUES

- A pickoff rescue involves a single rescuer who has direct physical contact with a rescue subject to remove the person from a hazardous situation.
- Other individuals may be involved in the rescue in support capacities.
- Teamwork and good communication are essential in a pickoff rescue.
- Pickoff rescue techniques do not usually involve the use of a litter.
- Pickoff rescue generally is performed only when the subject is uninjured or only slightly injured.
  - It is extremely difficult for only one person without a litter to rescue a seriously injured subject without complicating the injuries.
  - It is essential that pickoff rescuers evaluate and stabilize the subject's injuries before moving the individual.
  - The only exception to this rule may be the existence of an immediate threat to life.

BASIC TYPES OF PICKOFF RECUES

- There are two basic types of pickoff rescue:
  - Rappel-based pickoff
    - The rescuer rappels to the subject, attaches the subject to the rappel system, then rappels to a secure site
  - Lowering pickoff
    - The rescuer is lowered to the subject by other rescuers, the subject is secured, and rescuer and subject are lowered or raised to a secure location

BASIC SEQUENCE OF A PICKOFF RESCUE

1. Above the rescue, attach a rope to an anchor(s) that will sustain the weight of rescuer and subject.
2. Don a harness with leg and thigh supports and a large locking carabiner attached to the seat harness.
3. Attach to the seat harness carabiner a rappel device that has both variable friction and enough control to handle the weight of two people.
4. Clip a large locking carabiner onto one end of the rescue sling or adjustable rescue pickoff strap.
5. Rappel to the rescue subject.
6. Slow your rappel as you approach the subject so you can evaluate the situation.
7. Stop and tie off your rappel device when you are about above the subject.
8. Take the large locking carabiner at the bottom of the sling attached to your rappel system and clip it directly into the subject's seat harness tie-in point.
9. Remove the subject's original attachment point to his or her harness.
10. Have the subject put his or her full weight on your rappel system.
11. Rappel with the subject to the bottom.
12. Once at the bottom, get the subject's weight off your system.
13. Remove your rappel device from the rope.

LOWERING PICKOFF RESCUE

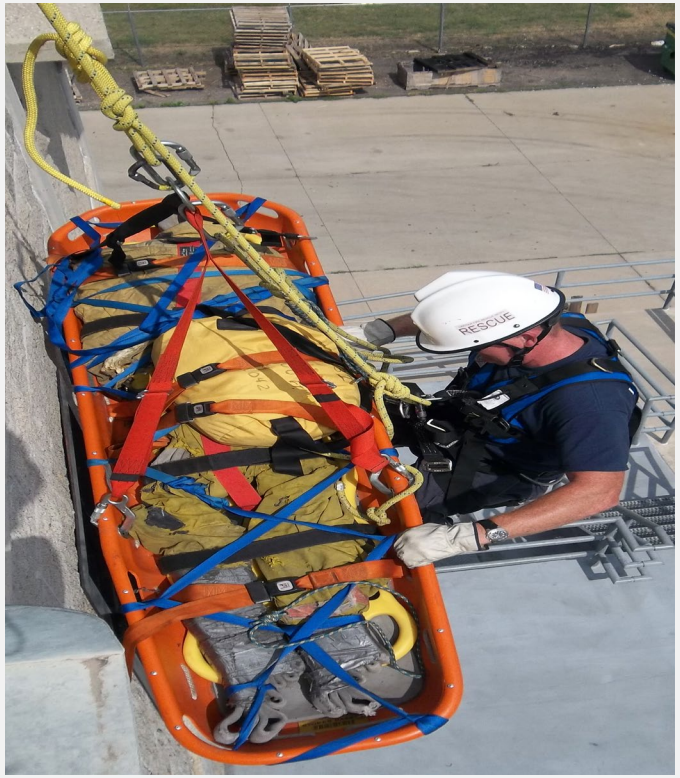
- In a lowering pickoff rescue, a team at the top lowers a rescuer to the subject.
- The procedure usually involves two ropes: a main-line rope for the rescuer and subject and a separate belay line.
- The lowering team lowers the rescuer to the subject.
- The rescuer attaches the subject to the main-line system and to the separate belay system.
- The team at the top then either lowers both individuals to the ground or converts to a haul system and hauls both to the top.

- **Advantages:**
  - It allows the rescuer greater use of the hand that otherwise would be used to control a rappel.
  - It may ensure greater control of the lowering.
  - It includes a belay.
- **Disadvantages:**
  - It requires more personnel.
  - It requires more complete communication.
  - It also requires team practice to coordinate the procedure.

