ROPE OPERATIONS MANUAL

Version 1 2006

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Scope

This procedure applies to all Clallam County Fire District No.3 members responsible for emergency response where there is the possibility of injury from a fall.

Purpose

1. To have all training and responses comply with WAC 296-305 Safety Standards for Firefighters, NFPA 1006 Rescue Technician Professional Qualifications, NFPA 1670 Operations and Training for Technical Rescue Incidents, NFPA 1983 Standard on Fire Services Life Safety Rope and System Components and all other applicable laws, regulations and standard.

2. To provide guidelines and procedures for responders so they can recognize a rope rescue emergency, hazards and basic rescuer actions.

3. To provide a reference for Awareness and Operations level training.

Clallam County Fire District No. 3 Mission Statement

Clallam County Fire District No. 3 is dedicated to excellence in serving, educating, and protecting our community through emergency medical services, fire suppression, and public education.

Technical Rescue Team Mission Statement

To make a safe, quick, positive difference in the care and rescue of citizens involved in incidents that require the application of special knowledge, skills, and equipment.

Respond Quickly
Make a Difference
Care about People
Be Nice
Come Home Safely

Definitions

Action Plan

The specific method of how members are to rescue/recover patients(s), created by the Rescue Group Leader after doing a complete size up and risk benefit analysis of the scene. This plan will have a contingency (plan B).

Anchor

1. A general term for the combination of anchor points, rope, webbing and other equipment to which rescue systems are attached.

2. The object that an anchor is attached to. Can be natural or man made.

Anchor Focus Point

A central point that is in line with the direction of force caused by the rescue system.

Anchor point

The place where a multi-point anchor or the legs of an anchor come together.

Angle

Degrees of incline which affect a rescue operation

Low Angle Rescue- (15°- 40°)

A non-technical rescue with minimal exposure and where the slope surface is stable. Four or five attendants are usually needed as they bear the entire weight of the stokes basket. Generally a modified belay line is connected to the stokes basket which is in turn connected to the attendants. This line can be used to haul the team up, but really is designed to keep the stokes basket from sliding down the hill should it be dropped. Considered Minimal to Low Risk.

Medium Angle Rescue- (40°- 60°)

An evacuation that uses a combination of high and low angle rescue systems to carry the patient out. The attendants will carry some of the load and some of the load will be carried by the mainline. Extreme Risk.

High Angle Rescue- (60°- +)

A technical rescue with significant exposure where there is a significant risk to the victim and rescuers should they slip and fall. The entire weight of the patient and attendants is supported by the mainline. Less extreme than medium angle.

Attendant

The rescuer that accesses the patient, provides necessary medical care, and packages them for retrieval.

Assistant

An additional person to provide help during a rescue usually helps rig and haul the mainline.

Belay (Belay line)

1. A back up to the main line, providing protection against a fall by a secondary, unloaded system.

2. The person creating and tending the back up line.

Change Over (Conversion)

The transfer from a lowering mode to a raising mode or vice versa.

Critical Angles

A measurement of the angle between the legs of an anchor. Avoid angles above 90 degrees as shallower angles exert forces on the anchor greater than the load itself.

Controller

The person who directs the movement of the system by staying in direct contact with the mainline, belay line, and attendant.

Directional

Designed to be pulled in only one direction, used to describe anchors or knots.

Exposure

A location where a fall would likely cause serious injury or death.

Fall Factor

The severity of a fall that is expressed as a ratio calculated by dividing the distance fallen by the length of the rope used to arrest the fall. *NFPA 1983 does not cover situations where a rescuer must climb into a loose rope where the fall factor could exceed 0.25.*

Hardware

Links various pieces of gear together, changes the direction of a system, adds, or reduces friction.

Haul Team

Personnel assigned to overcome the effects of gravity by providing the force to raise a load.

Litter Bearer

Personnel responsible for carrying the stokes basket.

Lock Out/Tag Out

A system used to secure and isolate equipment from its source of energy while personnel are working in, on, or around that equipment.

Mainline

1. The primary load bearing line in a rescue system.

2. The person creating and tending to the mainline.

Medical Group

The medical personnel standing by to care for injured people.

Mechanical Advantage

A force multiplying system where the rescuers strength is increased to aid lifting the rescue load. The relationship between a given load and the amount of force required to move it, expressed as a ration between output and input.

Packaging

The act of preparing a victim for removal; generally refers to placing the patient in the stokes basket, securing them, and doing first aid.

Personal Protective Equipment (PPE)

The equipment needed to shield or isolate personnel from chemical, physical, thermal or other hazards that can be encountered at an incident.

Pre-Rig

A system of rope or webbing carried tied and ready to deploy in a rescue setting.

Pre-Rescue Briefing

The detailed instructions given to the rescuers by the Rescue Group Leader occurs just before rescue efforts begin. This includes an outline of what the problem is, who is filling what roles, where the patient is, what the hazards are and what is going to be done to solve it.

Rappel

The act of descending a fixed rope in a controlled manner

Rescue Load

The combined weight of the rescuer, victim and their equipment supported by the rescue rope. Figured by NFPA 1983 to be 600 pounds.

Recovery

Actions taken by responders to retrieve the remains of victims or property when it is apparent there is no living patient involved. Recovery efforts are done only when the risk to responders has been reduced to the lowest possible level.

Rescue

Operations taken by responders to remove tenable patients from hazardous situations.

Rescue Operational Zones

Different sections at a rescue scene created to help control risk.

Hot Zone (RED)

Area of significant or potential hazard or risk where the rescue is taking place.

Warm Zone (YELLOW)

The area immediately outside of the hot zone where there is some risk to personnel.

Cold Zone (GREEN)

The safe area at a rescue incident, outside the warm and hot zones where apparatus, personnel and equipment not actively involved in the rescue are placed.

Response Levels

As defined by NFPA, the different training levels that dictate what actions individuals can perform.

Awareness Level

The training to identify technical rescue emergencies, the hazards and to recognize which additional resources are needed.

Operations Level

The minimum training needed to conduct basic technical rescue operations.

Technician Level

The most advanced training, they are able to conduct complex rescue operations.

Risk Benefit Analysis

The decision making process that weighs the hazards encountered by the rescuer versus the potential benefit. (Risk little to save little, risk a lot to save a lot.)

Safety

A designated position at any incident that is responsible for ensuring for the safety of everyone on the scene, this includes the general safety considerations and a specific check of the system

The specific checking of all the equipment, every knot and all the rigging to minimize the possibility of failure.

Safety Factor

The ratio used to describe the purposeful overbuilding of a system to allow for shock loading or unexpected change in loads. NFPA 1983 uses a 15:1 safety factor for a two-person load (600 lbs x 15= 9,000 lbs for rescue ropes).

Software

Soft rope rescue equipment (ropes, webbing, harnesses, etc.).

Staging

A funnel point or holding area to control the movement of rescuers into the scene so that they are contained, ready for assignments and in a safe location.

System

Inclusive name for the anchors, hardware and software used to perform a rope rescue.

Tag Line

A line used to deviate a load from a direct horizontal path avoiding an obstruction or to keep a load from spinning as it is being lowered or raised.

Vector

A force applied to a system or component. Vectoring is applying a force to a line that is in a different direction from the load it is supporting.

Whistle Stop Test

A conceptual check to ensure the complete safety of an operation. The system would pass if the load would not drop if every rescuer suddenly let go to the lines they were tending.

General Rescue Actions

This is an example of a way to perform a rope rescue. It is written vaguely with the knowledge that there is no *one* correct way to solve any event because not all events are the same. This will give an understanding of the *basics* of any scene while the *specifics* would be dictated by the actual event.

Phase 1 Initial Actions

The Fire Department is dispatched to the scene of a potential rescue.

Responding crews pre-think initial actions while enroute.

First in unit, regardless of training, will do the following things:

1. Figure out what is going on (from other first responders, visual inspection, witnesses, etc.).

2. Ensure safety for all people in the general area (including people attempting to affect a rescue with out the appropriate equipment or training.
   - Isolate and deny entry to unauthorized people
   - Limit personnel near the edges

3. Give a short report to incoming rescuers and request additional resources as needed

4. Initiate ICS (set up the status board, take command and create a command post)

5. Create a staging area for vehicles and personnel

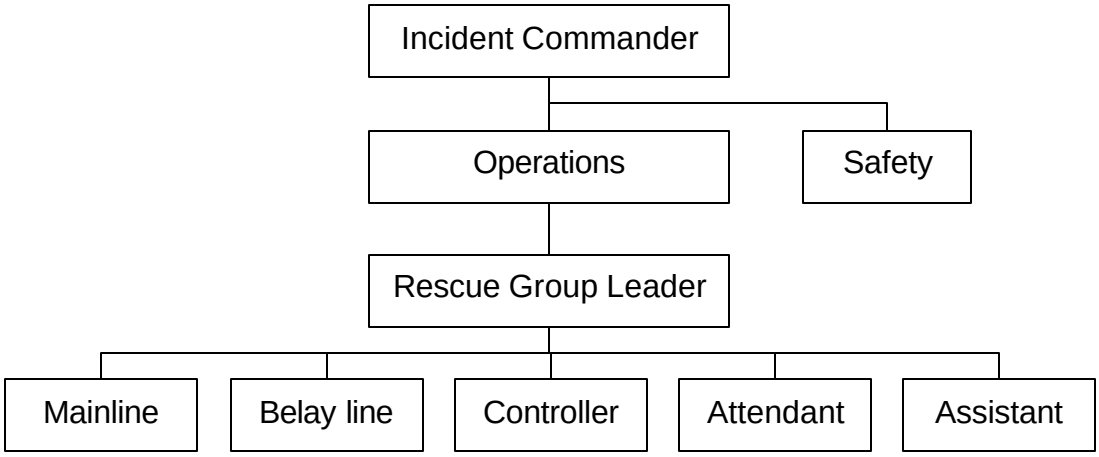
Phase 2 Pre-Rescue Actions

The first trained person one scene would assume the responsibilities of operations and figure out two things:

1. What is the problem?
   - Secure witnesses and obtain all pertinent information (who, what, when, where, why and how).
   - Determine number, condition (physical and emotional), and location of patient (distance and height up/down).
   - Determine if rescue or recovery (risk benefit analysis)
   - Identify immediate hazards.
   - Identify possible rescue routes (best access and egress routes).

2. What can be done?
   - Identify and establish strategic goals and objective. Develop an action plan.
   - Request additional resources as needed.
   - Re-evaluate plan based on number of resources enroute.
   - Create the following organizational chart.

Simple Rescue Organizational Chart

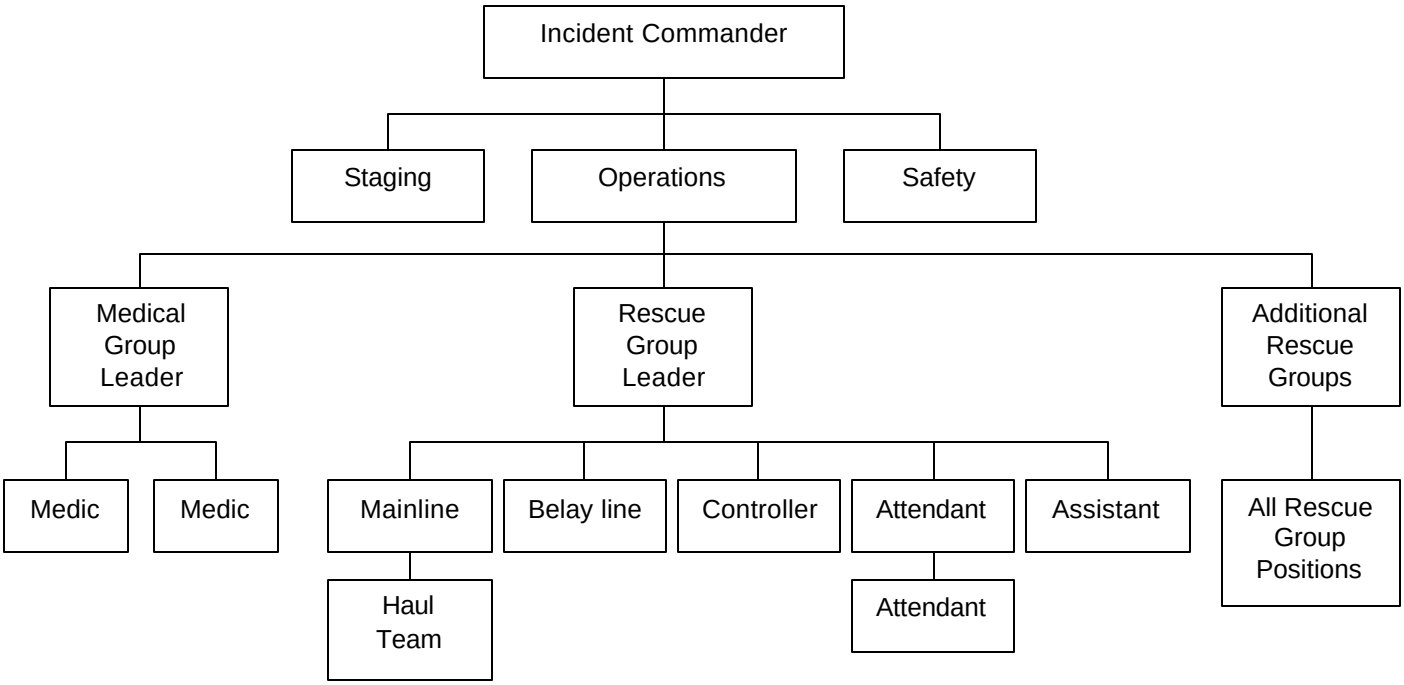


Six people (not counting the Incident Commander or the additional roles) can manage simple events. One person can manage Operations, Rescue Group Leader and Controller responsibilities and five others assume the other roles.

Additionally the following roles may need to be assigned: a haul team, extra attendants or liter bearers.

Complex Event Organizational Chart

On more complex events, CCFD#3 most likely would not have the staffing for all the required positions, a classic definition of a multiple casualty incident (MCI). The Incident Commander would call for additional help from other fire departments, triage the patients and work on getting the most critical patients out first.



Phase 3 Rescue Operations

Set the action plan in motion

Each Rescue Group assembles necessary equipment, dons the appropriate personal protective equipment and performs tasks as assigned.

The Incident Commander, Operations, Rescue Group Leader and Safety all perform ongoing risk vs. benefit analysis of rescue attempts. Everyone is responsible for constantly monitoring conditions which could necessitate a change of plan, including : hazards and the patient(s) condition.

Safety is the number one priority.

Create systems to perform the rescue.

Access and recover the patient.

Care for the patient in an appropriate manner until the medical group can take over.

Phase 4 Termination

Once the patient has been removed from the hazard and has been transferred to the medical group, everyone should move out of the hot zone and go through rehab (as needed).

The Rescue Group Leader will:

1. Perform a roll call and make sure all involved personnel are safe and accounted for.
2. Remove and secure all tools and equipment
3. Assist collecting evidence, as necessary.
4. Maintain all appropriate safety considerations and scene security.

After the event:

1. Clean and inspect ropes and equipment.
2. Complete rope logs
3. Conduct an incident debriefing to:
   - Analyze the incident.
   - Defuse stress (CISD as needed.)

Equipment

All equipment in a hazardous environment shall meet all applicable laws and standards.

Personal Protective Equipment

Everyone in a hazardous zone or performing a dangerous task shall wear the appropriate personal protective equipment. If the scene is IDLH and would dictate the use of hazmat gear, respirator, or structural fire gear, (in addition to rope rescue equipment) reconsider the rescue/recovery decision. There is no point in risking rescuers in an IDLH environment if there is no possibility for rescue.

Helmet

These are lightweight, fit securely, and have a low profile that allows them to fit in tight spaces which can be found in confined space, underground and some rock rescue situations. They should feature a three-point chin strap and quick adjustment to fit a variety of head sizes. In general, fire service helmets are not suited for rope rescue work.

Eye Protection

Consists minimally of safety glasses but consider using safety goggles as appropriate to the needs of the task performed.

Hearing Protection

When operating near noisy equipment or in a noisy environment, everyone shall utilize hearing protection.

Harness

Everyone must wear a harness if they are in an area with any exposure (to falls).

Footwear

Sturdy boots suited to the environment and task is necessary. (Steel-toed boots are minimally required.)

Gloves

The appropriate glove for the task *shall* be used. People using hardware, tending lines or over the edge *shall* be wearing work gloves unless they are providing care for a patient and then exam gloves.

Protective Clothing

Clothing can be a big issue in weather extremes, without proper clothing a rescuer may become ineffective.

