

KINNELON VOLUNTEER FIRE CO, INC.

ROPE RESCUE TRAINING COURSE

PERSONAL EQUIPMENT AND PROTECTION

TERMS

Emergency Seat Harness – A temporary, tied harness to be used when a manufactured, sewn seat harness is not available.

Fully Body Harness – A type of harness that offers both pelvic and upper body support as one unit.

Helmet – Head covering that protects against head injury both from falling objects and from head impact.

HELMET

Designed not only for protection from falling objects, but also to reduce the severity of brain injury should the wearer happen to fall and hit his head. That is why only helmet designed for high angle work should be worn. A chin strap should be used to help keep the helmet on your head. The helmet should also have what is called a "three-point suspension" system. This means that there is support on both sides and a rear support which helps keep the helmet from falling over your eyes. The brim is usually narrow to keep the rope from knocking it off your head.

CLOTHING

Should be made of materials that will protect you from adverse environmental conditions and provide comfort. Do to the fact that a rope rescue may take some time to complete, you may want to be dressed for a long stay during inclement weather, to protect yourself from the chilling effects of rain or cold. An outerwear "shell" made of waterproof material such as nylon can help protect against both perception and the cooling effects of wind. One draw back of nylon is that with intense physical activity, the lack of air circulation under the shell may make you sweat, making the inside as wet as the outside. Polypropylene or Goretex™ may be a solution to this problem.

FOOTWEAR

Leather is one of the good multi-purpose boots that are recommended for high angle work. Boots should have good ankle support and protect feet from scraps, cuts, and bruises. To help maintain balance against surfaces found in high angle rescue environments, soles should have good adhesion.

GLOVES

Should be worn to protect hands from the weather and against burns and abrasions from a running rope. Should be made from soft leather, such as deerskin or goat skin. The heavy fire fighter gloves are often too thick to feel the rope and tie the knots.

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FULL BODY HARNESS

High angle harnesses are constructed of nylon or polyester webbing that wraps the pelvic region to support it and attaches the rescuer to the rope. Webbing should be at least two inches wide for comfort at the waist and thighs. Should be easy to put on and adjust. Should not slip down when you walk. Should not allow you to fall out when you hang upside down. Have front tie-in points to maintain a correct center of gravity whatever the activity you are performing. Have a metal attachment point usually a large "D" ring where the carabiners are clipped directly into.

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ROPE AND WEBBING

TERMS

Abrasion – Damaging wear on rope and other gear caused by their rubbing against harder material.

Fall Factor – Calculation used to estimate the impact of forces on a rope when it is subjected to stopping a falling person.

Dynamic Rope – Type of rope designed for high stretch to reduce the shock on the climber and anchor system.

Kernmantle – Rope design consisting of two elements: an interior core which supports the major portion of the load on the rope, and an outer sheath which serves primarily to protect the core and also supports a minor portion of the load.

Static Rope – Type of rope designed for low stretch. It is used in applications such as rescue, rappeling, and ascending where high stretch would be a disadvantage and where no falls, or very short falls, are expected before being caught by the rope.

ROPES FOR RAPPELING AND ASCENDING

When used for rappeling or ascending, the rope does not act as a safety for the person on the rope, but as a means of travel. You travel up the rope with an ascender and down the rope with a rappel device. For these kind of activities the preference is to use a static rope, which has very little stretch.

ROPES FOR RESCUE USE

Ropes designed for rescue share some of the characteristics to ropes designed for rappeling and ascending: low stretch and high resistance to damage from abrasion. In rescue work, the quality of low stretch means greater control of the rope for performing a rescue.

ROLE OF THE FALL FACTOR

A method of estimating the forces at work on a rope is by computing a measurement know as the fall factor. The fall factor is calculated by dividing the distance the person on the rope falls by the length of the rope between him and the point of protection.

Example: Distance fallen: 150 feet
$$\frac{\text{Length of rope: 100 feet}}{\text{Distance fallen: 150 feet}} = \text{Fall Factor: 1.5}$$

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ROPE AND WEBBING

ROPE FIBERS

Polyolefins™ – Polypropylene and Polyethylene

Kevlar™ – Dupont™ trade name for a type of Aramid™ fiber

Polyester – Sometimes know as Dacron™

Nylon – Two most commonly used are Nylon 6 (also known as “Perlon™”) and Nylon 6,6.

ROPE CONSTRUCTION

Laid – Consists of twisting small fiber bundles of material and then combining them in larger bundles, which are twisted around one another, usually in groups of three.

Double Braid – A solid braid covered with a hollow braid combined into one construction.

Kermantle – Consists of a central core (kern) of fibers which supports the major portion of the load on the rope. This core is covered by a woven sheath (mantle) that supports a lesser portion of the load.

Static Kermantle – A type of rope with very low stretch. Because of very little stretch this rope provides a more sudden stop when catching a fall.

SAFETY FACTOR OF ROPE

The first thing you need to do is to estimate what the maximum load you expect to be on the rope. Then take this number and using a safety factor of 15:1 calculate the minimum breaking strength. Example: if you have a rescuer, with equipment and you add a rescue subject and a litter with assorted gear, the total might near 600 pounds. The total breaking strength should be 9,000 pounds. $600 \times 15 = 9,000$

WEBBING

Most webbing is made of nylon or polyester materials that have the same characteristics as those used to manufacture rope. Use the same procedure for determining the safety factor of rope.

Construction – **Flat webbing** is constructed of a single layer of material the same as belt webbing. It is stiffer and more difficult to work with than tubular webbing.

Tubular webbing is more supple and easier to work with and is more often used in rope rescue work. There are two different types of tubular webbing:

Edge Stitched - Formed by folding over flat webbing lengthwise and stitching the two edges together.

Spiral Weave – Is constructed by weaving a tube as a unit. Traditionally more common in rope rescue operations.