MODULE 4

- Litters
  - Stokes
  - Sked
  - Patient Tie-Ins
- Litter Lowering
  - Converting from lower to raise
- Hauling Systems (M.A.)
- Directional / High Points
- Knot Passing

LITTER LOWER OR STOKES LOWER



STOKES BASKET

- Lash patient as shown in previous slides
  - Begin with center of 30’ webbing
  - Attach center of webbing to bottom of basket with a girth hitch or a couple round turns
  - Form clove hitch around each foot, with one loop going around foot and the other going behind ankle
  - Criss-cross webbing in diamond fashion, using half-hitch at rail attachment point
  - Finish at head of basket with double clove
  - If raising vertically, consider using webbing harness (or “swiss seat”) around pelvis, as seen in previous slides, to take weight off feet and legs

STOKES BASKET TIE IN

SKED

- The Sked often is easier to move through confined spaces than are basket litters because it conforms to the subject's size.
- Most Sked litters have an adaptable harness system that allows the subject to be transported either in the horizontal or the vertical position.
- The Sked can be rolled into a compact shape that is stored or transported in its own backpack

BASKET LOWERING

- Used when a victim is injured or otherwise needs packaging
- Requires teamwork and practice
- Lowering device should be a “general use” brake bar rack for any two person load

DOWN, DOWN VERSUS DOWN, UP LOWERING RESCUE

- In sizing up the rescue scene, rescuers must decide whether they will use a “down, down” or a “down, up” technique.
- Down, down pickoff technique:
  - Once the rescuer has reached the victim and secured the individual into the rescue system, at the signal of the rescuer, the team lowers both to the ground.
- Down, up pickoff technique:
  - Once the rescuer has secured the individuals into the system, both are then hauled to the top.

HAULING SYSTEMS

- Hauling systems can create tremendous stress on rope, hardware, and anchors.
- Hauling team members and other rescuers must keep in mind that forces exerted by the hauling team are multiplied on portions of the system.
- Higher MA systems could result in even higher forces.
- These forces can develop quickly and quickly lead to system failure.
- All rescuers must be aware of the forces they are creating and be constantly on guard against problems that may be developing.
- If a haul suddenly becomes difficult, do not simply pull harder.
- The system may have become jammed, and pulling harder may cause a failure.
- Stop the haul and examine the system for problems.
- As with all rescue operations, one person should act as safety officer, overseeing the safety of rescuers and rescue subjects.

MECHANICAL ADVANTAGE (MA)

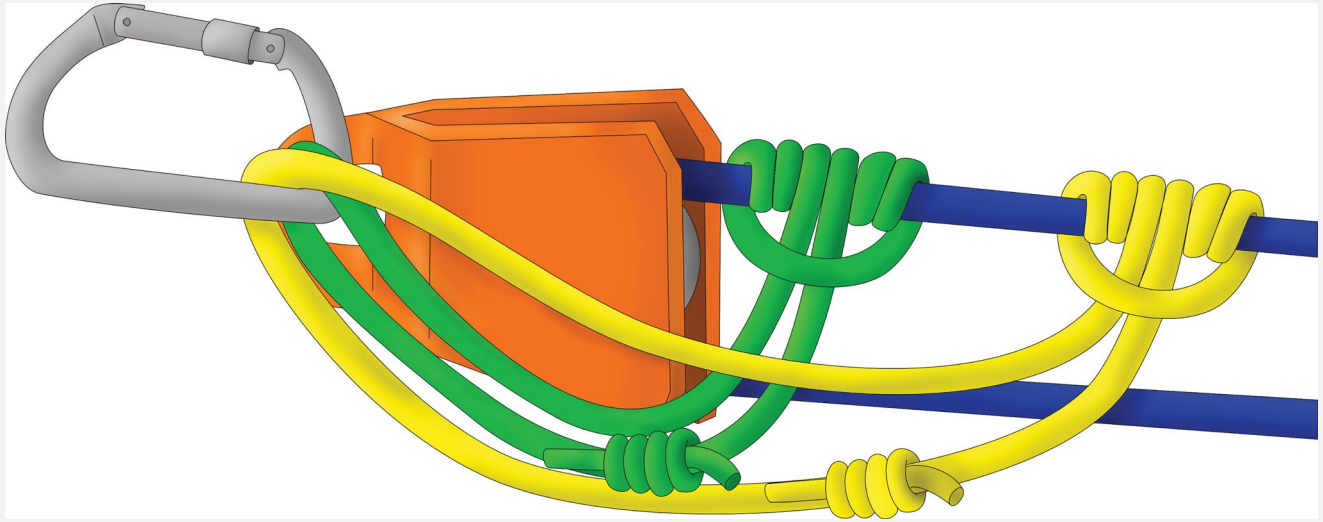
- Mechanical Advantage (MA) – the relationship between how much load can be moved, to the amount of force it takes to move it
- *Must* have moving (non-stationary) pulley to obtain MA.
  - Pulley is a circular lever.
  - 180 degrees – most efficient use of a lever
- A stationary or fixed pulley in only a change of direction.
- Too many changes of direction will make work harder.