The use of turnouts can be considered if conditions require it, keeping in mind that harnesses are difficult to fit over bulky turnouts.

Generally, the best thing to wear is coveralls that balance comfort, protection and freedom of movement.

Lighting

At a minimum your primary light source should be a headlamp to keep your hands free to work and which will make travel easier.

Personal Rigging

The idea of personal rigging is that every technical rescuer should have enough gear to not only protect themselves, but also rappel, ascend, build their own travel limiting system, and patient package attachment without the need to borrow from the group equipment cache. 1 complete set of Purcell Prusiks are ideal for this function.

Other

The patient condition will dictate the need for proper BSI.

Software

Care and Cautions

1. All life safety ropes, harnesses and other software used by CCFD#3 shall meet the applicable laws and standards, be inspected, logged after each use and be destroyed if there are any critical findings.

2. Do not straddle a line.

3. Never walk or stand on any piece of equipment.

4. Never drop or place things on top of software.

5. Protect software when it is in contact with sharp or abrasive surfaces: Do not drag it across unprotected ground or across edges or tie it to rough surfaces without some form of edge protection or ground pad.

6. Avoid jerky movements; instead use even pressure to move lines.

7. Fast rappelling or lowering can lead to excessive heat build up and can possibly damage software. Avoid this by slowing the rope movement down enough to let the heat dissipate.

8. Avoid prolonged exposure to sunlight.

9. Software should be kept away from harsh detergents, chemicals, fuel, oil and exhaust fumes, if contact occurs consider retiring that piece of equipment.

10. Any equipment found to be questionable shall be removed from service until it can be inspected by the equipment manager or by the manufacturer.

11. To clean software:

    a. Pre-rinse to wash off excess dirt and mud

    b. Place it in a mesh bag or appropriate washer (Station 4)

    c. Wash on a gentle cycle and use a gentle detergent.

    d. Dry out of direct sunlight before returning it to service (the bunker gear dryer is okay).

12. Visually inspect after each use for abrasion or other damage and cleanliness.

13. Once rope is dry, it is stuffed (flaked), not coiled, in its rope bag and stored in a dry, dust-free place, where not exposed to chemicals or direct sunlight.

Rescue Rope (Life Safety Rope)

Synthetic rope dedicated solely for supporting people during rescue, fire fighting, other emergency operations or during training evolutions where there are significant height differences.

There are two kinds of rope dynamic and static:

- Dynamic rope stretches, some brands can stretch up to 60% before breaking, good for lead climbing or activities when the rescuer may fall and the line needs to act as a shock absorber to ease them to a stop.

- Static rope does not stretch and is best used when a constant tension is kept on a line such as when lifting or lowering.

Specifications of fire service Life Safety Rope:

1. Static

2. Kernmantle
   - Inner core of continuous nylon fibers making up 75-85% of the overall strength
   - Protected by a woven outer sheath

3. ½ inch (12.7 mm) in diameter

4. Greater than a 9,000 pound breaking strength

5. Various lengths depending on its use (CCFD3 has 150, 300, & 400 foot ropes).

Care and Cautions

NFPA 1983 is very clear on the use and reuse of rope; it states that rope may be reused if all of the following conditions are met:

1. *Rope has not been visually damaged (cuts, exposed core material, discoloration)*

2. *Rope has not been exposed to heat, direct flame impingement or significant abrasion.*

3. *Rope has not been subjected to any impact load or loaded beyond its rated strength.*

4. *Rope has not been exposed to any liquids solids, gases, mists, or vapors of any chemical or other material that can deteriorate rope, including gas, foam etc.*

5. *Rope older than 6 years old (whether used or not, unless the manufacturer states differently.)*
WAC 296-305-05005 Rope Rescue Operations

6. *Rope passes inspection when inspected by a qualified person following the manufacturer's inspection procedures both before and after each use.*

In addition, any rope that meets any of the following conditions shall be destroyed.

1. *The rope was used (potentially used) in a situation that was not supervised and where there was potential damage done to it.*

2. *If the rope was used in a manner inconsistent with its intended use (life safety uses.)*

All rope shall be inspected after each use. The first step is to clean it as needed. Next, after it is dry, insert the appropriate end into the bag (the ends are flipped periodically to even wear.)

Hold the rope tightly in one hand, pull out 18 inches, feeling for soft spots or variations in diameter and visually inspect both sides for damage to the sheath. Continue the length of the rope stuffing it into its storage bag as you go along.

When done, document, its use and inspection in the rope log. (Example follows).

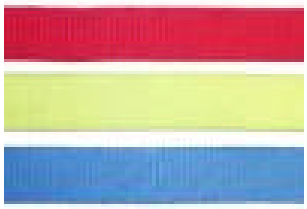
Serial Number	Lot Number	I.D. Number	Date of Manufacture	In-Service Date

Fiber/Construction	Diameter	Length	Color	Purchased From:	Purchase Date

Date	Location of Use	Type of Use	Inspected	Number and Initials	Comments

- Inspect the rope for damage or excessive wear after each use.
- Retire all suspect ropes
- Document findings/conditions after each use.

Webbing



Specifications

1 Inch Tubular Webbing

4,000-pound breaking strength

FEMA task forces have standardized the lengths of webbing by color

- 5’ green
- 12’ yellow
- 15’ blue
- 20’ red
- 25’ black

Care and Cautions

Webbing should be inspected, maintained and cared for like rope, except its use is not logged.

Accessory Cord

Specifications

8mm diameter

Lengths vary depending on use

4,000-pound breaking strength

When tied in a prusik loop

- Green (Short)
- Purple (Long)
- Red – 32.5’ (10M) for radium release hitch and back ties.

Care and Cautions

Same as for webbing

Pick Off Strap

Specifications

Flat webbing

D rings on each end (Pointed D attaches to mainline)

Adjustable length

8,000 pounds breaking strength

Care and Cautions

Same as for webbing

Anchor Strap

Specifications

Flat webbing

D rings on each end

Fixed length

8,000 pounds breaking strength

Care and Cautions

Same as for webbing

Use often results in carabiner “side loading”, use with **GREAT CAUTION**.

Hardware

Links various pieces of gear together, changes the direction of a system, adds or reduces friction.

Care and Cautions

Do not drop or throw any piece of hardware.

Do not walk or stand on any equipment, do not drop or place anything on top of any equipment.

Before and after each use, inspect for damage, specifically look for cracks, burrs, worn spots, loose bolts and smooth operation of moving parts.

Any questions or concerns warrant removing the item from service until it can be inspected by the equipment manager who will make the determination of repair or destruction.

Small burrs and nicks may be lightly sanded off.

Hardware with cracks or large burrs, nicks or worn spots need to be destroyed.

If the action of a piece of hardware is stiff, do not use grease or oil to lubricate it, instead thoroughly clean the action with soap and water or compressed air.

Brake Bar Rack

Uses

Friction device for lowering, rappelling or belaying rescuers, objects and patients.

Specifications

Stainless steel

10,000-pound breaking strength

Infinitely variable friction

Two bars with training grooves. Tie off bar ***(Also called a Hyper bar- Keep in first position)***

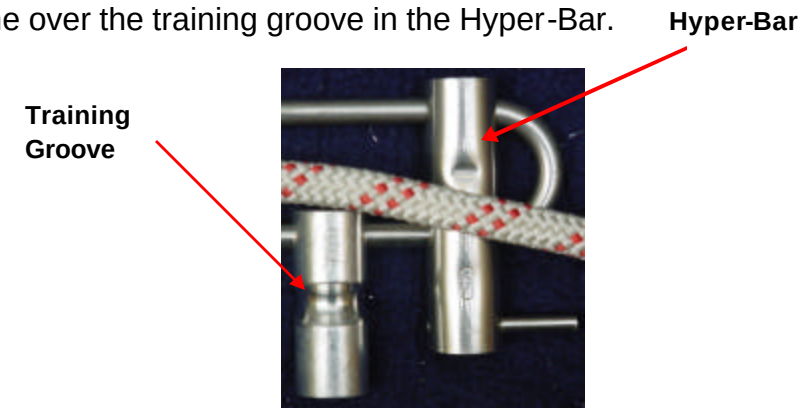
Care and Caution

Rack all bars before adding a load

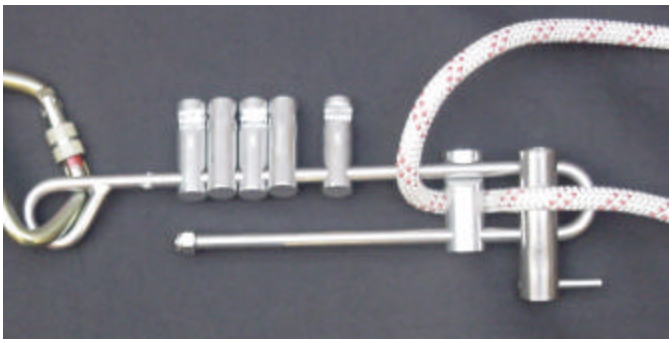
Thread the line through the correct side (through the training grove)

Thread the Brake Bar Rack

Lay the line over the training groove in the Hyper-Bar.



Weave it down and over the Safety bar (the second bar with training groove).



Flip the next bar in place and continue to weave the line until all the bars have been racked.

Make sure that the line is through both training grooves and that all the bars are loaded (it is catastrophic to load this incorrectly).

To Decrease Friction

Remove bars

Pull the line back towards the anchor or harness.

Spread the bars out

To Increase Friction

Add bars

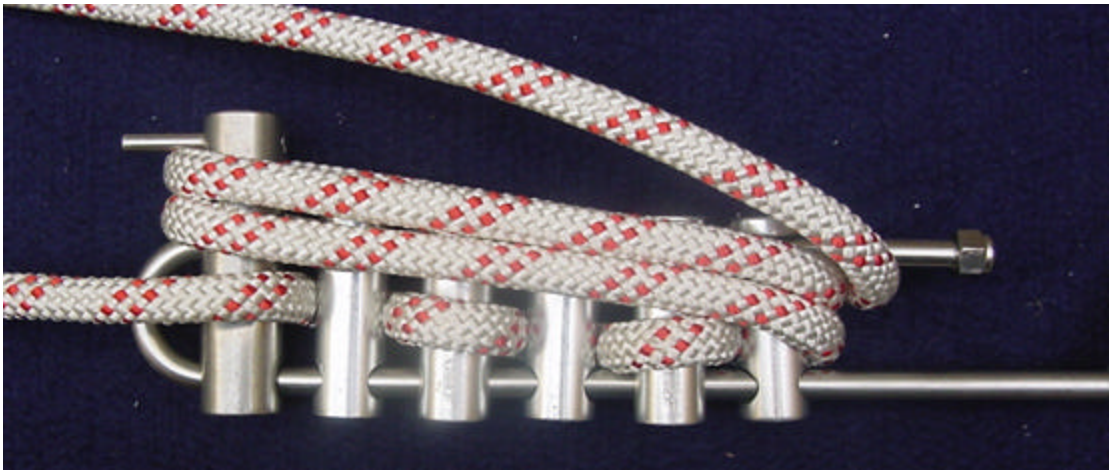
Pull the line to the top of the rack as shown in the picture.

Squeeze the bars together (away from the anchor or harness.)

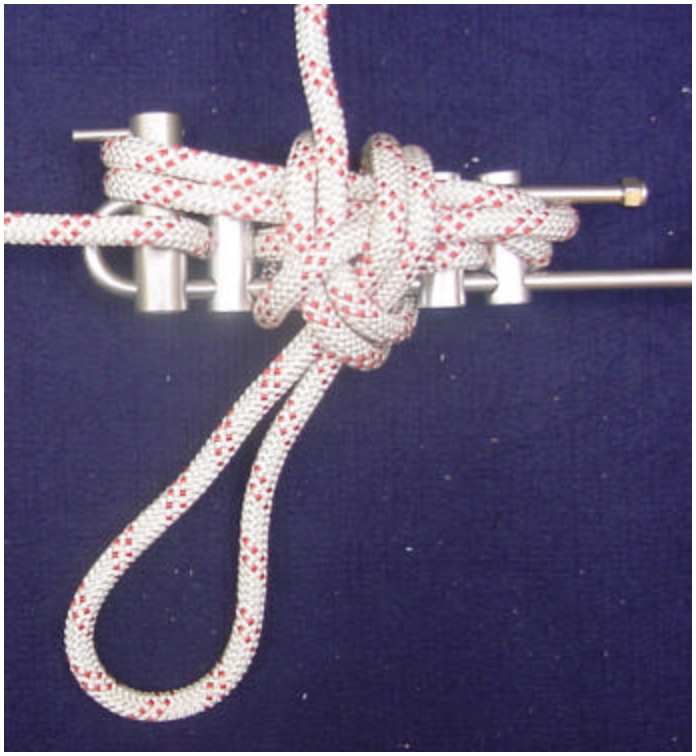
Tie off

Wrap the entire bars 2 to 3 times around the *Hyper-Bar* and open end.

(Pull each pass taut so it tightens the bars together)



Tie two half hitches tight around the entire bar



Carabiners

NOTE: NFPA 1983 *Standard on Fire Service Life Safety Rope and System Components* designates carabiners as either "Personal use" or "General use." Personal use is intended for a single person load such as rappel or escape. General use carabiners are intended for systems that could be subjected to a two-person load. A "G" or a "P" stamped on the frame identifies which rating the carabiner meets.

Specifications

Made from steel

D shaped with a locking gate

9,000-pound breaking strength

Care and Cautions

Make sure that the carabiner is big enough to safely hold the object it is clipped around.

Always lock all carabiners in a system. This prevents roll-out of your line.

Only finger tighten the lock nut; then back ¼ turn.

Load only in the long axis (never side load.)

Correct-loaded axially

Incorrect-side loaded

Edge Protection

Protects software from rough, sharp, abrasive or dirty edges or anchors.

This protection can be manufactured including pulleys and rollers or improvised: tarps, rope bags, bunker coats, fire hose etc.

Petzl caterpillar edge pro. Attached to accessory cord for adjustment.

Use common sense for the use, maintenance and care of specific objects.

Figure Eight Plate

Friction device for lowering, rappelling or belaying rescuers, objects and patients.

Specifications

Steel

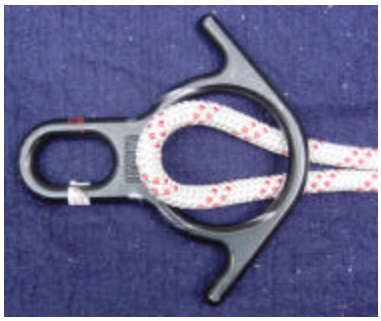
9,000-pound breaking strength

Care and Cautions

Only to be used for a single person load (because the friction is not as variable as the brake bar rack). *Do not use figure eight plates in a belay system for rescue loads. The human hand cannot generate enough force to reliably stop a falling rescue load (600lbs.)*

Load the figure eight

Pass a single bight through the big loop and around the smaller loop.



The smaller loop is attached to an anchor or harness with a carabineer.

Decrease Friction

Pull the line forward (away from the anchor or harness) and loosen your grip.

Increase Friction

Pull back on the line (towards the anchor or harness) and tighten your grip.

Tie Off

Wrap the line around the ears at least 2 times and tie an overhand knot on the line. Make sure that the loops around the ears and the line to the knot are tight, so as it is loaded there is no drop in the load.

Petzl I'D D20 Large

The Petzl I'D descender includes a mechanical clutch style braking system whereby a large handle is rotated in various orientations to control whether the unit is in descent, stopped, or complete lock-off. The I'D may also be used as a belay device or as a fixed brake lower.The large is available for ½" rope. The I'D descender is UL classified to NFPA 1983 (1995) as a personal use descending device, friction device for lowering, rappelling, or belaying rescuers, objects and patients .

Specifications

Aluminum. Anti-error feature help avoid accidents due to incorrect installation of the rope in the device.

Self-Braking system: if the handle is released during descent, the cam rotates to pinch the rope and brake the user's descent.

Anti-panic handle: the I'D will lock onto the rope if the user pulls too hard on the handle.

9,000-pound breaking strength / Weighs in at 530 grams.

Care and Cautions

Same as most hardware. Be sure to have appropriate training in its use.

Loading the Petzl I'D

Step by step loading the I'd

Pulleys

Uses

Reduce friction, change direction and to make mechanical advantage systems. Rule of thumb--- choose a pulley with a sheave's diameter four times the ropes diameter. **Ex. ½" rope = 2" Pulley.**

Specifications

Anodized Aluminum

9,000 pound strength rating

Rotating side plates (to be allow placement anywhere on the rope. *Side plates with squared-off bottom are Prusik Minding Pulleys*)

Roller is called a sheave.