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ROPE RESCUE TRAINING COURSE

CARE AND USE OF ROPE

ROPE HISTORY LOG

A card should be kept of every rope used for rescue work. The card should contain information on the manufacturer, diameter, tensile strength, date of purchase, etc. There should be space on the card to indicate each time and the type of activity the rope is used for.

TAGGING ROPE

Each length of rope should have its own permanent identification marking at each end of the rope.

STORAGE OF ROPE

Rope should be stored where it is protected from harm. Damage can occur when you do the following:

- a) Store it with knots still tied in it. This may eventually weaken the rope yarn.
- b) Store it in sunlight for long lengths of time.
- c) Expose to vehicle exhaust, fumes or residues from storage batteries.
- d) Leaving on floor, stepping on rope grinds in dirt and grit. Also, damaging substances and items can be dropped on the rope.
- e) Store in wet or damp area. Can cause mold or mildew on the rope.
- f) Store in areas of high temperatures. Can promote degradation of rope.
- g) Contaminate with dirt or grit. Works into the core and can damage yarn.
- h) Dragging a rope on the ground and stepping on a rope will force dirt and grit into the core which can cause damage.

BAGGING OF ROPE FOR STORAGE

The best way to keep rope stored and ready to use is to store it in a bag that is somewhat waterproof and durable enough to protect rope from damage. The rope can be flaked into the bag quicker than coiling, and can be deployed from the bag without tangles.

TECHNIQUES FOR AVOIDING ABRASION OVER OBJECTS

Various rope pads include: Canvas pads, fire hose, commercial rope protectors, packs, turnout coats, carpet squares, edge rollers, roof rollers, are just a few.

EFFECTS OF BENDING A ROPE

When ever a rope is place under load in a sharp bend, some strength is lost. Rope fibers on the outside receive a greater share of the load than those on the inside of the bend. One way to help prevent this situation form occurring is to use a pulley. When choosing a pulley, their effect on the rope can be estimated by using a 4:1 ratio. This means that a half inch rope should not have a bend that is less than two inches in diameter.

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ROPE RESCUE TRAINING COURSE

CARE AND USE OF ROPE

INSPECTING ROPE

Visually inspect rope, looking for:

- a) Discoloration – change in rope's original color.
- b) Glossy marks - could indicate heat fusion damage.
- c) Exposed core fibers (white in most static rope) – indicates damage to sheath.
- d) Lack of uniformity in diameter/size – may indicate damage to core.
- e) Excessive fraying – may indicate broken sheath bundles.
- f) Inconsistency in texture and stiffness – may result in soft spot that indicates core damage.

Run the rope through bare hands slowly, feeling for:

- a) Stiffened fibers.
- b) Obvious changes in diameter.
- c) Contamination with dirt and grit.

WASHING ROPE

Use of washing machine can thoroughly and effectively clean the rope. Use a front loading, tumbling type machine. It should have a glass window. Coil rope to prevent tangling. Use cool water. Use gentle soaps "safe for all fabrics" or Woolite™ or Ivory™. Do not use bleach.

DRESSING ENDS OF ROPE

Cut ends of rope should be dressed. Dressing the end of the rope can be done with heat such as small flame or a lighter. Taper the end of the rope slightly shape. This will prevent the ends from snagging on other materials and from growing in size. The dressing can also be done with a rope cutter. An alternative to melting the rope ends is to seal them with a liquid vinyl material such as Whip End Dip™.

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ROPE RESCUE TRAINING COURSE

HARDWARE

TERMS

Ascenders – Rope grab devices used to ascend a fixed rope or with specific types of ascenders, used in the creation of hauling systems.

Brake Bar Rack – (Rappel Rack) a descending device consisting of a “U”- shaped metal bar to which are attached several metal bars that create friction on the rope.

Cams – A generic term for ascenders that grip the rope through pressure. Some cams are spring loaded to assist in this function.

Carabiners – Metal snap links used to connect elements of a high angle system.

Edge Rollers – In line, free turning rollers that are anchored at an edge of a cliff or building to reduce rope friction.

Figure 8 Descender – A device used for rappeling and, in some cases, for lowering.

Locking Carabiners – A carabiner with a locking sleeve on its gate that secures the gate shut.

Pulley – A device with a free turning, grooved metal wheel (sheave) used to reduce rope friction, and with side plates to which a carabiner may be attached.

CARABINERS

- a) The basic parts include the spine, hinge, gate, and lock. When a “D” shaped carabiner is placed under load, the rope clipped into the carabiner will tend to slip into position on the spine side. This results in the stress being placed on the stronger side of the carabiner.
- b) The “D” shape carabiner under load places the stress onto the spine side rather than the gate side.
- c) For strength the carabiners used for rope rescue work are made of solid aluminum or steel. Rock climbing carabiners are not suited for rescue work.
- d) Gate opening should be large enough to be clipped over rope, litter rails, ascenders, etc.
- e) Locking carabiners can accidentally become opened do to various conditions.
 - 1) It comes in contact with a rock, a tree, a building edge, forcing the gate open.
 - 2) A rope or piece of webbing is pulled across the gate, forcing it open.
 - 3) Two carabiners used together with gates facing the same way. Place carabiners gates reversed or opposed to each other.

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ROPE RESCUE TRAINING COURSE

HARDWARE

CARABINERS – Continued

- f) Remember to check the locking knob after securing it in a system, an unlocked carabiner may fail, it is not as strong as a locked one. Lock only to light finger tightness. A carabiner's manner of function is designed for being loaded along its long axis, or lengthwise.
- g) Care of carabiners
 - 1) Clean gates by blowing out with an air hose.
 - 2) Lubricate gate mechanism with dry graphite. **DO NOT USE OIL OR GREASE BASED LUBRICANTS**
 - 3) Broken or bent carabiner should not be used and taken out of service.