MECHANICAL ADVANTAGE

- Count number of ropes coming off load to determine MA.
- If the end of the rope is tied to the load, the number will be odd.
- Simple Systems – 2:1, 3:1 (modified Z-rig), 4:1 (block & tackle), 5:1 (modified Z-rig)
- Compound Systems – using two simple systems together multiply the advantage (3:1 on 3:1 = 9:1)
- The two most used systems are the 3:1 (modified Z-rig) and the 4:1 (block & tackle)

ROPE GRABS (3WRAP PRUSIK)

- The most commonly used is the triple-wrapped Prusik hitch.
- The diameter of the accessory cord should be at least 2.5 mm smaller than the diameter of the rope it grips.
- If correctly sized and used, a three-wrap Prusik will hold until the accessory cord breaks or until it breaks the line it is gripping.
- A single Prusik (rather than tandem Prusiks) or two-wrap Prusiks (rather than three-wrap Prusiks) may be easier to operate as a main haul cam.
- Always test a system before using it in an actual rescue.



DIRECTIONALS

A directional pulley sometimes can be used to hold the rope above the edge and to protect against edge friction.

One way of anchoring a directional pulley is with a high directional.

TRIPODS

- Three-legged frames that can be used as high directionals
- One advantage is their ability to resist downward forces.
- Often placed over confined space openings, such as manholes, to raise a person in a rescue
- Relatively stable, but must be back-tied to prevent them from tipping over during the raising

ARIZONA VORTEX

Multi pod

Adjustable to many lengths

Different feet for many applications

True Strength

Can be used as:

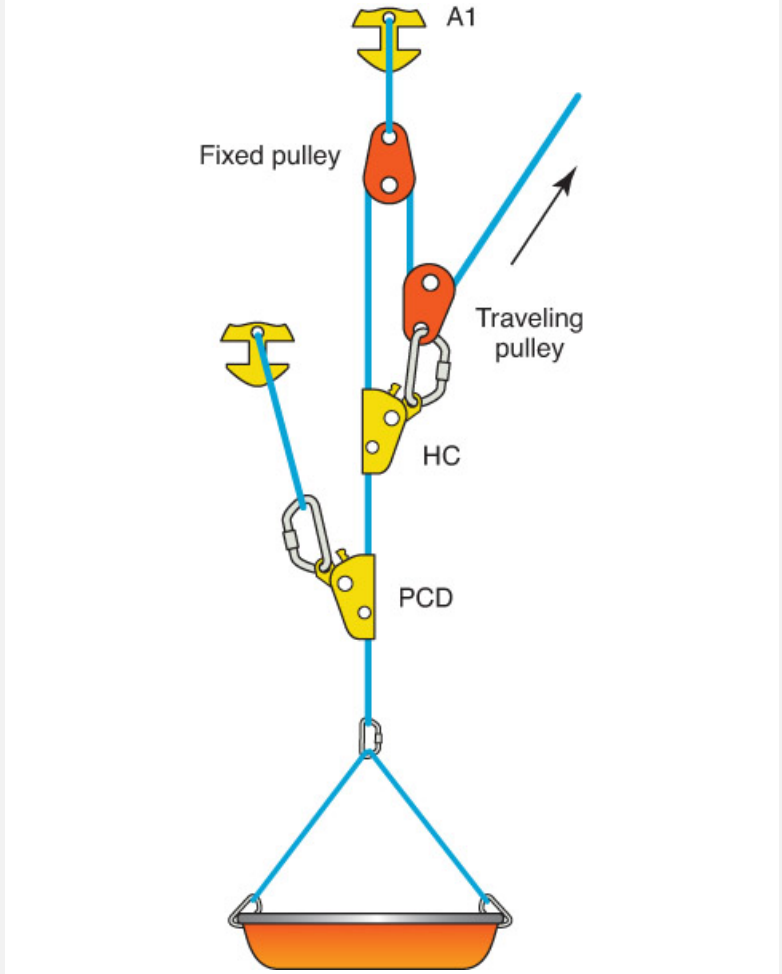
- Tripod
- Easel A
- Bipod

3:1 Z-RIG

This particular 3:1 system is commonly called a Z-rig because of the approximate shape the rope makes as it goes through the system.