Sealed ball bearings increase efficiency.

Care and Cautions

Check all moving parts for free action, clean as specified above.

Check connection points for elongation, stretching or cracks.

Check all bolts for tightness.

Knot-Passing Pulley (Kootney)

Uses

Knot passing in a system.

High directional anchor.

High strength tie off.

Rigging Plate

Uses

A device that allows for multiple attachment points from a single source.

Specifications

Anodized aluminum

CE - UL Classified to NFPA 1983 (2001) General Use

9,000-pound rating

540° Rescue Belay

Uses

The design allows either end of the rope to be used as the load line, greatly reducing the risk of an improperly loaded device. This device passes the demanding British Columbia, Belay Competency Drop Test.
The built-in release mechanism eliminates the need for a load release hitch. This reduces complexity and rigging time.

Proper training in its use is essential.

Specifications

Anodized aluminum

Accepts Rescue ropes from 7/16” to ½” (11mm to 13mm)

Stokes Basket (Litter)

Use

Safely carry a patient out of an exposed area.

Specifications

Style varies depending on manufacturer

Upper and lower rails connected by vertical posts with a basket to support the patient.

1,200-pound load test

Made of stainless steel

O.P.S style Litter (Orange Plastic Stretchers)

Use

Safely carry a patient out of an exposed area.

Specifications

Ferno Basket Stretcher (F71)

Use great care when using plastic (O.P.S. style) stretchers for technical rescue, some styles and models are inherently weak.

Knots

There are many ways to tie into a rope but only a few are right for rope rescue. To be a good knot it has to meet certain criteria:

1. Easy to tie

2. Readily identifiable

3. Strong. How much the knot reduces the strength of a rope. Knot strength really means knot efficiency (how much a given knot retains the strength of the rope).

4. Backed up when appropriate.
   - Rope will have a double overhand knot
   - Flat knots (in webbing) will have a single overhand knot

5. Every knot shall be dressed and set. “A knot that looks bad probably is.”

6. Every knot shall have at least a palms width of tail (longer is better) and loop knots should be smaller than palms width (shorter is better.)

7. Over the years, there has been much debate over the use of the bowline versus the figure eight. There is no absolute difference between the two; each has its benefits and drawbacks based on its intended use.

Definitions

Back Up Knot

A secondary knot to secure the tail of a primary knot, hitch or bend to decrease the likelihood of it coming untied.

Bend

A knot that connects two ends of line together

Bight

Formed when the rope doubles back but does not cross itself.

Directional

Designed to be pulled/loaded in only one direction.

Dressed and Set

To make a knot lay the way that it is intended, to make it as efficient as possible. All the strands should run parallel and lie flat against each strand (as intended). This makes the knot stronger and easier to check for safety.

End Knot

Tied into the end of a line

Hitch

Line wrapped around an object in such a way that if the object were removed the knot would fall apart.

Inline Knot

A knot tied into the middle of a line.

Knot

A generic term to describe a line that is intertwined in a prescribed way. Also specific to any knot that is not a hitch or a bend.

Loop

Formed when the rope double back and crosses itself.

Running Part

The rope in between the standing end and the working end. The part that is run through the system.

Standing End

The part of the rope attached to something, usually an anchor, the inactive end as opposed to the working end.

Stopper Knot

A knot to prevent the end of the line from pulling out of the system.

Working End

The end of the rope used to tie the knot.

Figure Eight Series

Figure Eight Stopper Knot

This is used as the foundation knot for the other figure eight series knots and as an end knot.

Figure Eight Stopper Knot

Figure Eight on a Bight

Makes a loop in the end of a rope for securing rescuers or anchors. It is backed up with a double overhand knot.

Figure Eight on a Bight (base knot)

Figure Eight on a Bight (backed up)

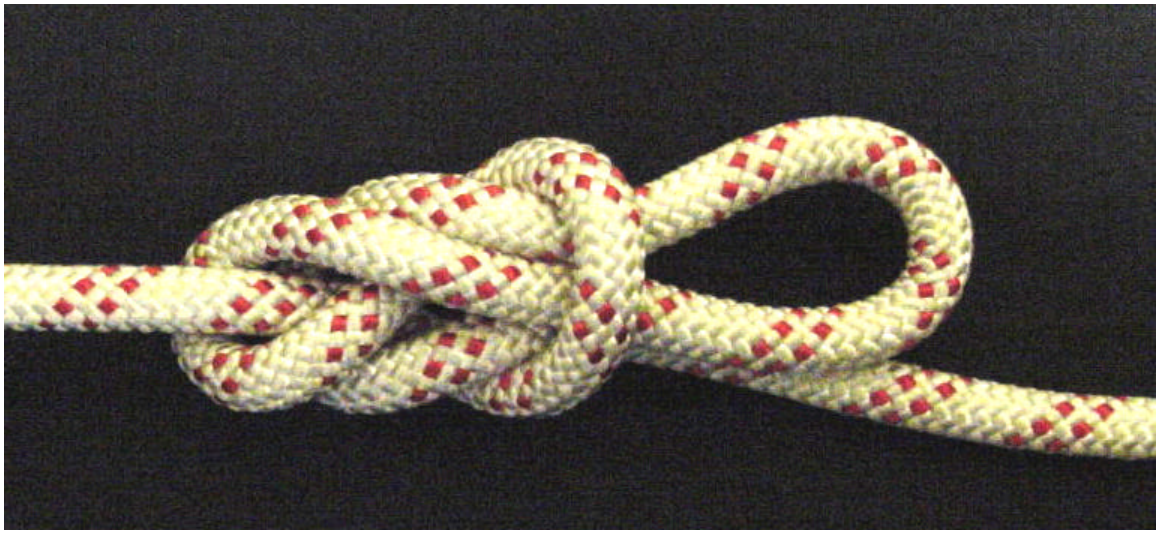
Figure Eight Follow Through

This knot is used in place of the figure eight on a bight when it is not possible to slip the loop over the intended object or clip it in with a carabiner. It is tied directly around an object.

Figure Eight Follow Thorough (backed up)

In Line Figure Eight (Directional Eight)

A directional knot tied into the middle of a rope.



In Line Eight (no back up needed)
See Appendix A for step-by-step directions

Bowline Series

Bowline

Just like the figure eight on a bight, the bowline makes a loop in the end of a rope for securing rescuers or anchors.

Bowline (base knot)

Bowline (backed up)

Long Tail Bowline

A directional knot tied into the middle of a rope.

Long Tail Bowline (no back up needed)

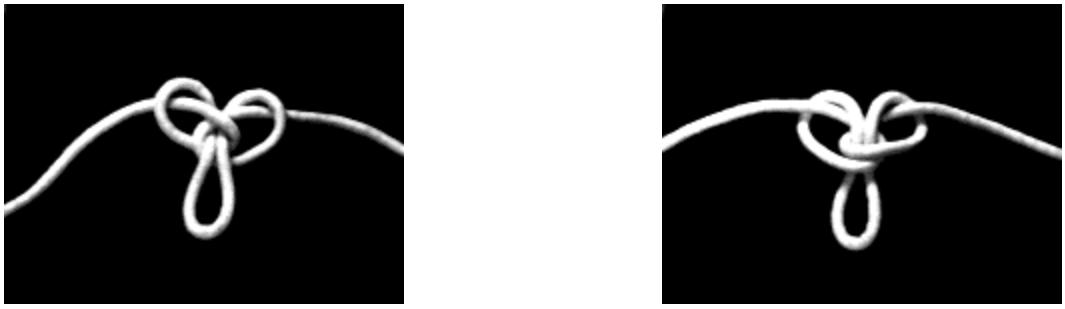
Interlocking Long Tail Bowline

Two long tail bowline tied around an object and around each other. So that if one were to fail the other side would still be supported.

Interlocking Long Tail Bowline
See Appendix A for step-by-step directions

Butterfly Knot

Used instead of eight on a bight where a strong mid-line, rather than a terminal end attachment, is desired. Knot can be pulled in either direction.



Butterfly Knot (Viewed Front and Back)
See Appendix A for step-by-step directions

Double Over-Hand Knot

A back up knot for the figure eight, bowline series knots and the basis for prusiks.

Double Overhand Knot

Double Overhand Bend

Used to tie two equal diameter rope ends together.

Double Overhand Bend
(in use the knots would be tight next to each other-shown apart here for clarity.)

Prusik

Attaches objects to a line by wrapping a pre-tied loop of accessory cord into a Three Wrap Prusik Hitch.

Three Wrap Prusik Hitch

Munter Hitch

A type of friction hitch used as the foundation of the Radium Release Hitch.

Munter Hitch

3:1 Radium Release Hitch

A hitch designed to allow the gradual release of a heavy load.

Use 8mm Nylon Accessory Cord (10M)

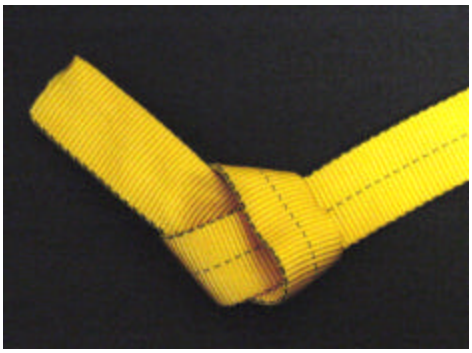
3:1 Radium Release Hitch
See Appendix A for step-by-step directions

Half Hitch

A hitch commonly used in the fire service to secure an end of rope or webbing to an object after a round turn.

Overhand Bend

Used as the start of the water knot and as a back up in webbing. (Shown in rope above for clarity.)



Overhand Bend in Webbing

Water Knot

Used to tie two webbing ends together because of the slippery material, leaving a long enough tail, dressing and setting this bend is critical.

Water Knot

Square Knot

Used to secure the ends of the hasty harness. It must be backed up by overhand bends.

Square Knot (shown here in rope for clarity)

Surgeons Knot

The starting point of a hasty harness, just like the overhand bend but with multiple wraps.

Surgeons Knot

Overhand on a Bight

The first knot in the hasty chest harness.

Overhand on a Bight

FEMA Sit Harness

An improvised harness made from lengths of webbing.

Hasty Harness

An improvised harness made from lengths of webbing. This term is used interchangeably for either the seat or chest harness or both.

Hasty Harness
See Appendix A for step-by-step directions

Harnesses

Class 1

A belt fastened around the waist that can provide fall protection but not designed to be used as a sole means of support.

Class 2

A harness that fastens around the waist and thighs (under the buttocks).

Class 3

A full body harness that has webbing around the waist, thighs (buttocks) and over the shoulders. Designed for use where inverting may occur.

Victim Harness

A package harness (that fits into a compact package) with quick connect snap links and color coded straps for quickly attaching a patient to the rescue system. CCFD#3 has a CMC victim harness (class 2) with an optional chest harness attachment.

Hasty Harness

An improvised harness made from lengths of webbing. This term is used interchangeably for either the seat or chest harness or both.

Anchors

Definitions

Anchor

1. A general term for the combination of anchor points, rope, webbing and other equipment to which rescue systems are attached.

2. The object that an anchor is attached to, which can be natural or man made.

Anchor Focus Point

The lining up of the anchor with the direction of pull of the load which it is supporting.

Anchor Point

The place where a multi-point anchor or the legs of an anchor come together. Also consider the following types: Natural, Structural, Vehicles, and Pickets. *(When using vehicles: Chock the wheels, set the emergency brake, remove the keys and give them to the incident commander)*

Load Sharing Anchor Systems

Two or more anchor points each carrying part of the weight of the load. If a single anchor point in an anchor system should fail, the anchor system will remain intact.

Critical Angles

A measurement of the angle between the legs of an anchor. Avoid angles above 90 degrees as shallower angles exert forces on the anchor greater than the load itself.

Bombproof

An anchor or anchor point so strong that there is no question that it will support far more than the expected and unexpected loads of the rescue system.

General Rules:

1. The Mainline and Belay line need to be separate. The same object maybe used (provided it is sufficiently strong) but separate equipment must be used.

2. The anchor shall be large and stable enough to hold a 600-pound rescue load with an appropriate safety ratio.

3. Edge protection must be used anytime software comes in contact with sharp or abrasive edges or objects.

4. Avoid critical angles (those over 90 degrees).

5. When setting up an anchor tie as close to the base as possible.

Considerations when Selecting Anchors:

1. What is the purpose of the system that is going to attach to the anchor?

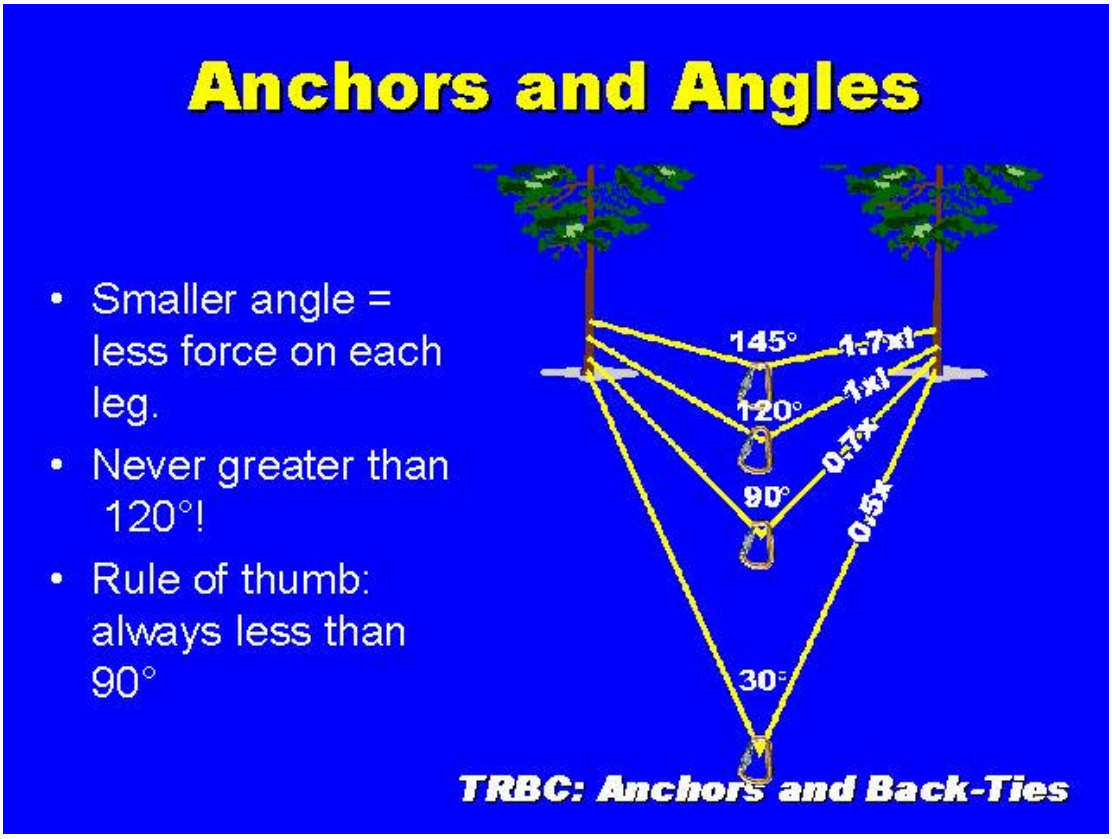
2. What direction will the pull come from?
   - A non-directional anchor will withstand a pull from any direction.
   - A directional anchor will withstand a pull from only one direction.

3. Is the anchor over the top of the load or over to a side?

4. Is the anchor large enough to support the expected load

5. Anchors need to be set up away from the edge to allow room to work, but close enough to remain in contact with the Controller and to avoid running out of rope.

Critical Angles

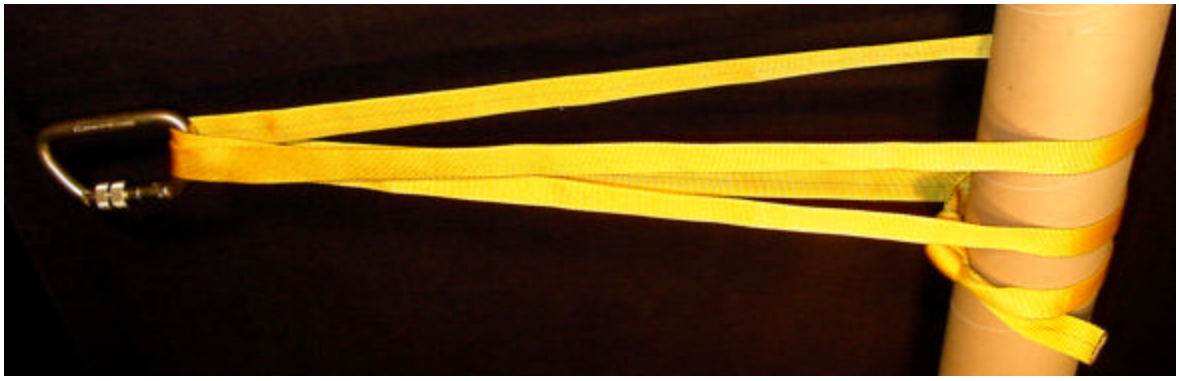


As a rule of thumb, the angle of the strands of material that connect the carabiner to the anchor should always be 90° or less.