DESCENDERS

- a) Figure or Friction 8 with "ears" the ears are specifically designed so that the rope contours better around the large ring and does not slip over it.
- b) Large Figure 8 is preferred because they dissipate heat better, will accept large size rope, easier to lock off.
- c) Brake Bar Racks offer a great amount of control and the ability to vary the amount of friction, so can be used for longer rappels. You should use a six bar rack for rope rescue work.
 - Consist of two primary elements:
 - a) An inverted "U" shaped frame, with one leg longer than the other. the longer leg has an eye which a carabiner can be clipped. The shorter leg is threaded, with a locking nut.
 - b) A series of bars with a hole drilled in one end so that they slide freely on the long side of the rack. The other end is notched so that the bar will clip into the short side of the rack. The rope is woven through the bars. When under tension, the rope keeps the bars in place on the rack. Friction for rappelling may be controlled by hand, by varying the bar spacing and by varying the number of bars engaged on the rope.

ASCENDERS

Ascenders are devices used to travel up a fixed rope. When correctly attached to the rope, their cam action allows you to slide the ascender freely in one direction. But lock in place when downward pressure is applied.

Cam ascenders are preferred in rescue work because of their higher strength, and they tend to hold better on wet, muddy, or icy ropes.

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ROPE RESCUE TRAINING COURSE

HARDWARE

ASCENDERS (continued)

Spring Loaded Cam Ascenders – A spring assists in setting the cam.

PULLEYS

Pulleys are designed to help reduce rope friction, to help keep rope from making a sharp bend which can brake the rope fibers when under load and to change the direction of a rope in a system. They are also helpful in a hauling system to develop mechanical advantage.

Parts of the pulley include:

Sheave (wheel) should have a diameter that is four times the diameter of the rope.

Side plates should be moveable so the pulley can be placed on the rope anywhere along its length.

Axles should have rounded bolt heads that will not snag rope, other gear, or rock.

Bearings two types:

- a) Ball bearing type turn slightly freer, sealed so is not contaminated by dirt, does not take stress (such as sudden blows) well.
- b) Bronze bushing type can be taken apart for cleaning, very strong, can be contaminated by dirt.

EDGE ROLLERS

Used to reduce friction of rope over an edge. Helps with lowering and hauling systems. Single unit sets are designed for cliffs and uneven surfaces found in natural terrain.

ROOF ROLLERS

Used as one unit for a 90 degree edge such as those found on buildings.

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ROPE RESCUE TRAINING COURSE

KNOTS

In this section you will learn seventeen different knots that you may need to use when working a rope rescue. You will be taught how to tie each knot and be given an example where it may be used.

TERMS

Bend - A knot that joins two ropes.

Bight - The open loop in a rope formed when it is doubled back on itself.

Running Part - The part of the rope that ties the knot. You will need approximately ten feet of rope to tie most of the major knots.

TYPES OF KNOTS

- 1) Butterfly - Used for anchoring and loading in three directions.
- 2) Clove Hitch - **NOT FOR LIFE BEARING USE!!** Can be tied directly on an object, adjustable hitch for rope, clinches down when force is applied.
- 3) Underhand Clove Hitch - **NOT FOR LIFE BEARING USE!!** Can be used to secure lashing cord to a stokes basket.
- 4) Split Clove Hitch - **NOT FOR LIFE BEARING USE!!** Can be tied on two sides of an object.
- 5) Drop Over Clove Hitch - **NOT FOR LIFE BEARING USE!!** Made before placing over an object.
- 6) Figure Eight - Placed on end of rope to indicate end is near when feeding rope through hands or used to keep end from slipping through equipment. Basis for other knots and bends.
- 7) Figure Eight Follow Through - Used for anchoring and tying end of rope into a harness. Tying around an object.
- 8) Figure Eight On A Bight - Used for anchoring and tying end of rope to a harness, litter and other rescue equipment.
- 9) MR (multi-rope) Eight - Used for anchoring and tying end of rope to harness. Most preferred knot when using rope for main life lines and belay safety lines.
- 10) Bowline - Used for anchoring.
- 11) Bowline On Object - Used for anchoring to an object. Place end of rope over or around an object then tie knot.

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KNOTS

TYPES OF KNOTS

- 12) Bowline On Self - Used for emergency evacuation from a building.
- 13) Square Knot – Used when tying ends of litter lashing.
- 14) Safety Knot – Used for backing up other knots.
- 15) Munter Hitch – Is a multi-directional friction knot. Used for belaying.
- 16) Water Bend – For tying webbing together to make two pieces longer or tying two ends together to form a loop.
- 17) Fisherman's or Prusik Knot – Used as a binding knot on a rope. Used when ascending a rope.
- 18) Overhand Knot – Used as a "foundation knot" for beginning other knots such as the Water Bend. As a backup to secure other knots. Must be pulled tightly and close to the knot it is backing. Used to secure ends of harness straps after tightening them.

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ROPE RESCUE TRAINING COURSE

ANCHORING

TERMS

Anchor – The means of attaching the rope and all other portions of the system to something secure.

Anchor Point – A single secure connection for an anchor.

Anchor System – Multiple anchor points rigged in such a way that together they provide a “bombproof” anchor.

Bombproof - An anchor that will not fail.

Directional – A technique for repositioning a rope at a more favorable angle than would exist using only its anchor.

Self-Equalizing Anchor – An anchor established from two or more anchor points that:

- a) Maintains near equal loading on the anchor points despite direction changes on the main line rope.
- b) Reestablishes equal loading on remaining anchor points if any one of them fails.

ANCHOR POINTS

Natural – Trees with good root system and large in diameter, rocks that are massive in size and are largely buried in the ground, pickets driven into earth, snow and ice

Structures – Structural columns, projections of structural beams, supports for large machinery, anchors for window cleaning equipment, brickwork with large bulk, such as corner walls.