Minimum equipment requirements include:

- One main-line rope
- Three locking carabiners
- Two pulleys
- Two rope grabs
- A separate belay system appropriate for the load to be hauled

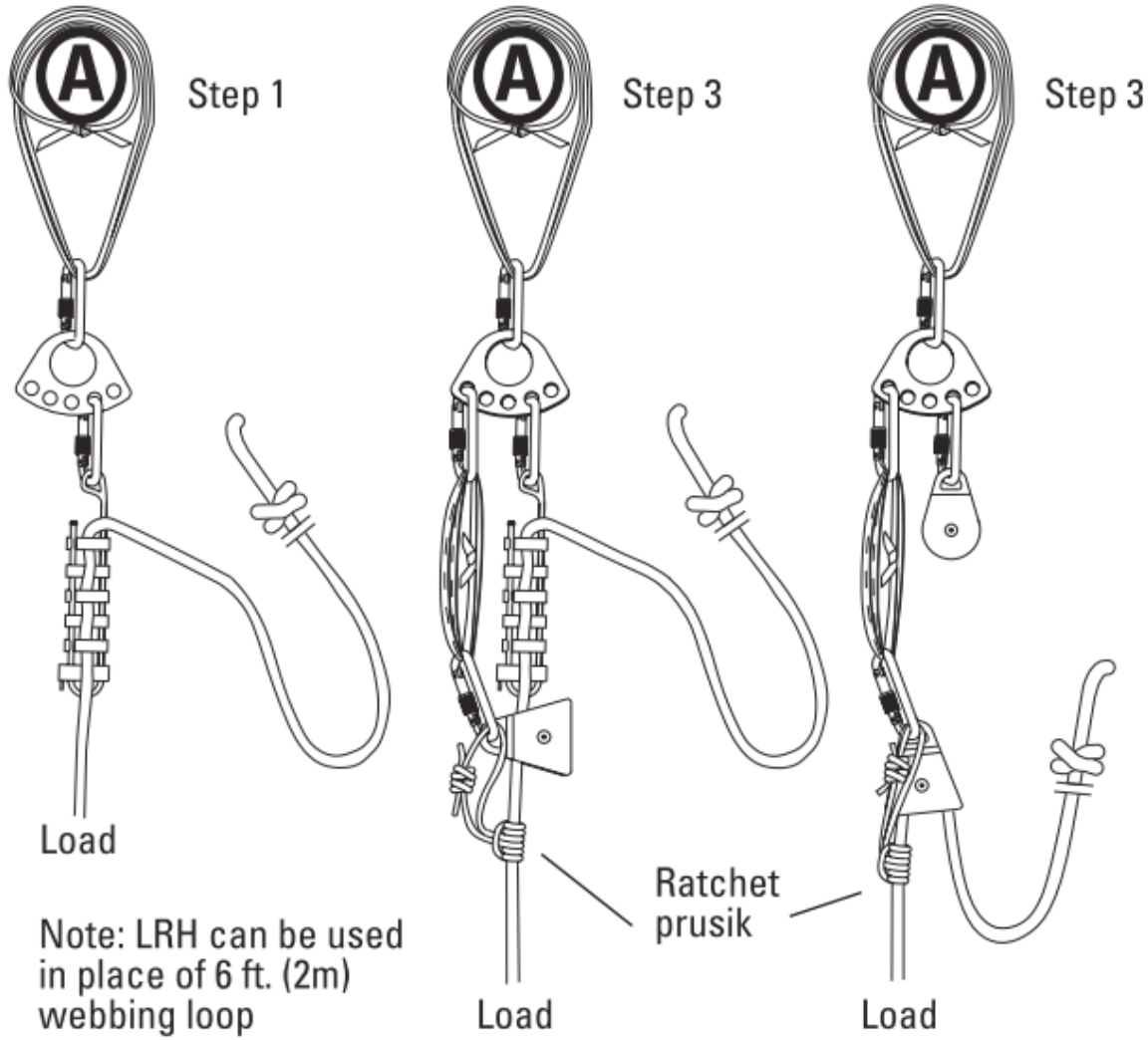


NE-TF1 3:1

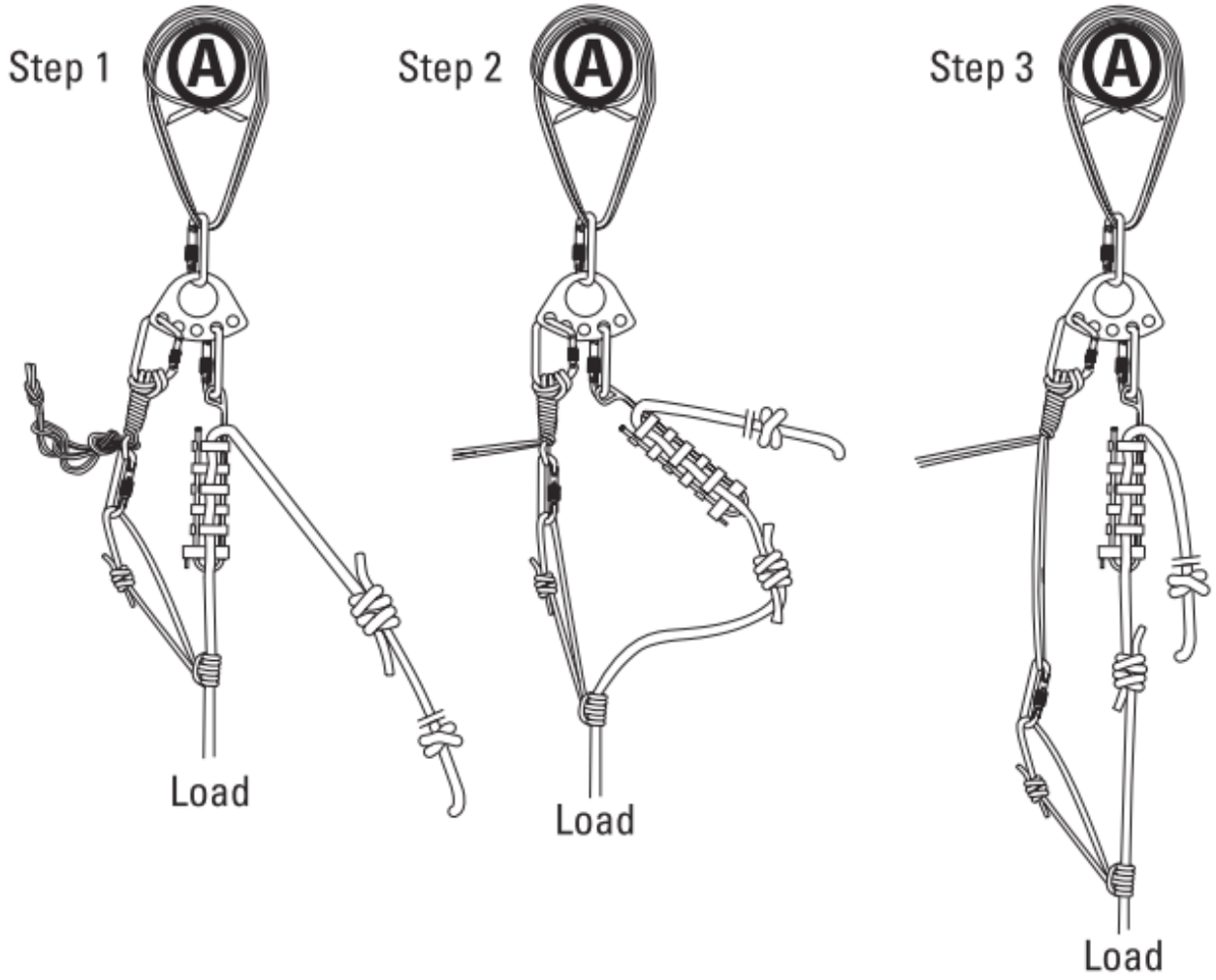
NE-TF1 BLOCK AND TACKLE 4:1