Single Point Anchors

Wrap Three Pull Two

A length of webbing is wrapped around the anchor three times and tied with a water knot. Two strands are pulled tight, leaving the one tied strand tight against the anchor. The water knot should be located against the anchor towards the direction of pull.



Wrap Three Pull Two Anchor

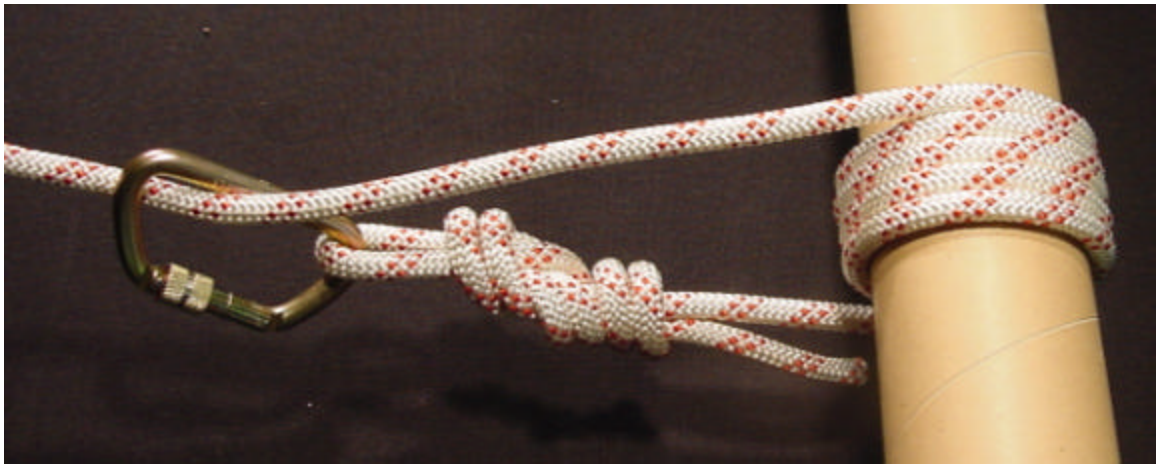
Single Loop Anchor

A length of webbing tied with a water knot into a loop around the anchor.

Single Loop Anchor

High Strength Tie Off (No Knot Anchor)

Used to create a fixed line for rappelling or to extend an anchor. The end of the rescue line is wrapped around the anchor at least three times and tied back around itself with a figure eight or bowline. The friction of the rope around the anchoring will distribute the load so that the knot is under no tension.



High Strength Tie Off

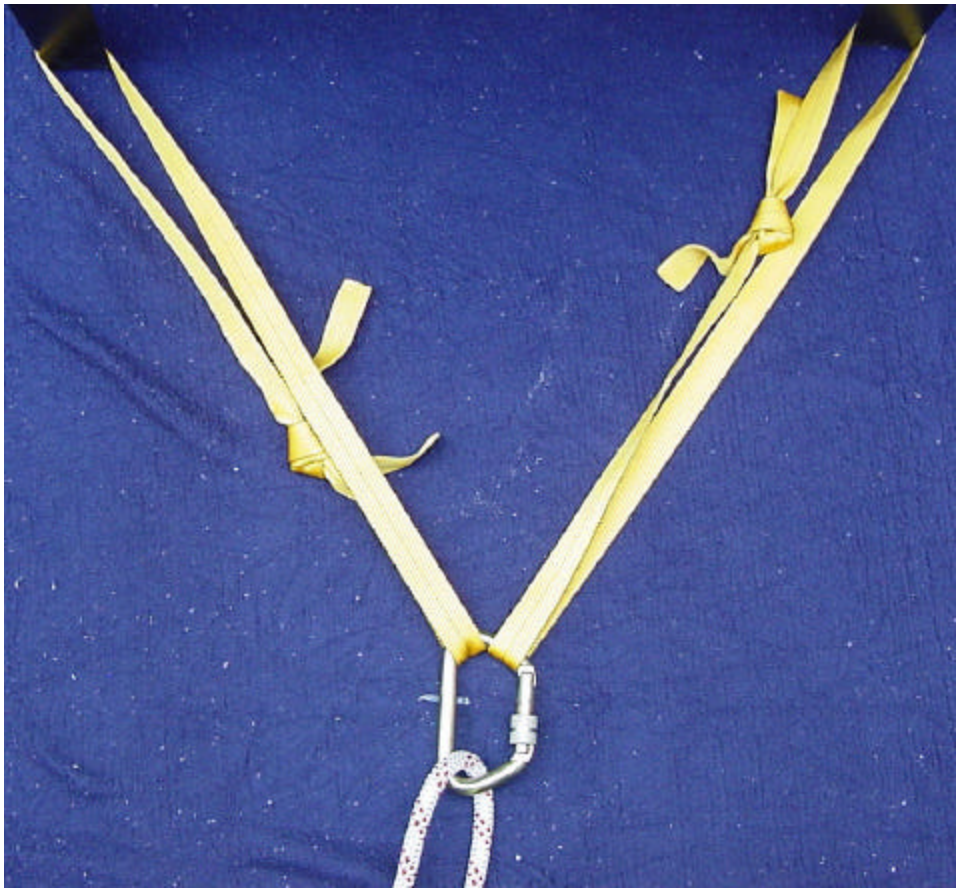
Multi-Point Anchors

If a single anchor does not appear strong enough for the expected load, it may become necessary to use a multiple point anchor to establish a solid anchor point. There are three kinds: load sharing, tied back (pre-tensioned) and load distributing anchors. A load distributing anchors self-adjusts to keep equal weight on each of the single anchors (and is a technician level skill and is not explained here).

Regardless, multi-point anchors that need more than three points of contact might not be the best system (as it is getting too complex) and another way might be better.

Load Sharing Anchors

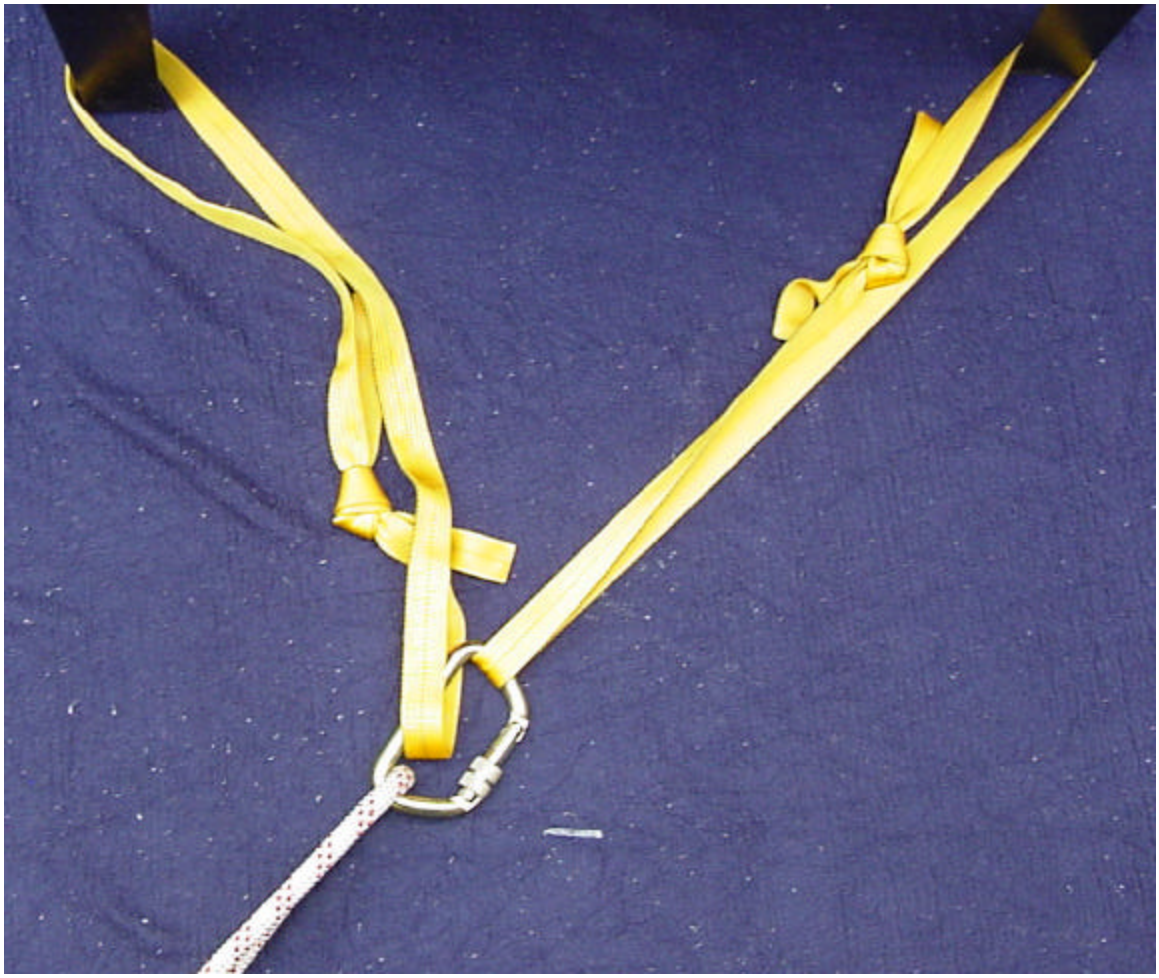
Connect two or more single point anchors together and focus them towards the load. (Adjust the length of the legs by tying the webbing the correct length.



Two Point Load Sharing Anchor

Anchor Focus Point

Care needs to be taken when using a load sharing anchor, as long as each leg is stressed equally, the anchors are sharing some of the load. Any shift in the direction of the load shifts a greater portion of the load onto one anchor, negating the effect of creating the multiple anchors in the first place.



Incorrect-unfocused multi-point anchor putting the entire load on the anchor on the right side.

Tied Back Anchor

A weak anchor is backed by a strong one. The weak anchor is in a perfect place but is too small to carry the intended load.

Two single point anchors are established as described above, one above the other.

Single Wrap Interlocking Anchor

Interlock a piece of webbing into the weak anchor point (effectively tie a third anchor facing back, towards the strong anchor.)

This interlocking part is just like the interlocking long-tail bowline, if the anchor were to disappear, the pieces of webbing would be wrapped around each other and still support the load.

A carabiner is connected to the strong anchor and to another is attached to this back tied piece of webbing.

Tie a loop knot in the end of a section of life safety line and connect it to one of the carabiners.

Pass this through the other carabiner; back to the original carabiner (creating a 3:1 system).

Tension this and tie it off with two half hitches.

There needs to be appropriate tension, to avoid shock loading the strong anchor if the weak anchor fails and to ensure the weak anchor is supported.

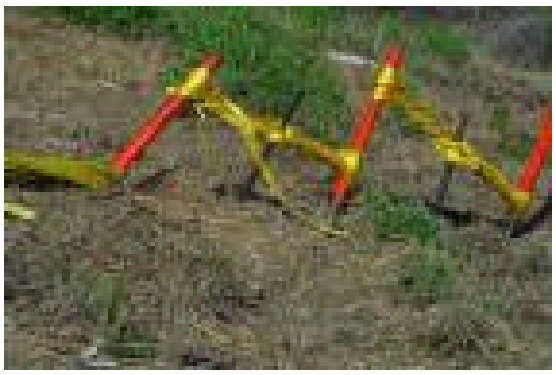
High Directional Anchors

Ladder Gin

Bi-pod (“A” frame)

Alternative Anchors

Pickets



Commands

The controller's job is to coordinate the movement of the load to ensure a smooth and safe rescue.

The following commands will be used:

Only on command from the controller can the load start to move, anyone can stop it should they see an unsafe operation.

Position	Statement	Meaning
Controller	Safety Check?	Is the system safe-hands-on-check complete?
Safety	Safety ready.	
Controller	Attendant ready?	Prepared to move?
Attendant	Attendant ready.	
Controller	Mainline ready?	Prepared to move the load?
Mainline	Mainline ready.	
Controller	Belay line ready?	Prepared to move the load?
Belay line	Belay line ready.	
Controller	Tension	
Controller or Attendant	Raise Lower	

Controller or Attendant	Slow	
Controller	Set	Mainline sticks the ratchet prusiks.
Controller	Reset	Expand the mechanical advantage system so it can be raised again.
Controller	Change Over	
Anyone	Stop	
Any Role	Standby	Not yet ready to perform.

In the case of a rappel, the commands are similar.

Position	Statement	Meaning
Controller	Safety ready?	
Safety	Safety ready.	
Controller	Rappel ready?	
Rappel	Rappel ready.	
Controller	Belay line ready?	
Belay line	Belay line ready.	
Controller	Rappel to the edge.	Stand on the edge and tension the line.
Controller	Sit	
Controller	Down	
Controller	Stop	Movement of line ceases.
Controller	Continue	Movement of line continues.
Controller	To the ground	Rappel is off belay

Systems

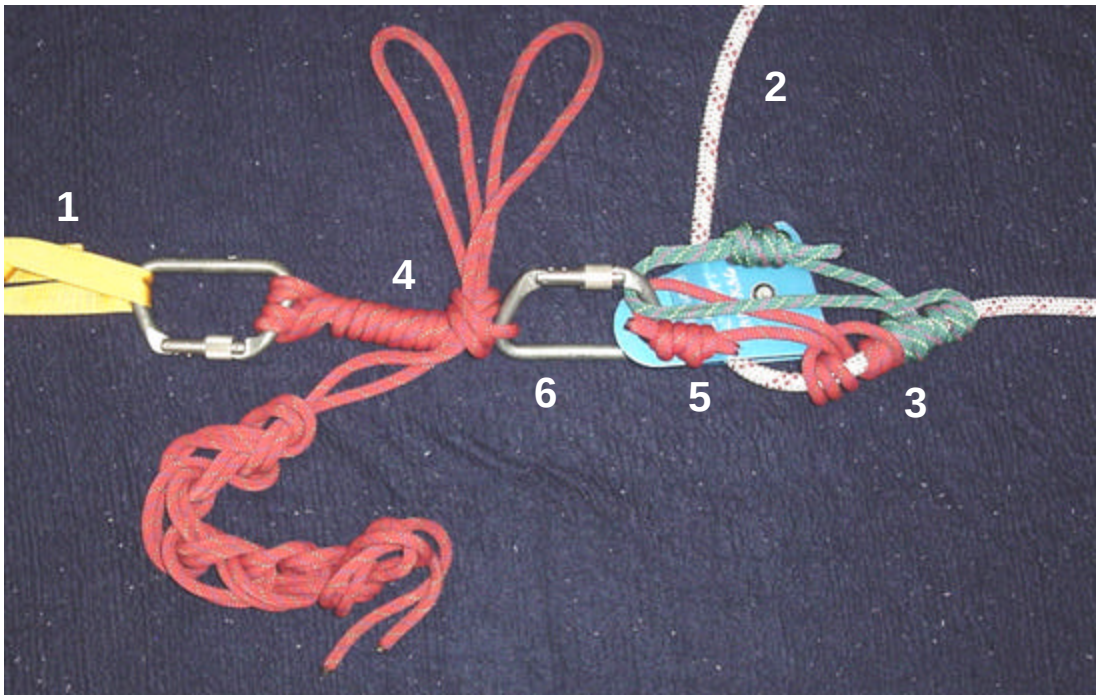
The inclusive name or the anchors, hardware and software used to perfo rm a rope rescue. For every event, every rescuer must have two points of contact, a mainline and a belay line. In low angle events, the rescuers feet count as their mainline and the rescue rope would be their belay line.

Belay Line

The belay line is designed to catch the load in the event of failure of the mainline. It is not loaded unless the mainline is compromised in some way used any time aback up would be needed (free climbing, rappelling.)