Bomb Proof – Anchors that are so strong they will withstand any force that a system will deliver to them.

Elevator and Machine Housings – Take a length of rope and run it around the housing several times, then tie the ends together with a Figure Eight Bend.

Wall Section Between windows and/or Doors - If they are close enough together you can pass webbing or rope around the walls and then tie it together. This should be done on the opposite side you are use the main line.

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ROPE RESCUE TRAINING COURSE

ANCHORING

POSITIONING OF ANCHORS

An anchor should be placed close to and directly above the rescue subject when ever conditions allow. At times however, there may be circumstances where an anchor will need to be placed off to the side of the subject.

They include: a) Conditions where rocks or other dangerous objects might fall on the rescue subject or the rescuers.

b) Where there are conditions between the anchor point and the rescue subject that could endanger rescuers or damage equipment such as rope.

c) Where there are no suitable anchors directly above.

DIRECTIONALS

Is a technique for bringing a rope into a more favorable angle. This will involve setting another anchor point (this anchor should also be a bombproof anchor), and possibly attaching a pulley or a carabiner to the mainline to make it change direction.

MATERIALS FOR ANCHORS

Using the main line rope tied directly to the anchor point may be one of the easiest ways to establish an anchor. This method can be used in urgent situations. However, this may limit your ability to make modifications in your anchoring system. A solution is to use a shorter piece of rope of the same diameter or larger than the main line.

Use of webbing is a convenient material for an anchor. Webbing is good to make a continuous loop around an object. There is also a commercially made anchor made of webbing with metal loops sewn into the webbing.

KEEPING ANCHORS IN PLACE

There are a number of ways to secure anchors in place, we will cover some of them.

a) Tensionless Hitch – Wraps of a rope around a bombproof anchor. It is simple to do. It reduces stress on rope and equipment. It gives flexibility to deal with changing conditions.

b) Anchor Webbing – Tied in a girth hitch around an anchor point is a method for holding an anchor in place. A drawback to this is the temptation to cinch the webbing back on itself, this can create a potentially dangerous stress on the webbing.

EXTENDING ANCHORS

You can use lengths of rope to extend anchor if one its not available nearby. You must use static rope. An example of extending an anchor might be if there are not any good anchor points on a roof of a building. The static rope can be run over the edge or through an opening to a floor below where a good anchor can be found.

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ROPE RESCUE TRAINING COURSE

ANCHORING

USING VEHICLES FOR ANCHORS

A good anchor point to use if none can be found is an emergency vehicle. However, there are some safety guidelines you should follow:

- a) Begin by setting the parking brake.
- b) Chock the wheels.
- c) Shut off the engine and remove the ignition key if there is one.
- d) **DO NOT USE** bumpers, tow.

Good parts of a vehicle to use as an anchor point are axles, cross members.

LOAD SHARING ANCHORS

At times you may have anchor points that by themselves are not strong enough to maintain the load. One way to solve this problem is to create a multiple anchor system. If you use two anchor points each with a rope or sling around the anchor point, make them equal in length and clip them together with a carabiner.

WARNING: A concern for rigging any type of complex anchor is not to create too wide an angle between the legs of the anchor. Ideally, this angle should not exceed 90 degrees, and must never exceed 120 degrees.

SELF-EQUALIZING ANCHORS

This type of system will share the force of the load, equally to the anchor points, if the load is not directly in the center of the anchor points. When correctly constructed, this type of system has some important advantages.

- a) The forces on anchor points should remain close to equal, whatever the direction of pull.
- b) Should any anchor point fail, the system should readjust itself to where once again, there is close to equal loading on the remaining anchor point(s).

You will want to readjust the system so that the knots are less likely to run through the carabiners when the system readjusts. Try to design the system so that there is as little drop as possible should any anchor fail. Make all of the anchor points as bombproof as possible.

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ROPE RESCUE TRAINING COURSE

BELAYING

TERMS

Belay – The securing of a person with a rope to keep him from falling a long enough distance to cause them harm.

Belayer – The person who performs the belay.

Munter Hitch – A type of running knot that slips around a carabiner to create friction against itself.

BELAY SYSTEM

- a) A person tied to the rope and who is at risk of falling
- b) The rope that is attached to the person
- c) A belay device, in essence a braking mechanism
- d) The belayer, he controls the belay device and the rope, his main duty is to brake the rope should the climber fall

SITUATIONS REQUIRING A BELAY

Anytime a rescuer goes on a main line, or for any of the reasons listed below, a belay system should be used.

- a) In a rescue situation where there is a danger of falling
- b) When a person is crossing an area not generally dangerous, but there is a small area of exposure
- c) When a person is rappeling for the first time, or attempting a new skill which they are not sure of themselves
- d) When a person's mental or physical capabilities are diminished
- e) When environmental factors, such as potential rockfalls or areas slick with ice
- f) When one or more persons are being raised or lowered by rope

BELAYING SIGNALS

When belaying you should use the standard voice signals to keep from momentary confusion which can lead to an accident.

1. "ON BELAY" is used by the climber. It means "I am ready to climb or rappel are you ready to catch me if I fall?"
2. "BELAY ON" is used by the belayer. It means "I am ready to catch you if you fall."
3. "CLIMBING" or "RAPPELING" is used by the climber. It means "I am starting to climb."
4. "CLIMB" or "RAPPEL" is used by the belayer. It means "Go ahead."
5. "OFF BELAY" is used by the climber. It means "I am in a secure place now. I no longer need the belay."
6. "BELAY OFF" is used by the belayer. It means "I am no longer belaying you."

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RAPPELING

TERMS

Brake Bar Rack - A rappel device that consists of a series of short metal bars fixed to, and sliding along, a "U" shaped metal rack with an eye at one end for attachment.

Brake Hand - Usually the dominant hand, that grasps the rope to help control the speed of descent during a rappel.