COMPOUND PIGGY BACK 9:1

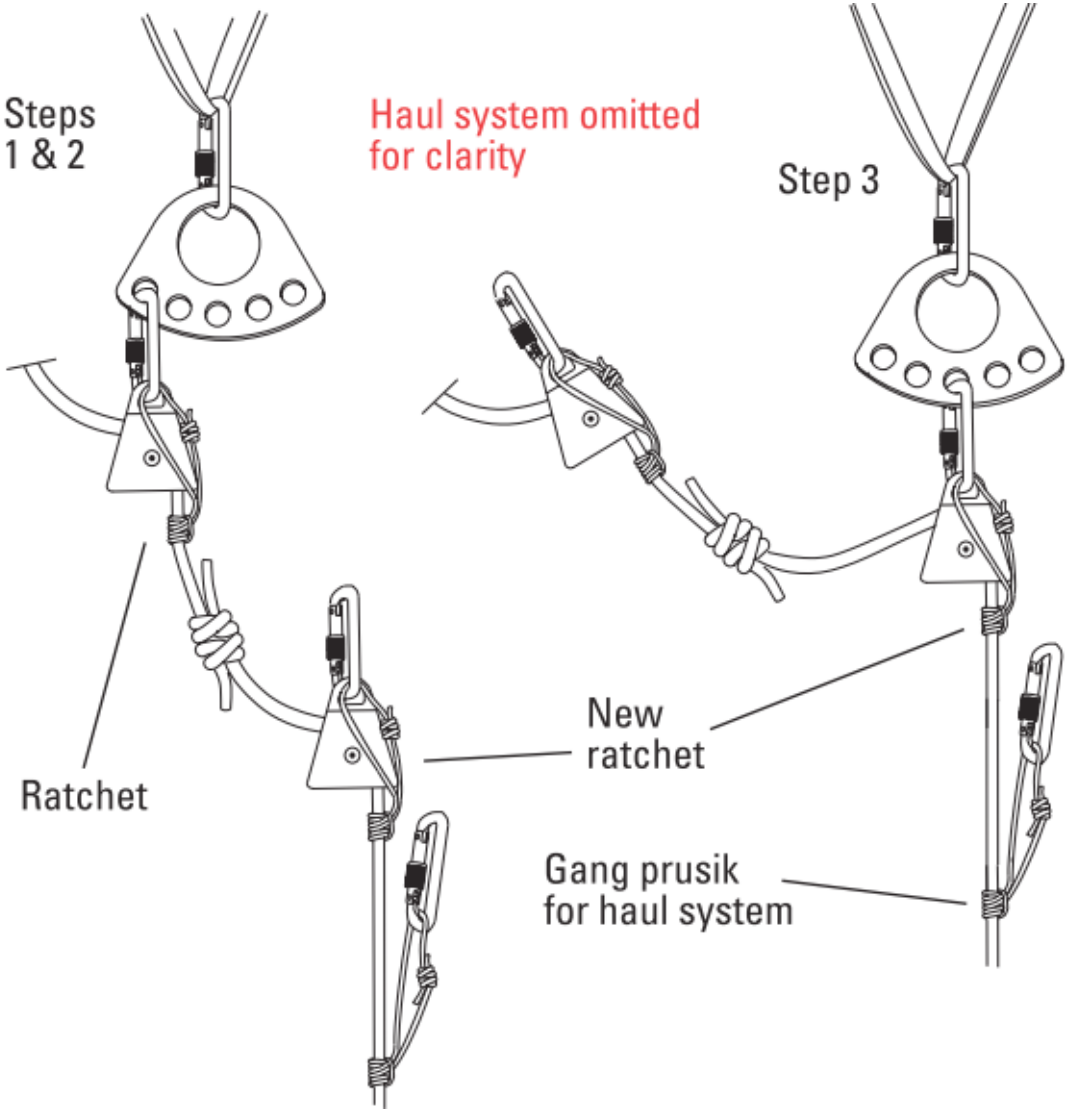
CONVERTING FROM LOWER TO RAISE



KNOT PASSING (LOWER)



KNOT PASSING (RAISE)



MODULE 5

- Highlines
- Low Angle

HIGHLINES

HIGHLINES IN RESCUE

- A highline is a rope line suspended between two points on which people, equipment, or other loads can be moved.
  - Also sometimes referred to as a tyrolean or a telpher
  - Can be simple or very complex to rig
  - A highline can be horizontal or steep-angle

HIGHLINE CARRIAGE SETUP

NEAR SIDE SETUP

FAR SIDE ANCHOR

- Main line tensionless wrap
- Double anchor strap for haul line

TRAVELING THE HIGHLINE