Components:

1. An anchor
2. Life safety rope
3. Tandem prusik to arrest the movement of the rope (should the need arise).
4. Load release hitch
5. Pulley
6. Carabiners



To Raise

The controller gives the command “raise”

Belay pulls the rope in; the prusik minding pulley will tend the prusiks.

To Lower

The Controller gives the command to “Lower” Belay controls the tandem prusik, and pulls the line out.

Tending Prusiks

Belay line tension should be loose enough to keep the prusiks from sticking, but tight enough to keep the load from falling a big distance.

Raising

The tension on the belay line cannot be too tight, (unless it takes load off the mainline), as the prusiks are set to catch only on the way out.

Lowering

The best way to ensure the correct tension is to systematically pull out to about arms length of line and turn your hand about 90 degrees (see picture).

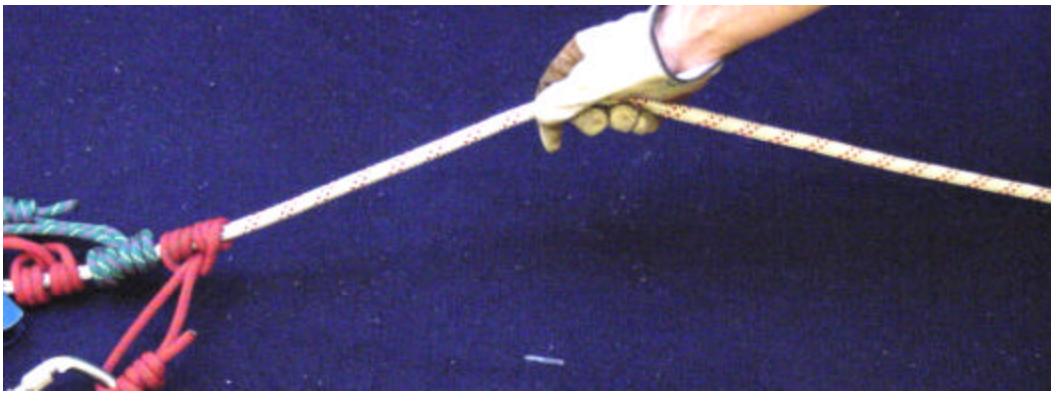
When the load pulls tension on the line, quickly slide your hand in and repeat.

Unsticking Belay Line Prusiks

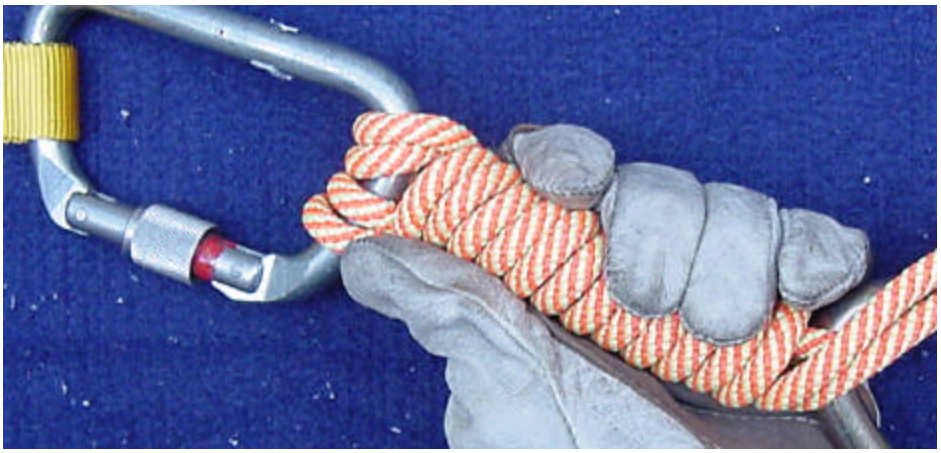
If this tension gets too great (either the belayer makes a mistake or the mainline fails), the prusiks will jam, stopping the movement.

There are two ways to fix this: (first make there is no problem-if there is fix it before un-jamming the prusiks).

1. The quickest and easiest is to “vector” the mainline. Pull tension on the mainline in a different direction than the load. Pull the slack out of the mainline until the weight is all on the brake bar rack and tie it off. Pull or push on the mainline between the brake bar rack and where it goes over the edge until slack is created in the belay line. The loosen the belay line prusiks and go back to lowering the load (making sure the prusiks do not stick again.)



2. Pull the slack out of the mainline until the weight is all on the brake bar rack and tie it off. Loosen the load release hitch until the load is on the main line. (Then check the load release hitch to see if you need to replace it.)



Mainline

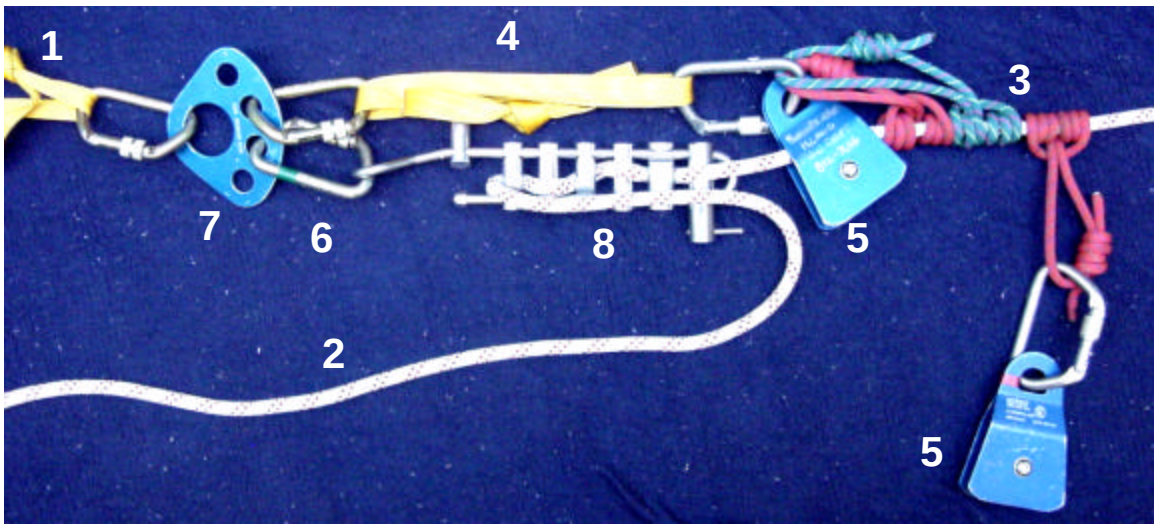
High Angle

Characteristics

1. The rescue rope carries the entire weight of the rescue load.
2. One attendant is needed to tend the stokes basket as it is moved.
3. There is a significant possibility of a fall.
4. Two points of attachment must connect to any person over any edge. (mainline and belay line)

Components

1. Anchor system
2. Life safety rope
3. Prusiks
4. Webbing
5. Pulleys
6. Carabiners
7. Rigging plate
8. Brake bar rack



To Build

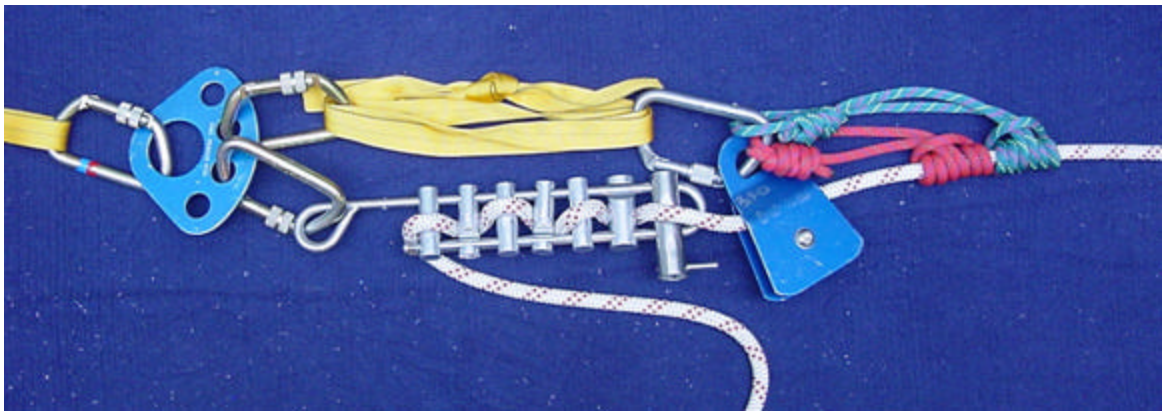
An anchor is created and connected to a rigging plate; this plate has two parts of the system attached to it.

The first is the same system as the entire belay line system, but the load release hitch is replaced with a length of webbing (tied into a loop long enough to connect the prusiks to the anchor away from the brake bar rack).

The second has a brake bar rack.

Lowering

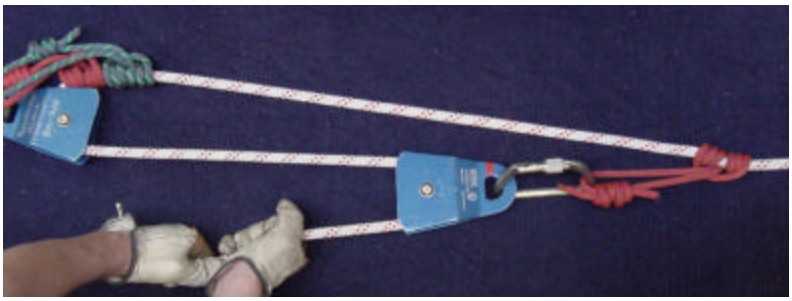
The line comes from the load through tandem ratchet prusiks through the pulley to the brake bar rack is weighted.



On the Controller's command, the line is eased out of the brake bar rack while the Assistant tends the prusiks.

Raising

Any mechanical advantage system could be put here (see Appendix B); the standard is a 3:1. The brake bar rack is unloaded (but kept on the rigging plate); and a second pulley is added to the load side (with a prusik). The line runs straight from the load through the prusiks and the anchor pulley to the load pulley and then to the haul team.



The Controller gives the command “Raise” and the haul team pulls on the line, lifting on the load. When the load pulley gets close to the anchor pulley the Controller calls for “Stop”, “Set”, and “Reset”.

The Mainline stops the movement and sets the ratchet prusiks

The Assistant slides the other pulley away from the anchor.

Controller then calls “Raise” to continue to raise the load.

Change Over

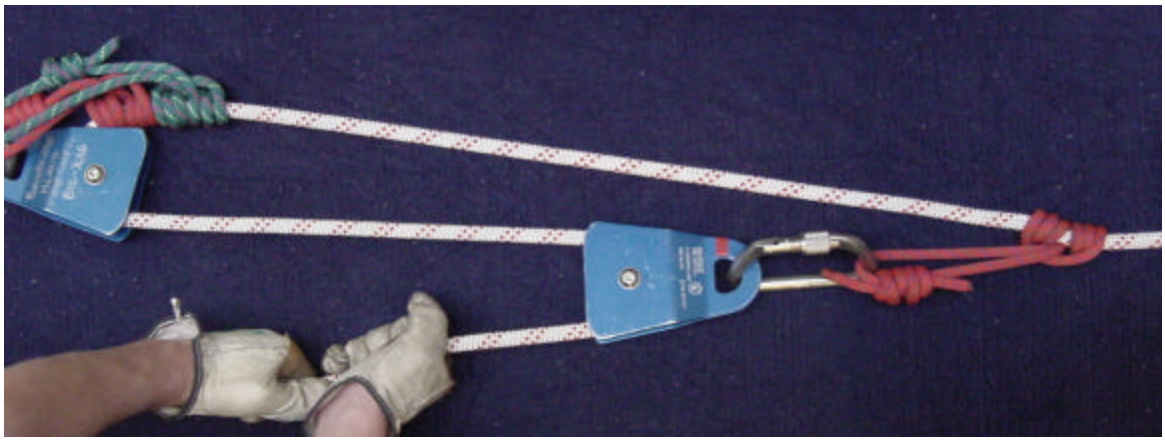
Lowering to Raising

Controller calls “Stop”, “Set” and “Change over”

The Mainline stops the movement and sets the ratchet prusiks

Mainline then unloads the brake bar rack and sets up the raise system as described above.

(Set up the load pulley and thread the line from the anchor pulley to the load pulley.)



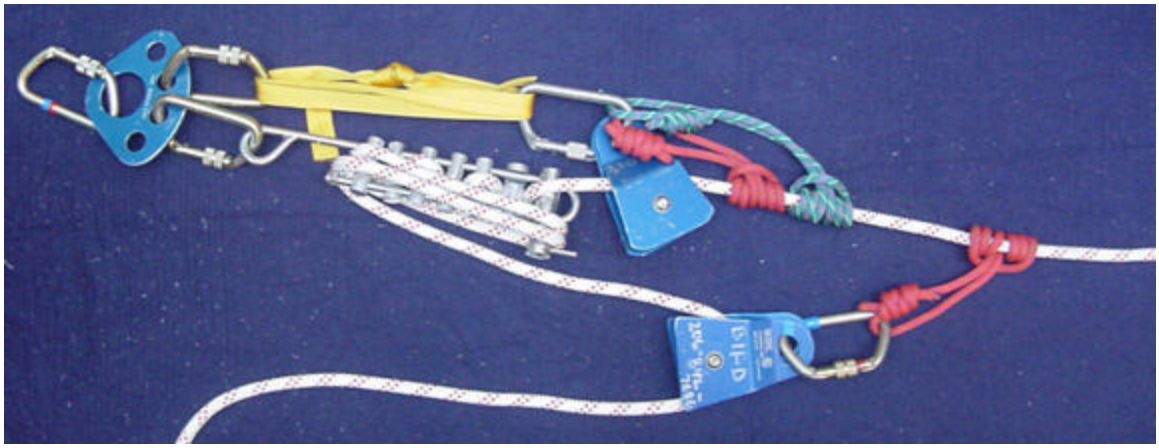
Raise the load on command of the Controller.

Raising to Lowering

Controller calls “Stop”, “Set” and “Change over”

The Mainline stops the movement and sets the ratchet prusiks

Make slack in the line coming out of the anchor pulley and load the brake bar rack in this loop. (With the line through the load pulley forming the other end of the loop.) Load all the bars and wrap the brake bar rack three times. (This is effectively a 2:1 mechanical advantage system.)



Pull in on the haul line just enough to unload the ratchet prusiks.

Release the haul line (while tending the prusiks) and transfer the load onto the brake bar rack.

Release the line from the load pulley and slide it up tight with the ratchet prusiks. As you lower the load, tend all three prusiks.

Un-sticking Mainline Prusiks

To unstick the prusiks, wrap the brake bar rack 2 to 3 times, attach a pulley to the load (with a prusik), feed the line from the brake bar rack to the load pulley and tension the line until the prusiks can be unstuck (similar to a change over).

Medium Angle

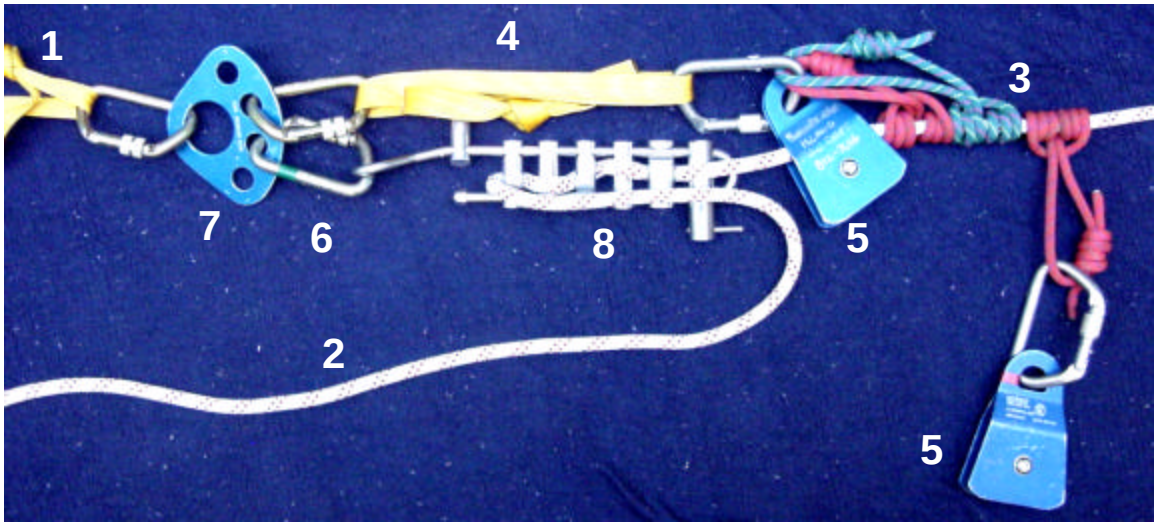
The division between a high to medium and a low to medium angle rescue is often hard to define.