Descender - A rappel device that creates friction by a rope running through it and is attached to a rappeler to control descent on a rope. Most descenders can also be used as a fixed brake lowering device.

Figure 8 Descender - A commonly used descender that is made roughly in the shape of the number 8.

Guide Hand - Usually not the dominant one, that cradles the rope to help in balancing the rappeler.

Locking Off - The technique of jamming a rope into a descender or tying off securely so that the rappeler can stop the descent and operate hands freely of the rope.

Rappelling - The controlled descent of a rope using the friction of the rope through a Descender.

HOW RAPPELING WORKS

A technique for rappelling uses friction with the rope to slow the rate of descent. Most techniques use a rappel device or descender. The rate of the descent is based on the amount of friction applied to the device used. This controlling action is usually done with the rappeler's dominant hand (brake hand). The other hand (guide hand) cradles the rope above the device.

USING A FRICTION FIGURE 8 WITH EARS

- a) Take a Friction Figure 8 in your guide hand
- b) Face the anchor with the rope running past you on the brake hand side
- c) Take a bight of rope in your brake hand and push it through the large ring from the top
- d) Bring the bight of rope around the end of the small ring and across the waist of the rappel device
- e) Pull the rope snugly around the Figure 8 descender
- f) Clip a carabiner to the small ring on the Figure 8 descender and into your harness
- g) Take the rope that is on the lower side of the Figure 8 descender in your dominant hand this is your brake hand **NEVER TAKE YOUR BRAKE HAND OFF THE ROPE**
- h) With your less dominant hand, lightly cradle the rope above the descender **YOU MUST NOT SUPPORT YOUR WEIGHT WITH THE GUIDE HAND**

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ROPE RESCUE TRAINING COURSE

RAPPELING

LOCKING OFF A FRICTION FIGURE 8 WITH EARS

To lock off a Figure 8 descender, have the brake hand allow rope to slide through the descender until the brake hand is about a foot from the rappel device. Now, hold the rope taut with the brake hand. In a continuous motion, use the brake hand to pull the rope in an arc from the rappel position, straight out in front of you, passing below the main line, bring the rope down across the rappel device. Pull the rope downward so it becomes trapped between the rope and the rappel device this action needs to be done rather quickly and can be mastered with practice. You need to be careful where you place your hands, they can become caught in the rappel device.

THE BRAKE BAR RACK

This type of descender several advantages for rappelling:

- a) It offers greater friction, and greater control than most descenders
- b) It provides the ability to change friction once the person has begun to rappel
- c) It provides the ability to easily rappel longer drops, because it does not heat up as much as a Friction Figure 8.

USING THE BRAKE BAR RACK (RIGHT HANDED OPERATION)

Hold the Brake Bar Rack in your hand with the locking nut to the right. Attach the Brake Bar Rack to your harness with a carabiner. Stand facing the anchor point. Disengage all of the bars except the one at the top of the rack. Load the rope onto the Brake Bar Rack from the top over the top large bar, the v-notch is where you place the rope. Reach behind the rack and pull the rope towards the anchor. Clip in the second bar and slide it up to trap the rope between it and the large top bar. Repeat this weaving process with the remainder of the bars, until all are used. The brake hand should be below the rack and off to one side. The guide hand should be resting on the bars of the rack, holding the bar ends between the thumb and fingertips.

To tie off the rack, make sure all bars are in place against the rope, bring the rope around the bottom bar and up towards the top bar, go across the top bar on an angle and under the rope. Do not trap the rope between the top bar and the main line, it will become tight and you may not be able to free it. If you are going to be tied off in this position for some time, or to do rescue work, take a large bight of rope in your hand and use it to tie an overhand knot in the main line that goes to the anchor point.

PREVENTING A RAPPEL OFF THE END OF A ROPE

When you are rappelling off an area and you may not know if the rope will reach the bottom. You do not want to rappel off the end of the rope. One way to prevent this from happening is to place a stopper knot in the end of the rope. The stopper knot should be a Figure 8 on a bight. This knot will form a loop to give you something to stand on while you figure out what you are going to do.

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ROPE RESCUE TRAINING COURSE

BASIC ASCENDING TECHNIQUES

TERMS

Ascender – A mechanical device, or a friction knot, that is used in ascending a fixed rope.

Ascending – A means of traveling up a fixed rope with the use of either mechanical devices or friction knots.

Ascender Slings – Attachments of webbing or rope that connect a person to his ascenders.

Cams – Mechanical rope grab devices without handles which slide in one direction on a rope and are used for ascending.

Prusik – A type of friction knot used in ascending.

Prusik Loop – A continuous loop of rope in which a Prusik knot is tied.

THE PURPOSE OF ASCENDING

Ascending a rope is in essence the opposite of rappeling. It may be necessary to ascend a rope if you become entangled in the rappeling device you are using. Also, you may have to ascend a rope if you rappel past your victim that you are rescuing and you can not be pulled back up.

HOW ASCENDING IS ACCOMPLISHED

WARNING NOTE – Ascending is a strenuous activity, to be attempted only by those persons known to be in good physical condition.

Ascending is accomplished through the use of rope grab devices, called ascenders. There are two basic types of ascenders:

- 1) Friction Knot – Most commonly used is the Prusik knot.
- 2) Mechanical Ascenders – These work by an offset camming action that presses against the rope to keep the device from sliding down the line. A common brand name is the Gibbs™ ascender.

Ascenders are attached to the user by slings (connectors made of either webbing or rope). These slings are connected to a foot harness, feet, or a combination of both. To do ascending properly, you need to use three ascenders, one for each of your feet, and one above you on the main line.

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BASIC ASCENDING TECHNIQUES

HOW TO USE A SELF RESCUE SYSTEM

Listed are the basic parts of the ascending system and how they are used.