Characteristics:

1. Some of the weight is carried by the attendants and some by the life safety rope.
2. Multiple litter bearers will be needed to carry the stokes basket.
3. Depending on the terrain there will a minimal to significant exposure and risk.
4. Two points of attachment must be connected to any person over any edge.

Components

1. Anchor system
2. Life safety rope
3. Prusiks
4. Webbing
5. Pulleys
6. Carabiners
7. Rigging plate
8. Brake bar rack



Raise, lower and change over is identical to high angle rescues.

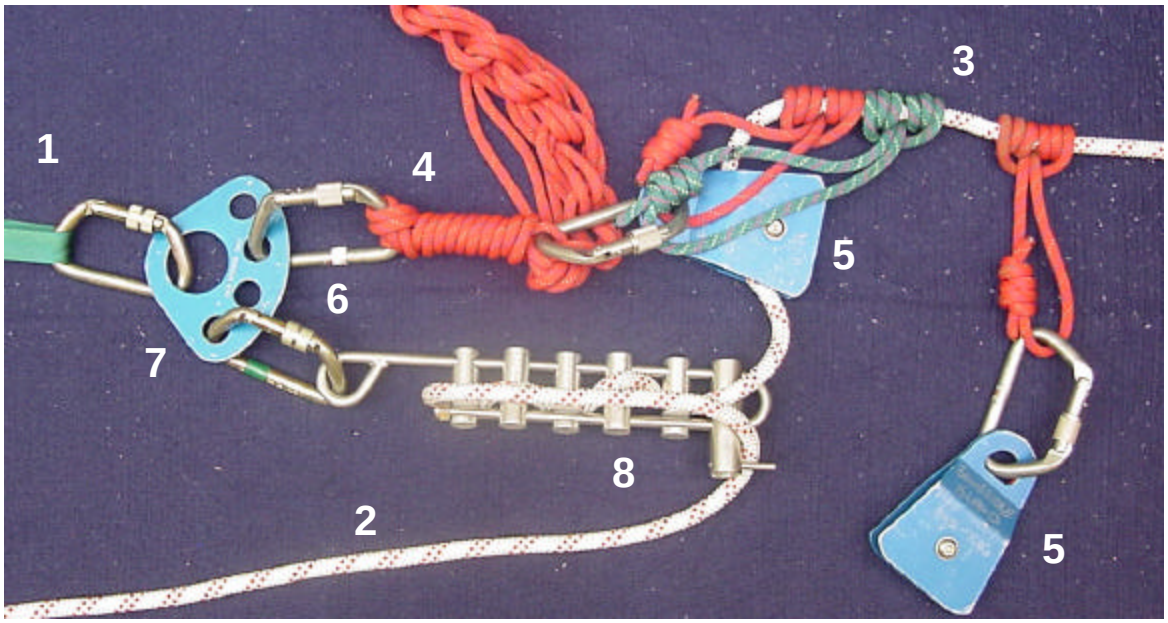
Low Angle

Characteristics:

1. The weight of the stokes basket is supported by the bearers and not the rope.
2. There are three to four liter tenders instead of one.
3. There is some (slight) possibility of fall with injury should rescuers should lose a step.
4. In low angle events, only a single line is needed as the attendants feet are effectively their mainline.

Components

1. Anchor system
2. Life safety rope
3. Prusiks
4. Load release hitch
5. Pulleys
6. Carabiners
7. Rigging plate
8. Brake bar rack



To Build

Make a system that is just like the high angle mainline system, but substitute a load release hitch in place of the webbing strap.

Raise, lower, and change over just like a high angle mainline.

Travel Limiters

A line designed to attach rescuers to an anchor (who are working near an edge but not intending to go over).

Create an anchor and a fixed line separate from the rescue system.

Fixed Travel Limiter

The rescuer is connected a knot tied close to the edge.

Adjustable Travel Limiter

A prusik is attached to the line and the harness, which allows them to adjust the length of the travel if they need to move around to different parts of the edge. (This is more convenient but more risky than the fixed travel limiter)

Aztec Pro 4:1 Pre-Rig

Accessing the Patient

Before using a system to access the patient (and as a part of the size up) rescuers need to make every effort to get to the patient by alternative means, provided they are safe and quick. (Choose the safest, easiest and quickest method of reaching the patient, which often is not building a rope system.)

There are three options (at least) on how to access the patient on a system: Be lowered (as previously described), rappel or free climb.

Rappelling

In the fire service, there are two main ways to rappel; with a brake bar rack or with a figure eight plate. (When rappelling the two points of contact rule still needs to be obeyed.) A new option is the Petzl I'D as it passes the whistle stop test.

A single line rappel can be performed if there will only be a single person load applied and the devise used passes the whistle stop test. This is appropriate to access a victim and size up the situation or to provide immediate EMS care.

If attempting a rescue and a two person load is anticipated use two lines.

Brake Bar Rack

1. Create a fixed line and a belay line.
2. Attach the rack to a class 3 harness with a carabineer (and lock it!)
3. Stand facing the anchor and load the brake bar rack as described in the equipment section.
4. Pass the line across the training groove and weave the line through the bars.
5. Pull the slack out of the system and step off the edge (on the controllers command.)
6. To control the speed (friction) take off or add bars, slide bars apart or together or pull the rope tight against the incoming line or back (180 degrees) from the incoming line

Figure Eight

Create a fixed line and a belay line.

Stand facing the anchor and load the figure eight as described in the Equipment Section.

Pass a single bight through the big loop and around the smaller loop. This is attached to a harness with a carabiner.

Pull the slack out of the system and step off the edge (on the controllers command.)

To increase friction (slow down) pull the line tight against your thigh and tighten your grip.

To speed up (decrease friction) hold the line parallel with the incoming line and loosen your grip.

Petzl I'D

Create a fixed line and a belay line.

Stand facing the anchor and load the Petzl I'D with the main line as described in the Equipment Section and following the drawing on the devise itself.

Slide the moveable plate over the rope and secure it to your harness with a carabineer. Be sure that the latch has fully closed.

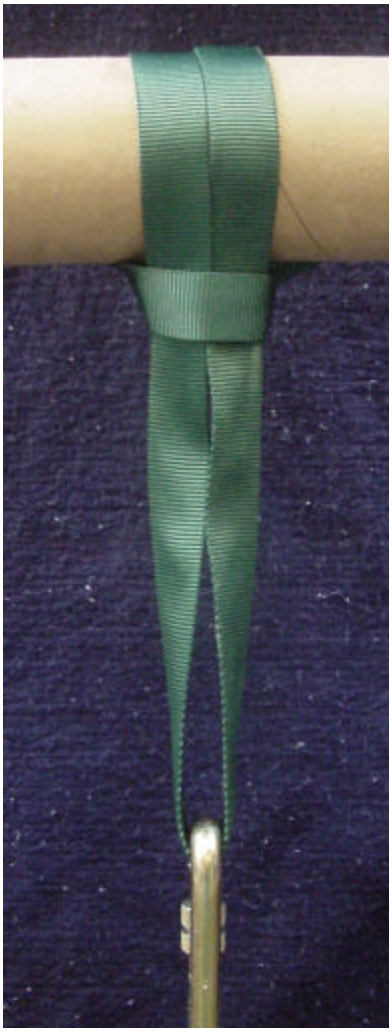
Pull the slack out of the system and step off the edge (on the controllers command.)

Swing the lever up and over to release friction on the devise. To increase friction (slow down) let up on the lever.

To speed up (decrease friction) apply pressure to the lever feeling for a "sweet spot". If you pull to hard it will lock off with the built in Panic function. To reset swing the lever up until you feel a ratchet and apply pressure to the lever.

Free Climbing

When it is necessary for rescuers to climb a vertical ladder or work along an elevated structure, they must be attached to two points of contact, with their limbs acting as one point and a belay line as the second. Because they are working away from the anchor, they are increasing the fall distance. In order for the belay line to protect them it must run through additional anchor points created along their route of travel. These anchor points can be created by girth hitching pre-tied webbing loops around or through opening in the structure every five to six feet.



Pass the webbing up from behind, around the object and girth hitched in front.

The belay line is attached to the webbing with carabineers.

If the rescuer should fall the distance they will fall is twice the distance from the last anchor point. In other words, if the rescuer is 5 feet above the last anchor they will fall five feet to the anchor and 5 feet past below it (a 10 foot fall) before they come to rest.

The belay line will be created just as before, the person tending the belay needs to keep a careful watch to adjust the tension to an appropriate level tight enough so the climber is safe, but loose enough not pull the rescuer off the edge.

When the climber is where they need to be, they can set up an anchor and attach whatever system(s) they need to access and rescue the patient.

To climb down they would clean their set anchors as the reached them. The belay needs to exercise the same caution to not pull them off the edge.

Patient Packaging

General Rules

Regardless of system, every person and object needs to have two points of contact (mainline and belay line.)

Pick Off

If the patient uninjured and a system is needed to access and rescue them a patient pick off maneuver should be performed. If any injury is expected follow local protocol (backboard and c-collar) and use the stokes basket to remove them.

1. Create a mainline and belay line system as needed for the angle.

2. The belay line has an in-line knot (long tail bowline or inline eight) and an end loop knot (bowline or figure eight) tied 4-6 feet away.
   - The attendant connects to the inline knot and the patient is connected to the end knot.

3. The mainline just has an end knot (figure eight or bowline)
   - The attendant is connected directly to the knot in the mainline with a pick off strap going from the knot to the patient harness. The pick off strap is used to adjust the attendant and the patient closeness depending on what the needs of the patient and what the terrain dictates.

4. Access the patient.

5. Put the harness on the patient and connect them to the mainline and belay line. The specific technique of how to put on the harness varies, if the patient is agitated stay above them, put on the waist strap and invert to get the leg straps. If the patient is calm, it may be acceptable to stop eye to eye and place the harness on them. It is a judgment call on attendant comfort, patient condition and attitude.

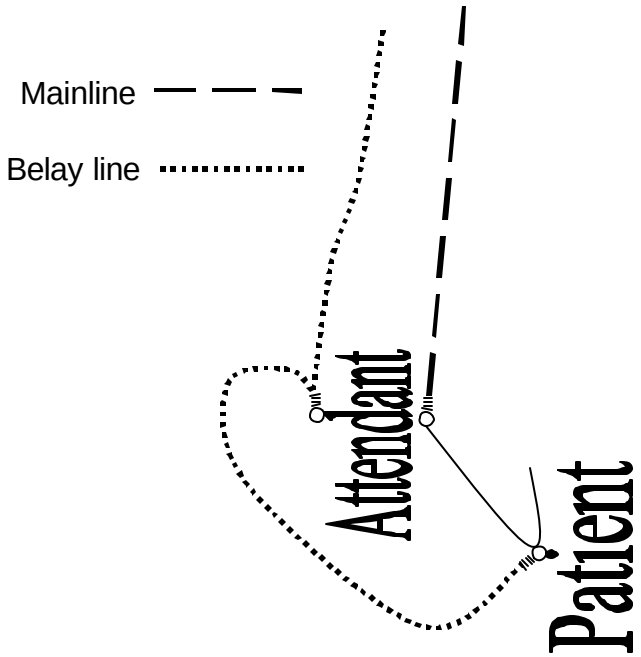
6. Tighten the pick off strap as much as possible.

7. Safety check the system.

8. The Controller calls “Raise” (to get slack in the patient system)

9. As soon as there is slack, take the patient off their system entirely onto the rescue system.

10. Patient and Attendant are brought to safe ground.



Stokes Basket

System Connections

Every person or stokes basket over an edge must have two points of contact (mainline and belay line).

High Angle

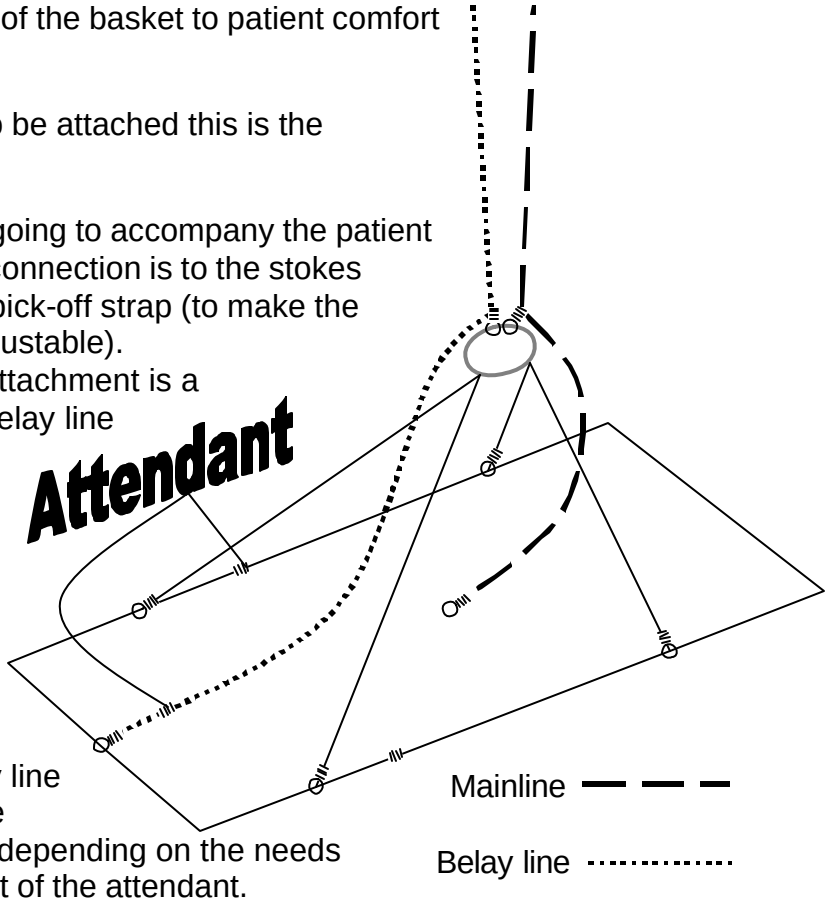
1. Create a mainline and belay line system.

2. Tie two interlocking long tail bowlines through the stokes bridle ring.
   - The mainline end needs to be a little longer than the stokes bridle arm and is tied to the patient as their back up line.
   - The other long tail bowline end is a little longer than the first and tied to the foot of the stokes basket (which is its back up line).
   - The mainline connection for both stokes and patient is the stokes bridle

3. Lift the stokes basket just off the ground and use the attached prusiks to adjust the level of the basket to patient comfort or medical need.

If no attendant is going to be attached this is the complete setup.

4. If an attendant is going to accompany the patient
   - The mainline connection is to the stokes basket with a pick-off strap (to make the connection adjustable).
   - The back up attachment is a prusik to the belay line tail with a length of webbing to permit free movement.



Alternatively, the mainline connection could be to belay line and the back up could be the connection to the stokes -all depending on the needs of the patient and the comfort of the attendant.

Medium Angle

Medium angle connections are a combination of high and low angle rescues.

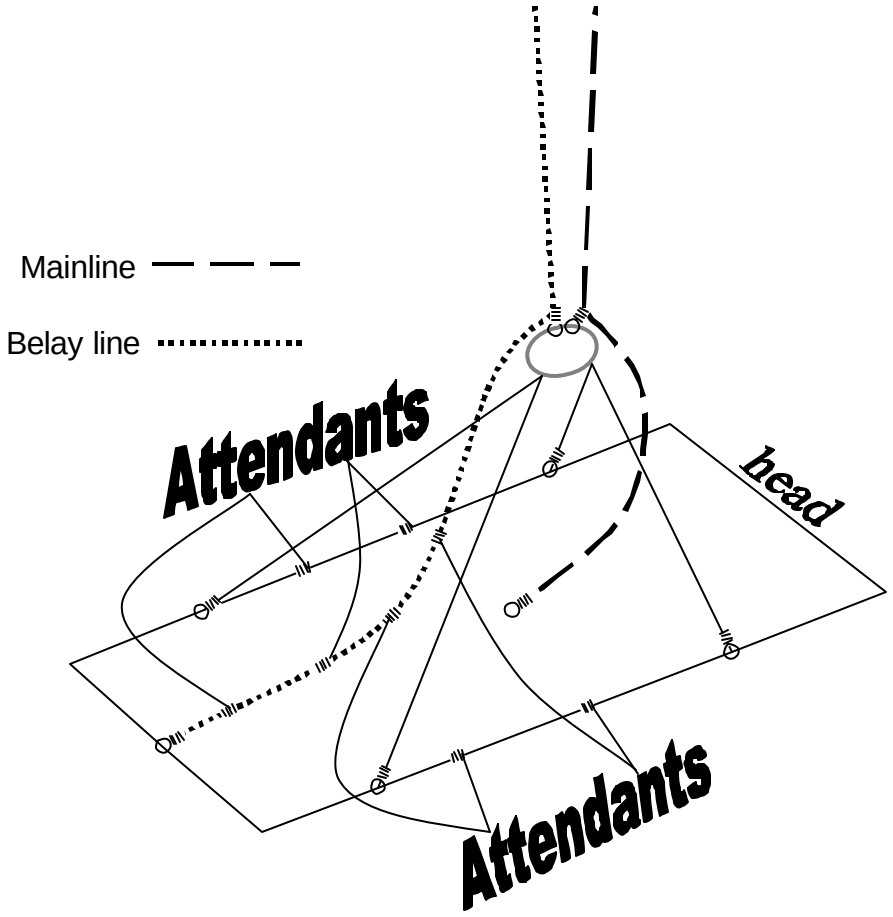
1. The mainline and belay line systems and stokes bridal are identical to the high angle rescue.

2. Raise the stokes off the ground and adjust the bridal to the direction of pull.

3. Tie two long tail bowlines:

    - The mainline tail goes to the patient (as their back up line)

    - The belay line tail is longer than in high angle and tied to the foot of the stokes and the attendant and litter bearers are attached to the belay line below the knot with a prusik and a section of webbing.



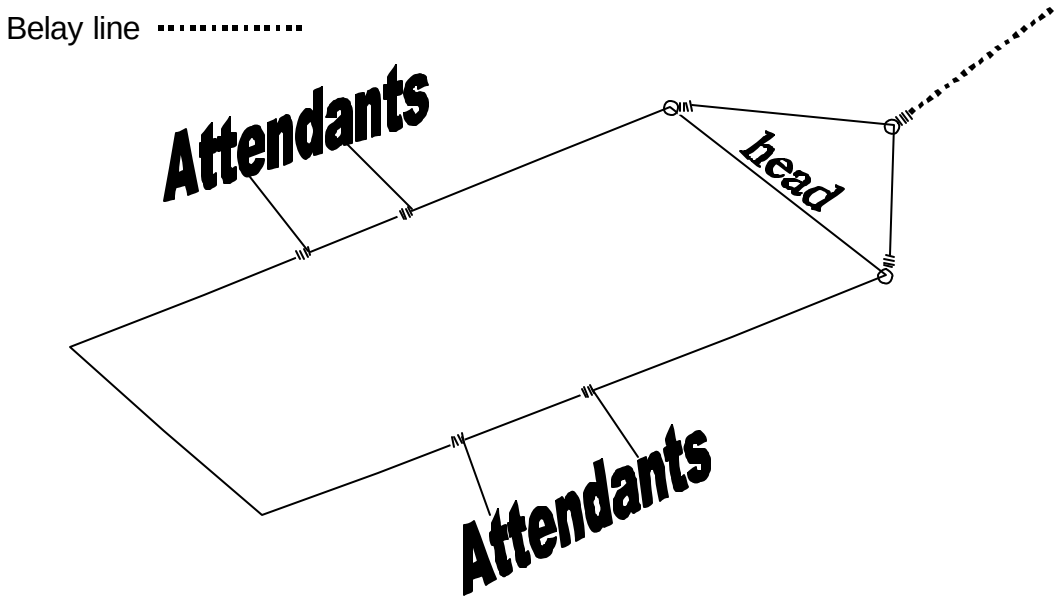
Low Angle

Single Line Belay Systems

1. Create a low angle system.

2. Attach the rescue line to the head of the stokes basket by tying a section of webbing or life safety rope to both side of the stokes basket and with an overhand on a bight or inline figure eight on a bight in the middle as a connection point.

3. The litter bearers are attached to the stokes basket by an adjustable strap either to their harness or depending on the slope by a hand held strap.



Lashing a Patient to the Stokes Basket

Regardless of the angle of rescue, the patient is connected to the stokes basket the same way.

1. Put the patient into a class 2 harness, (victim harness or hasty seat harness).

2. Put them into the stokes basket (remember medical treatment, depending on injury and protocol they should be back boarded and c collared prior to placement in the stokes basket.)

3. Secure the patient twice into the stokes basket with an interior and exterior lashing.

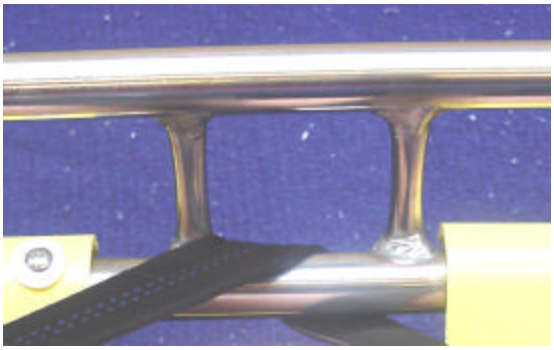
4. The interior is an X formed with two pieces of red webbing, girth hitched through the connection point of their harness and tied to the stokes basket with a round turn and two half hitches to the vertical posts.

    - The lower is tied about ankle level

    - The upper is secured over the patient's shoulders. (Tie an over hand knot about mid sternum to avoid choking the patient.)

5. The exterior lashing is a piece of black webbing (25') woven over the patient

   - Find the center of the webbing and place it at between the patient's ankles. Thread webbing up both sides of the stokes basket (like lacing a shoe). Use the lower rail where there are breaks in the basket to attach the webbing.



6. Secure one end to the vertical post below their neck with a round turn and two half hitches.

7. Start at the tied end and pull tension back through to the other end. Secure it in the same spot on the other side.
   - Tension the lashings so that the patient has no slack (but can still breathe).

8. Tuck the ends of the webbing into the basket under the patient to avoid tripping on them.

Safety

Safety is the number on concern at any rescue.

General Safety Rules

Critical Factors:

1. Every system must have a back up system. In most cases, this is in the form of a belay line. (For low angle scenarios, the “mainline” is the attendants feet and the belay line is the single rope.)

2. Whistle Stop Test. If every line was let go, the load must not fall.

3. Every system must be “safetied”. A touch every knot and piece of equipment in all systems to ensure that everything is correct.

4. Critical Point Test. If any one point were to break, the load must not fall.

General Rules

1. Every System will be over built. NFPA standard for life safety rope is 15:1 (this is only for the rope, not the entire system.) A 15:1 ratio with a 600-pound rescue load means that a 9,000-pound force will be exerted on the rope before it breaks.

2. Do not straddle the rope or work between two lines.

3. All rescuers must be on the look out for hazards and changing.

4. Everyone near the edge or in danger of falling will be attached to a travel limiter.

5. Everyone shall have the appropriate PPE on.

In addition to the normal hazards at a rescue scene (falling rocks, steep slope, etc) there are additional risks that rescuers need to keep in mind.

Common Causes of Errors

1. Lack of hands-on-safety checks
2. Rushing to rescue
3. Degradation of skills due to lack of training
4. Not asking for clarity when directions are confusing.
5. Not being focused on the task at hand.
6. Personnel not being self-limiting, attempting to perform a task they are not qualified or physically incapable of performing.
7. Attempting a rescue without all the necessary people present.

Equipment Limitations

1. Necessary equipment is not available on scene.
2. Equipment is being used in a manner inconsistent with the way it was designed.
3. The anchors not good enough to support the rescue load.

Communications

1. Rescue Group Leader neglecting the pre-rescue briefing or being too vague or too specific.
2. A misunderstanding of the definitions of the terms being used.

Lock Out/Tag Out

If personnel are to be working on, around, near, or reliant on a piece of equipment it must be de-energized and physically prevented from moving or being operated before it is entered or used. There are manufactured equipment that can be used to secure power sources. If none are available, it is acceptable to post a guard with a radio at the site to ensure the switch is not thrown or the vehicle moved. This guard is relieved of duty only when one of the following takes place:

1. The posted guard is relieved by another member who assumes the responsibility of the locked out/tagged out energy source.

2. Termination of lock out/tag out is relayed to the posted guard by Face to Face communication by a FD representative followed by confirmation (via radio or in person) with ALL of the following:
   - Safety
   - Operations
   - Rescue Group Leader

Upon termination of the incident, fire department personnel will leave the energy source de-energized until the owner and any investigating parties approve its re-energization.

Safety Checking the system

Before anyone goes near an edge, the system they are to rely on must be checked by a third party (who had no part in assembling the system.)

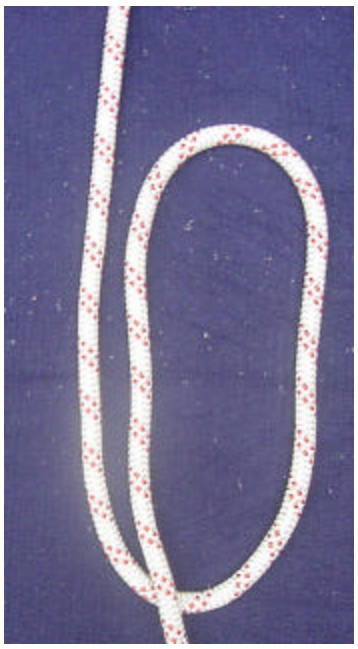
A safety check includes a hands on touch every connection in the entire system.

1. All Knots dressed, set and tied correctly.
2. Every carabineer to make sure they are locked.
3. Verify the strength of the anchor points.
4. Look for loose clothing, hair, or equipment that could get tangled in systems.
5. Check harnesses to ensure correct donning.

Appendix A

Step- by- Step Instructions

In Line Figure Eight



Create an overhand loop.

Wrap the loop behind the working end.

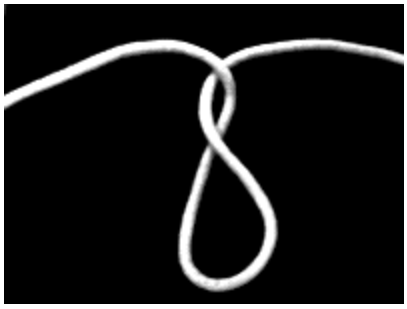
Wrap back across the top

And back through the loop (so that the end comes out the same way as the line.)

Butterfly

1. Take a bight

2. Twist



2. Take a second twist

3. Flip the original bight

4. And pull through second loop and dress out.

The butterfly is a bi-directional knot.

It can be placed in a line and pulled either direction.

Interlocking Long Tail Bowline

Tie one long tail bowline pass the second line through the loop of the first and around the ring.

Tie the second long tail bowline with this line. (Note these are designed so that if either line fails, the system below the knots will still be supported.)

3:1 Radium Release Hitch

1. First tie a figure eight on a bight dressed neatly as shown above.

2. Next, add a second carabiner and pass the line through; then back up through the first carabiner.

3. Now, place a muenter hitch on the second carbineer. Be sure it doesn't have to flip when tension is applied. This is how to tell if it is correct.

4. With remaining cordage take a bight, tie off with two half hitches. *The final distance between carabiner's should be about 10cm*.

5. Finish off the remaining cordage with a neatly dressed daisy chain.

Hasty Harness

1. Take a red (20') piece of webbing and find its mid point. Place this on your hip and bring the ends all the way around your waist.

2. Directly in front, tie a surgeons knot and pull it snug.

3. Make sure that the ends of the knot continue going the same direction and pass each end between your legs.

4. Feed the ends through the working ends you just made, making loops around your thighs; continue these loops around your body.

front view

side view

5. As the ends come around to the front wrap them around the original knot and continue wrapping around your waist.

6. When you get close to end of the webbing, finish the harness by tying the ends off in a square knot with a single overhand back up knot. This knot should end up off to one side.

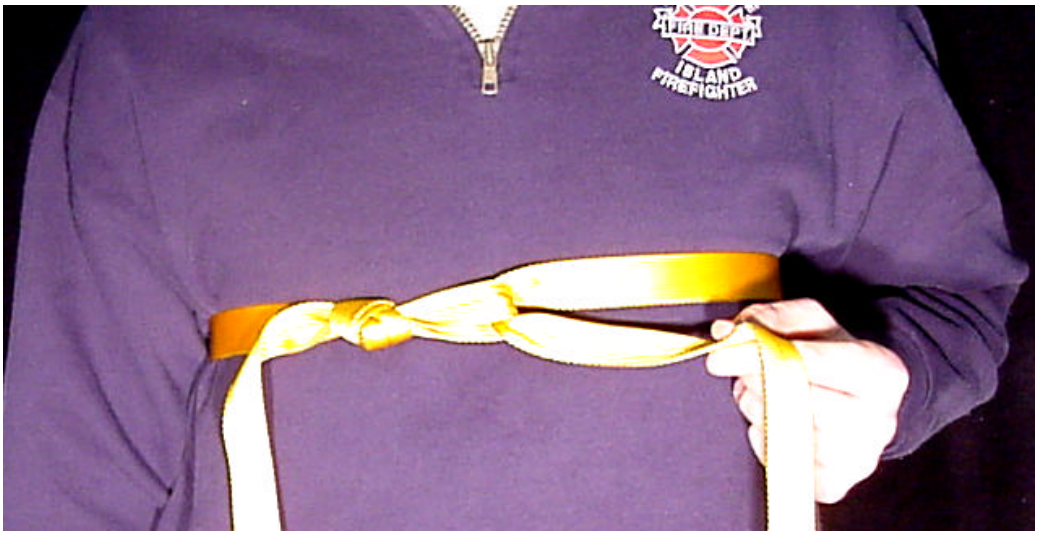
Note that the back up knots should be tied tight to the square knot; they are tied apart here for illustration purposes.

Hasty Chest Harness

Any seat harness can be made a class 3 harness with the addition of this simple chest harness.

1. Tie an overhand on a bight in one end of a yellow (12') piece of webbing, leaving about a 12 to 18 inch tail.

2. Pass the long tail around your chest about nipple height, insert the end into the bight and pull it snug.



3. Tie a half hitch where it is passed through the bight (to prevent the chest loop from constricting under load).

4. Pass the tail over a shoulder from front to back.

5. Tuck it under the strand between your shoulder blades.

And pass the tail over the other shoulder from back to front.

6. Tie this end to the end combing out of the overhand bend bight, with a square knot backed up with overhand knots.

Unlike manufactured harnesses, this harness must be tied, not clipped into.

Appendix B
Mechanical Advantage

Definitions

Mechanical Advantage

A force multiplying system where rescuers strength is increased to aid lifting the rescue load. The relationship between a given load and the amount of force required to move it, expressed as a ratio.

Simple

A single line connected to a load and anchor alternating through pulleys.

Compound

One mechanical system connected to another mechanical system (2 separate lines).

Complex

A system with pulley moving at different speeds (pulley are attached to the line they are ultimately pulling.)

General Rules

1. Pulleys on anchors are a change of direction and do not add to the mechanical advantage. (Figure 1)

2. If the pulley moves (is attached to the load) it adds to the mechanical advantage. (Figure 2)

3. If the haul line comes from the anchor, the system will be odd. (Figure 1)

4. If the haul line comes from the load, the system will be even. (Figure 2)

Look at it another way:

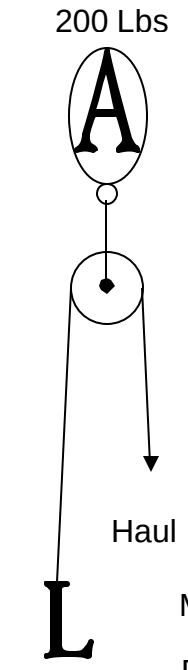


Figure 1

Figure 1. If the pulley is on the anchor and a 100-pound load is on one end the other end must also be supporting 100-pounds of load (the anchor would have 200-pounds). The mechanical advantage will be 1:1.

If the haul line moved a foot, the load would move a foot.

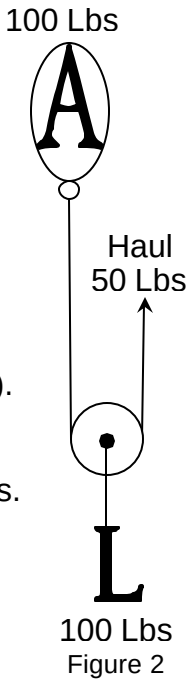


Figure 2

Figure 2. If the pulley is on the load (100 pounds), the anchor and haul ends would each only support half that (50 pounds). The system would be a 2:1 mechanical advantage.

If the haul line moved one foot, the load would move six inches.