- a) The harness attachment - you will need a Gibbs™ ascender placed above the rappelling device and above your head (but not out of reach) on the main line. Next a carabiner attaches to the Gibbs™ ascender you placed above, a pre-tied Prusik cord gets folded in two around the carabiner above, another carabiner is placed where the two loops of the Prusik cord come together, this carabiner gets attached to your harness.
- b) The feet attachment – you will need two pre-tied Prusik cords for each of your feet. Place the first Prusik cord on the main line just below the rappelling device this will be for you dominant foot. Next, place the second Prusik cord on the main line and push the knot up against the first Prusik cord knot.
- c) The operation of the system is as follows: after attaching all of the above equipment to the main line. The first thing you must do is lock off and secure your rappelling device with an overhand knot. The second thing to do is place your feet into the Prusik cord loops that you pre-made for your feet. Next, while you hold onto the main line lift yourself up to a standing position using the Prusik cords attached to your feet. Now, slide the Gibbs™ ascender up the main line as far as you can and make sure it sets. Sit back down into your harness. If done correctly you should have taken the entire load off of the rappelling device and can now free it or change it to another type of device if you have one. If you still have load on your rappel device you need to repeat the above procedure.
- d) Once you have completed the self rescue you reverse the procedures and remove the equipment, but keep it with you. Now, you can finish your rappel.

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ROPE RESCUE TRAINING COURSE

ONE-PERSON RESCUE TECHNIQUES

One person rescue techniques are procedures in the rope rescue environment in which a single rescuer has direct physical contact with a rescue subject. It does not mean that one person works alone, there are other people involved in the vital support activities such as belaying, lowering and hauling systems, spotting, etc.

This operation often involves the attaching of a rescuer directly to the rescue subject, with the rescuer controlling the rappel of both the rescuer and the rescue subject. Some situations where this technique may be needed are:

- a) Only one person is needed to perform the rescue
- b) There is a shortage of personnel and/or resources
- c) The urgency of the situation means there is no time to await additional personnel

EQUIPMENT REQUIRED

The following equipment will be needed for this operation, the rescuer already has a harness on.

- a) One main line rope with adequate safety factor for two persons
- b) One sewn, manufactured harness or webbing to be made into a rescue seat
- c) One rappel device with enough friction to handle the weight of two people
- d) Four large, locking carabiners, one pick-off strap

WARNING: During one-person rescue operations, anchors, rope, hardware, and personnel are subjected to sudden increased loads, shock loading, and loads that may come from directions different from those originally anticipated.

DOING A ONE-PERSON RESCUE

Do to the fact that the anchor system will be subjected to the weight of two people, you want to make sure that the anchor system is going to hold up to this type of loading. Also, make sure that the rope is long enough to reach the bottom. Next, after you secure the main line and the belay line to their anchor points, drop the main line over the edge making sure you do not hit your victim with the rope. Now, attach the Brake Bar Rack to your harness with a large carabiner and load the main line on the Bar Rack. Take the nylon bag marked "pick-off" with you and rappel down to your victim. Once you are about two feet above the victim, stop and tie off the rappelling device. Take one of the pick-off straps out of the bag and secure the end with the adjusting buckle to the victims harness with a carabiner and the other end to the main line knot with a carabiner. Now, pull out any slack in the pick-off strap. Tell your victim try to stay in a sitting position, place their hands on your legs, and have them face you. Check all carabiners to make sure they are locked. If everything is ready start your rappel and go slowly.

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ROPE RESCUE TRAINING COURSE

ONE-PERSON RESCUE TECHNIQUES

MAKING A SAFETY SEAT HARNESS

If possible use two inch wide webbing at least twenty feet long. Tie a water knot to form a loop in the webbing. It is easier to place the webbing on the subjects if you can do it from behind them. Place the loop across the shoulders so that the sides of the loop hang down along his side and the top of the loop runs across the back of his neck. With both hands, reach around the sides and under the arms of the subject and have the vertically hanging sides of the webbing loops go to the outside of your arms. Now reach down with either or both hands, between the subjects legs from the front and grasp the bottom of the loop. Pull the loop back through the subject's legs and up toward the front of his waist. As you pull the loop up the section across the back should fall down. Bring the two loops back to the center together and clip a locking carabiner across them together.

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ROPE RESCUE TRAINING COURSE

SLOPE EVACUATION

TERMS

Haul Team – The group of people who provide the power to raise the load

Litter Tender – The person who physically manages the litter in the evacuation

Packaging – The placing of a rescue victim in a litter so that the primary medical considerations are cared for and the subject is physically stabilized in the litter

Safety Cam – A cam type ascender or knot that is placed on the rope in a litter hauling system to prevent the rope (and litter) from unintentionally slipping back down

Slope evacuation might be a more commonly used operation in our area than high angle rescue. There are a lot of steep slopes that can be navigated by foot, but if you were to add the job of trying to handle a victim in a litter, it might be hard to control the ascent and descent without the help of a lowering system or hauling system.

ELEMENTS OF SLOPE EVACUATION

The Litter – Must be strong enough to support the weight of the rescue victim and withstand blows from hitting rocks, trees, and other hard objects. Tie-in points to attach ropes, rescuers, and patient protection.

Rope – Static kernmantle type. Is generally attached to the head of litter.

Braking System – Used for lowering a litter down a slope. Use of a friction device makes it easier to control the rate of descent of the litter.

Hauling System – Used for raising litter up a slope. Provides the force to safely and efficiently raise the litter.

Litter Tenders – Usually no more than four attendants are used.

Litter Tie Ins - To maintain better footing and stability attendants can be tied into the litter.

PACKAGING THE SUBJECT IN THE LITTER

The major considerations for packaging a victim include:

- a) The medical condition of the victim
- b) The victim not be further harmed by being carried in the litter
- c) The victim be protected from cold, rain, snow, etc.
- d) The victim be physically stabilized so he does not shift whatever the angle or nature of litter movement
- e) The victim remains as comfortable as possible since it may be a long evacuation.