To calculate the ratio, use the following expression:

$$\text{Mechanical Advantage} = \frac{\text{Effort}}{\text{Load}}$$

Do rescuers need to know what the specific mechanical advantage ratio is? Not practically, if there is not enough force to lift the object, add another pulley or more muscle to increase the effective effort. It is nice to know how to calculate this ratio.

Recognize that this is the theoretical mechanical advantage not the actual mechanical advantage; theoretical does not take friction into account so reality would be slightly different.

There are two methods to calculate this ratio: “Counting Lines” and “Adding Tensions”

Counting the Lines-Simple Systems

1:1

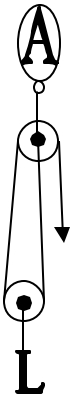
Figure 3

Counting the lines is easiest method for determining the ratio with a simple system (but can be used on complex and compound systems.)

To do this, cover the top half of the system (the anchors and its pulley’s) and count the number of lines attached to the load or to the pulley attached to the load. This is the effort. (MA=effort/load)

2:1

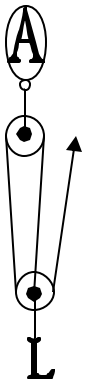
Figure 4



2:1

Figure 5

Add a pulley to figure 4 (creating figure 5), if the top section is covered there still are only two lines attached to the load. (A pulley attached to the anchor, is a change of direction and does not add to the mechanical advantage.)

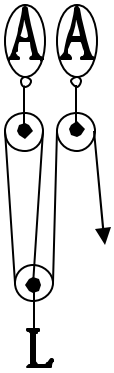


3:1

Figure 6

What if figure 5 was flipped end for end (figure 6), what would the mechanical advantage be? (Cover the top half and count the lines.)

Add yet another pulley to the anchor (figure 7), what does this do to the MA?



3:1

Figure 7

Counting the Lines-Compound Systems

Counting lines method is also easy to use to calculate mechanical advantage of compound systems. Compound systems, as defined earlier, are two separate systems connected together. To count the lines, figure the ratio of the individual systems separately.

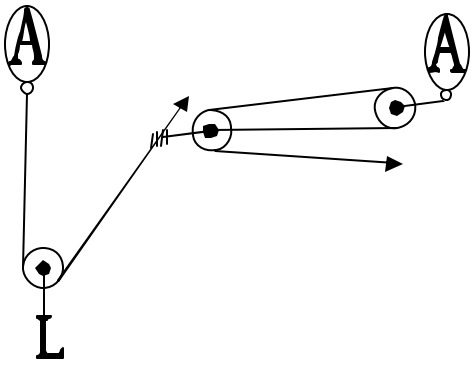


Figure 8

separate figure 10 from figure 9.

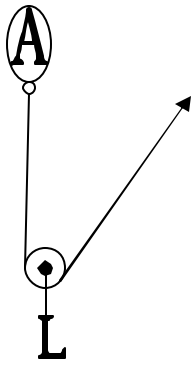


Figure 9

Figure 9 is a 2:1 just like figure 4.

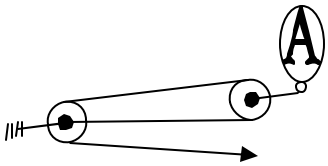


Figure 10

Figure 10 is a 3:1 just like figure 6.

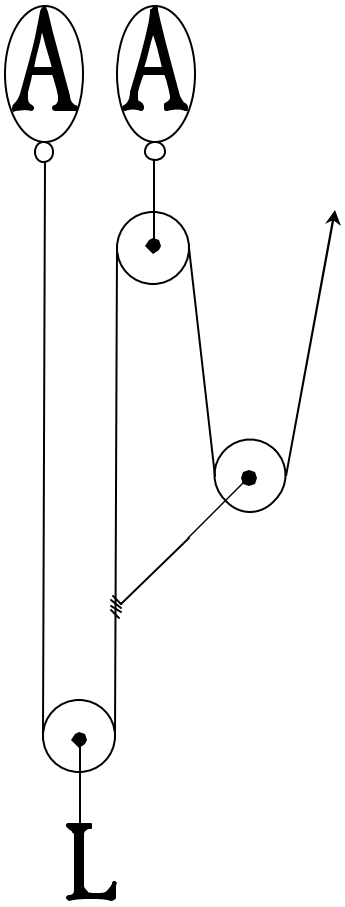
Any system piggybacked onto another effectively multiples the force so, to figure the total mechanical advantage, multiply the two ratios together.

2:1 x 3:1 = 6:1

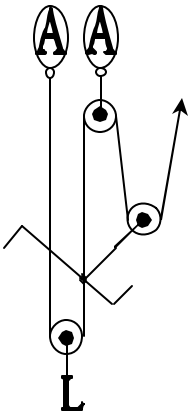
(Technically a ratio cannot be multiplied, but the principal works.)

Counting the lines-Complex Systems

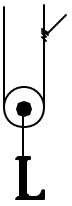
Complex systems are “solved” very similar to compound systems. Separate the system into two parts and figure out each independent of each other then multiply the load.



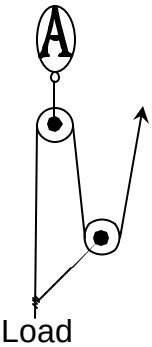
Separate the system into two separate parts at the line drawn below (at the prusik).



The lower part is a 2:1.



Treat the prusik just like a load (and count the lines), the upper part is a 3:1.



To figure the total mechanical advantage, multiply the two ratios together. 2:1 x 3:1 = 6:1

(Again, ratios cannot be multiplied, but the principal works.)

This is remarkable similar to the compound system shown above, this is complex because line going through the pulley attached with a prusik would move at a different speed than when it goes through the load pulley.

Adding the Tensions

Another way to figure out mechanical advantage is to figure out the tension each time a line is in contact with the load (tied to or on either side of a pulley.)

Figure 11

Consider figure 11, one unit of tension on the load will be one unit on the anchor.

Figure 12, two units on the load would equal one unit of load on each anchor.

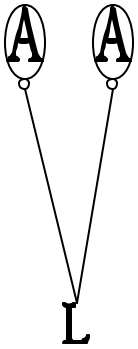


Figure 12

To count the tension, start at the haul line and write the unit of load as it passes through each device in a system. When done, add the tensions on the load, this is the mechanical advantage ratio.

Figure 14 one unit of tension on the haul line will pull one unit of tension on the load (and two on the anchor). Adding the tension is silly (because 1+0=a 1:1)

Place the pulley on the load, (figure 15). One unit of pull on the haul line puts one unit on the anchor and two on the load. Add the tensions 1+1=2 (a 2:1 ratio.)

Figure 16, start the line on the load and add a pulley to the anchor, one unit of tension on the haul pulls one through the pulleys and back to the load. (Adding the tensions at the load gives us a 3:1 ratio.)

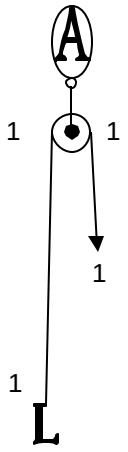


Figure 14

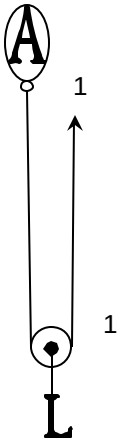


Figure 15

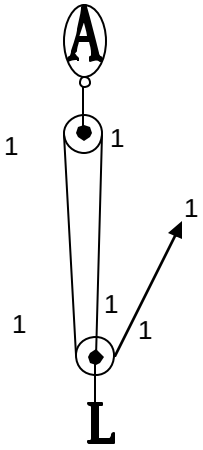


Figure 16

Adding Tensions-Compound Systems

Start at the haul line one unit of tension passes through all the pulleys.

Add the tension at the prusik (effectively splitting the system into two parts.) The system above the prusik is a 3:1 so three units of tension are passed to the other line.

Those 3 units pass through the pulley; add the tensions at the load pulley. 3+3=6:1.

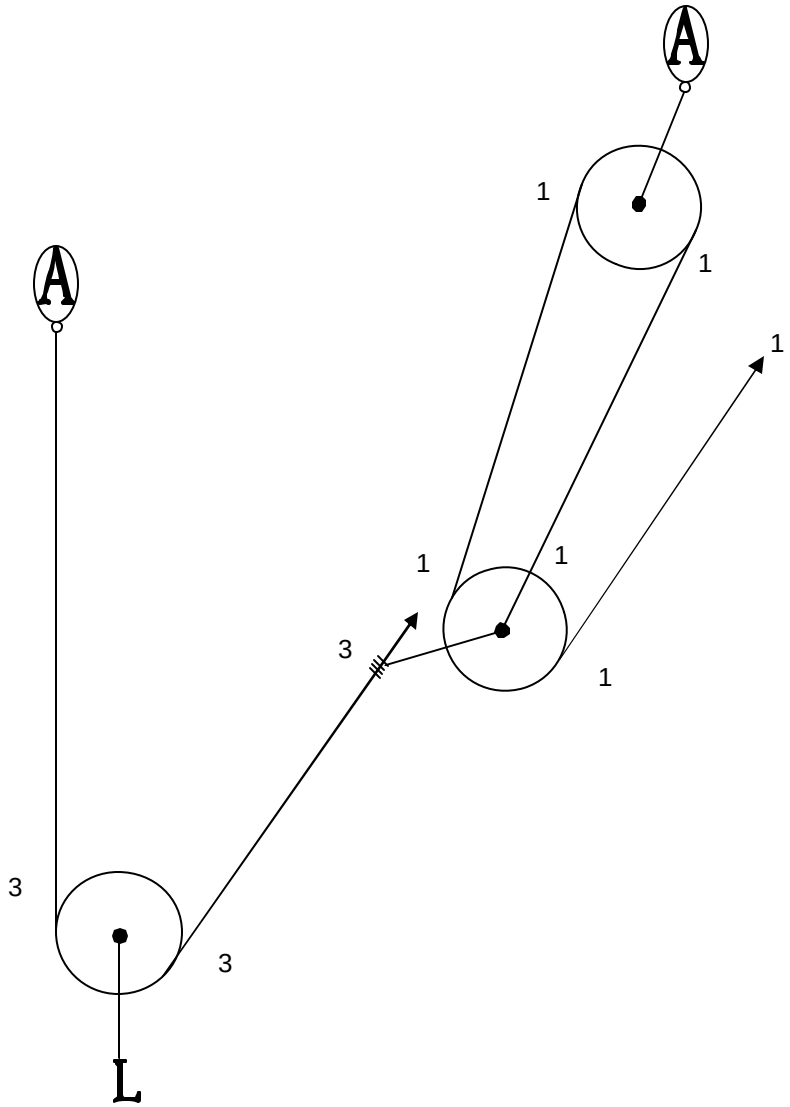
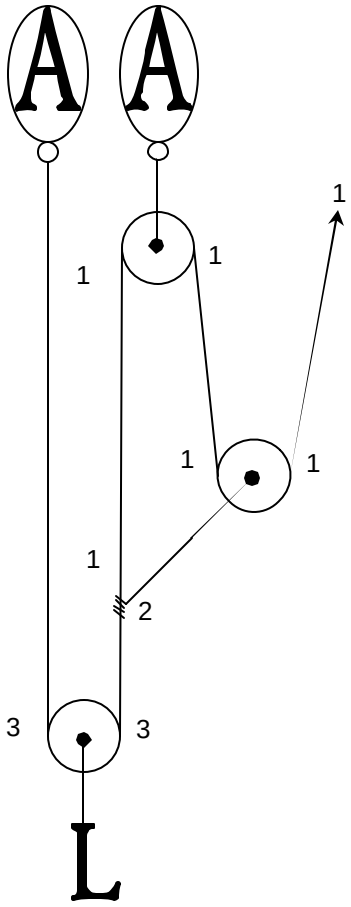


Figure 17

Adding Tension-Complex Systems

Start at the haul line with one unit goes through the first pulley, the second pulley to the prusik. Stop here and add tensions at the first pulley (1+1=2) this sum is the tension on the prusik, add the tensions at the prusik (1+2=3). This is the tension on the load pulley that is passed on the other side of the pulley. This is added together to get the mechanical advantage (3+3=6:1).



Appendix C

WAC 296-305-05005
Rope Rescue Operations.

(1) Fire departments engaged in rope rescue operations shall comply with the requirements of this section and WAC 296-305-02019.

(2) Employees engaged in rope rescue operations shall be properly trained and qualified by the employer to perform such activities.

(3) Employers shall establish standard operational procedures for rope rescue activities and training.

(4) When engaged in rope activities, employees shall be provided and wear either structural fire fighting helmets and gloves, or helmets that meet ANSI Standard Z89.1, 1986 edition, Class A and B; gloves.

(5) Records shall be maintained of inspections and repairs made to rope rescue equipment.

(a) Equipment shall be inspected after purchase and prior to placing in service, after each use, and at least semi-annually.

(b) Harnesses shall be inspected for worn or broken stitching, rivets worn out of holes, and damage from abrasion, cuts, or chemicals.

(c) Descending/ascending hardware shall be inspected for wear, cracks, distortion, sharp edges, and ease of operation.

(d) Equipment showing damage or wear that can affect employee safety, shall be either repaired prior to further use or retired.

(6) The manufacturer's recommended shelf life of rescue ropes shall be followed. If no shelf life is specified, ropes greater than six years old, whether used or not, shall be taken out of service or destroyed.

WAC 296-305-02019
Life Safety Ropes, Harnesses, and Hardware Protection.

(1) All life safety ropes, harnesses, and hardware used by fire departments shall meet the applicable requirements of NFPA 1983, Standard on Fire Service Life Safety Rope, Harness, and Hardware, 1990 edition.

(2) Ropes used to support the weight of members or other persons during rescue, fire fighting, other emergency operations, or during training evolutions shall be life safety rope.

(3) Life safety rope used for rescue at fires, or other emergency incidents, or for training, shall be permitted to be reused if inspected before, and after, each such use in accordance with the manufacturer's instructions and provided:

(a) The rope has not been visually damaged by the exposure to heat, direct flame impingement, chemical exposure, or abrasion.

(b) The rope has not been subjected to any impact load.

(c) The rope has not been exposed to chemical liquids, solids, gases, mists, or vapors of any materials, known to deteriorate rope.

(d) If the rope used for rescue at fires or other emergency incidents, or for training, has been subjected to (a), (b), or (c) of this section, or fails the visual inspection, it shall be destroyed after such use.

(e) If there is any question regarding the serviceability of the rope after consideration of the above, the safe course of action shall be taken and the rope shall be placed out of service. See Appendix B.

(f) Rope inspection shall be conducted by qualified inspectors in accordance with rope inspection procedures established and recommended as adequate by the rope manufacturer to assure rope is suitable for reuse.

(4) Fire departments shall establish written procedures for the use of life safety ropes and rescue operations utilizing harnesses and ropes.

(5) Records shall provide a history of each life safety and training rope. The minimum information to be reflected in the record of history of life safety and training ropes shall include: Date of manufacturer, organization serial number, use list to include inspectors name and space for comments.

(6) Rope used for training evolutions shall be designated as training rope and shall be permitted to be reused if inspected before and after each use in accordance with the manufacturer's instructions.

(7) The destruction of a rope means that it shall be removed from service and altered in such a manner that it could not be mistakenly used as a life safety rope. This includes disposal or removal of labels and cutting into short lengths to be used for utility purposes.

(8) All repairs to life safety harnesses shall be done by an authorized manufacturer's representative, or the manufacturer.

Note: See WAC 296-305-06003 (3), (4), (5), and (6) for the testing of life belts, ropes, and harnesses.

(9) Class I safety harnesses shall be used for fire fighter attachment to ladders and aerial devices.

(10) Class II and Class III life safety harnesses shall be utilized for fall arrest and rappelling operations.

(11) Rescue ropes shall be padded when deployed over edges or rough surfaces.

Note: See WAC 296-305-05005 for rope rescue applications.

Bibliography

1. WAC 296-305 Safety Standards for Fire Fighters.
2. NFPA 1983 Standard on Fire Service Life Safety Rope and System Components (2001 Edition).
3. NFPA 1670 Standard on Operations and Training for Technical Rescue Incidents (1999 Edition).
4. NFPA 1006 Standard on Rescue Technician Professional Qualifications (2000 Edition).
5. Seattle Fire Department Training guide #10.
6. Pierce county Training Guide
7. IFSAC Rescue
8. BIFD SOG 330
9. Clallam County Fire District #3 SOP
10. Rick Lipke's Technical Rescue Riggers Guide *Revised Edition 7/98*
11. TRBC Anchor Diagram.