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ROPE RESCUE TRAINING COURSE

SLOPE EVACUATION

PROTECTING THE SUBJECT IN THE LITTER

Underside - When using a wire basket stokes protect the bottom from protruding objects
With a tarp or blanket.

Topside - Protect from wind, cold, and rain. Blankets will keep subject warm. While a windproof/waterproof outer layer will protect from wind and rain.

Face and Eyes - Protect the subjects face and eyes from branches, falling debris, rain or snow with a litter shield, face shield, or at least goggles and a helmet.

Backboard - If the victim's injuries require the use of a backboard, make sure it is well secured into the litter

Securing Subject In Litter - Using at least thirty feet of lashing rope. Find the center of the rope. In the center of the litter foot railing, tie off the center of the rope. Begin to lace the rope through opposite points along the side of the railing until you reach the middle of the subject's chest. Tie off with a clove hitch on the railing sides.

BRAKING SYSTEMS

It is better if you use a Brake Bar Rack because you may need to vary the friction when lowering the litter. If you are on a steep slope, there is loose or slippery footing, large boulders, or thick underbrush you may want to use a Belay.

HAULING SYSTEM

If possible it may help to set up a hauling system to assist the litter tenders. Remember to use the safety cam when setting up the system. The safety cam should be connected to a secure anchor system, and if possible, separate from the anchor system used for the hauling system. Don't forget if you are using a Gibbs™ ascender that the arrow faces the load. Place the safety cam close to, and parallel to, the main line. Make sure you have someone operating the safety cam while hauling up a load. A spring loaded cam will close on the rope when needed. But, will ride up the rope as the rope moves, unless released.

Another type of safety can be used if you do not have a mechanical safety cam is a Prusik cord. Wrap the Prusik cord around the main line three times. You need to practice using these two types of safety's.

SAFETY FOR PERSONNEL

One problem in slope evacuations is the safe movement of personnel up and down the slope due to terrain and weather conditions. To help avoid this problem immediately establish well anchored safety lines and place them off to the side away from the rescue victim.

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ROPE RESCUE TRAINING COURSE

HAULING SYSTEMS

TERMS

Haul Cam – A cam ascender (or Prusik knot) that grips the rope to provide the “bite” in hauling.

Load Release Strap – A type of strap device used in a hauling system that allows you to release the load onto a belay line, so you can free an object caught in the system or to change the system to a lowering system.

Mechanical Advantage – The relationship of how much load can be moved to the amount of force it takes to move it.

Safety Cam – The cam ascender (or Prusik knot) in a hauling system that prevents the rope and the load from accidentally slipping should a mishap occur to the haul system.

Tag Line – A line attached to a load that can be used to maneuver the load to prevent it from snagging, and to hold it away from a vertical face.

Z-Rig – Common name given to a specific type of 3:1 hauling system. The name is taken from the general shape that the rope makes as it runs through the system.

HOW HAULING SYSTEMS WORK

A hauling system makes the job of raising a load easier by spreading the work over distance of the rope. The relationship of how much load can be moved to the force it takes to move it is referred to as mechanical advantage. The way to calculate the mechanical advantage is by the weight of the load to the force it takes to move it. If you have a rope that goes down a drop 10 feet and you connect the rope directly to the load that weighs 100 pounds and it is a straight haul, the required force is 100 pounds. It will also take 10 feet of rope to do it. This would be a ratio of 1 to 1.

If you have the same 10 foot drop and the same 100 pound load and you place a pulley on the load (this is known as a traveling pulley). The rope is anchored at the top. It then runs through the pulley and back to the top where you can pull it. Now you have 20 feet of rope, and two strands of rope that are moving. You will pull 20 feet of rope to move the load 10 feet. As a result of having half the load on the anchor and half the load on the side you are hauling, you will pull with a force of 50 pounds. This would be a ratio of 2 to 1.

Now, take a pulley, place it on an anchor, this will become a stationary pulley. The main line will go to the load. On the main line as close to the load as possible place a Gibbs™ ascender, to it attach a pulley with a carabiner. Take the main line from behind where the Gibbs™ ascender is attached and place it on the pulley that is attached to the anchor. Now run the main line through the pulley attached to the Gibbs™ ascender. This particular type of system is commonly called a “Z-rig”. This would be a ratio of 3 to 1. Remember to always attach a load release to this system.

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ROPE RESCUE TRAINING COURSE

HAULING SYSTEMS

THE ROLE OF CAMS IN HAULING SYSTEM

In hauling systems, devices referred to as cams are used to grip the rope. These devices are usually one of two types: Cam ascenders or Prusik knots.

A cam will serve the following purposes:

- a) To grasp the rope so it can be pulled by the hauling system. This is known as a haul cam.
- b) To hold the rope while the haul team resets itself to get another bite on the rope. This is known as a ratchet cam.
- c) To act as a safety by grabbing the rope in case the haul team slipped and let go of the rope. This is known as a safety cam.

In many hauling systems, the ratchet cam and the safety cam can be the same. The Prusik knot can be used in all of the above situations.

For the safety cam to offer the greatest protection against failure in other elements of the hauling system, it should be positioned as far forward of the hauling system as possible, while still being safely in reach of the rescuers. If you are working on a building the safety cam should not be placed over the edge of the building, it may become caught on the edge when you start to haul.

In almost every situation where you use a cam, you will need someone to attend to it for either setting or unsetting it.

WAYS TO PROTECT THE ROPE FROM EDGE FRICTION

One problem in the rigging of hauling systems, that often goes unnoticed until it causes a problem is rope friction. Because the ropes are often highly loaded, there are two significant problems that can result:

- a) It can result in a tremendous increase in load for the haul team
- b) It can result in severe damage to the rope and other equipment

Possible solutions to edge friction include:

Edge Rollers – One of the most efficient solution to edge friction. However, they must be centered under the rope and securely anchored at each side.

Directionals – A pulley is used to hold the rope above the edge.

Changing the Position of the Haul Rope – Moving the rope to a higher angle above the edge so there is less friction.

Rope Padding – This may only slightly reduce the friction problem. But, significantly reduce the damage to the rope.

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ROPE RESCUE TRAINING COURSE

HAULING SYSTEMS

TAG LINES

Can be used for controlling the movement of a litter and preventing it from hanging up during a hauling operation. Usually used in hauling litters. It can help to keep the litter away from a wall and from getting hung up on overhangs. Also, can keep the litter from spinning on free hanging hauls.

GETTING OVER THE EDGE

Getting the litter over the edge when hauling can be very difficult. Below are some tips.

- a) Tie short tag lines on head and foot of the litter before starting the haul.
- b) Securely tie in edge attendants.
- c) Before the litter makes contact under the edge, stop the haul.
- d) The litter attendant will hand each of the edge attendants the a tag line, one for the foot and one for the head.
- e) Restart the haul very slowly but, be prepared to stop instantly should the litter hang up.
- f) The litter attendant pushes his feet against the face and pulls the litter rail opposite him and away from the face, the two edge attendants help to pull the litter up and over the edge.

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ROPE RESCUE TRAINING COURSE

LOWERING SYSTEMS

TERMS

Brakeman – The person who operates the braking device for controlling the rate of descent of the load in high angle lowering.

Edge Tender – A person connected to a safety attachment who works at the edge of a drop in a rope rescue lowering. Duties include assisting in getting the litter over the edge, reducing edge abrasion to the rope, and relaying communications between the litter tender and the brakeman.

Load – The object/person being lowered by rope in a rope rescue lowering. This might include a rescue subject, a rescuer, and subject in a litter with attached litter tender.

Spider or Harness – A device that attaches the rope to the litter. The spider has four legs that connect to various points of a litter to equalize loading. Each leg can be adjusted so you can place the subject's head above their feet.

THE LOWERING SYSTEM

Sometimes called vertical lowering or technical lowering. Both are basically the controlled lowering of a rescue subject using rope. If the subject is injured the lowering is done with the subject packaged in a litter.

At times you may work on the inside or on the outside of the following environments:

- Cliffs
- Buildings
- Other structures such as cranes, towers, stacks, or silos
- Vertical caves

The basic elements of a lowering system include:

- a) The Load – This is often the subject packaged in a litter. But if the subject is injured the rescuer may be attached to the litter.
- b) The Litter Tenders – This may be one person, or may require two litter tenders.
- c) Attaching the Load to the Main Line – The litter is attached to the main line with spiders. They usually have at least four adjustable legs that attach to the litter and come together where the main line attaches.
- d) The Main Line(s) - These lines must have a safety factor adequate for the load they are to lower.
- e) Belay System – This is attached to the load and acts as a safety should there be a failure in the main line lowering system.
- f) Brake Device – These friction devices that are the same as, or similar to, rappel devices. They provide friction on rope running through them to control the descent of the load.

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ROPE RESCUE TRAINING COURSE

LOWERING SYSTEMS

The basic elements of a lowering system include: (continued)

- g) Brakeman – This person controls the speed of the descent of the load by controlling the rope through the brake system.
- h) Rope Handler – This person assists the brakeman by feeding him the rope and making certain there are no kinks to jam the brake device.
- i) Belayer – This person controls the belay rope through the belay device and catches the load with the belay rope should the main lowering system fail.
- j) Edge Tenders – They assist the litter tender(s) in getting the litter over the edge of the edge of the drop, prevent rope abrasion on the edge, and, if needed, relay voice communications between the litter tender and the brakeman.

BRAKING SYSTEMS FOR LOWERING

The best device for this operation is the Brake Bar Rack. But, you can also use a Friction Figure Eight. One thing to remember when choosing a friction device is that you may be lowering more than one person on this device, so there must be a greater safety factor for the device because of more weight placed on the rope.

BELAYING FOR LOWERING SYSTEMS

The belay system should be set up on a separate anchor system from the main line and far enough apart from the main line that they do not interfere with one another and possibly have the ropes become tangled. However, the main line and belay line should be close enough to prevent a dangerous pendulum should the main line fail and the belay has to catch the load. Remember that the anchor system for the belay must be able to hold the weight of the rescue load plus any force from shock loading.

LOWERING SYSTEMS FOR USE WITH THE LITTER

This type of operation takes a lot of teamwork and skills in rope management. The system also requires a higher load rating than a one person lower. The increased loading mean greater stresses on the entire vertical system, including ropes, carabiners, knots, anchors, braking systems, and belay systems. These loadings include the combined weight of litter, hardware, and other rescue gear; the rescue victim; and one or two litter tenders.

Single Rope Lowering – Is used when the litter needs to have only one tender accompany the victim. You need to use a main line and a belay line with this operation.

Double Rope Lowering – Is used when the litter needs to have two tenders accompany the victim, such as a complicated medical problem or the vertical face is too difficult to manage for one tender.

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ROPE RESCUE TRAINING COURSE

LOWERING SYSTEM

RESCUE VICTIM TIE-IN

If possible the victim in the litter should be wearing a harness. A safety sling runs from the victim's harness to the carabiners at the top of the spider. Always leave slack in the safety sling so the victim will not be pulled upwards if the litter tilts.

LITTER TENDER TIE-INS

A litter tender tie-in serves the following purposes:

- a) To support the weight of the tender so that he can have his hands free to help manage the litter and attend to the victim.
- b) To provide safety from falling.
- c) To allow freedom of movement for the tender. This will allow you to move around the litter to clear possible tangles, to clear obstructions under the litter, and to reach all portions of the victim.