Zone 3 Technical Rescue Manual

Rope Rescue

Rope Rescue Manual Committee

F.F. Dale M. Laginess, Auburn Fire Department, Chair
F.F. Ian Bird, Kent Fire Department
Lt. Henry Dykes, Renton Fire Department
F.F. Karl Hangartner, Mountain View Fire and Rescue
F.F. Scott Howard, Kent Fire Department
F.F. Mark Morales, Tukwila Fire Department

Contents

Roles and Responsibilities

Rescue Group Leader (RGL):

Reports directly to the on scene Incident Commander.

Meets technician level standards for rope rescue under NFPA 1670 and 1006.

Is responsible for direct supervision of the rescue team operations. (1670)

Determines RESCUE or RECOVERY mode. Performs a continuous hazard analysis and risk assessment. (1670)

Provides passport accountability and maintains an ongoing awareness of the location and condition of all members. (1500)

Provides and maintains safety and scene security. (1500)

Makes key assignments of personnel:

1. Technical Safety Officer
2. Rigging Team Leader
3. Entry Team Leader
4. Support Team Leader
5. Back-Up Team (as required)

Determines an action plan, communicates the plan, and ensures that the plan is adhered to. Develops a back-up contingency plan. (1500)

Ensures that the appropriate PPE is utilized and equipment to provide protection from those hazards to which personnel are exposed or could be exposed is provided. (1670)

Initiates, maintains, and controls incident communications. (1500)

Ensures that medical care at a minimum level of basic life support (BLS) is provided. (1670)

Conducts pre-entry briefing with the entry team.

Ensures that all rope systems have been safety checked by the Technical Safety Officer and Rigging Team Leader prior to operation.

The RGL is the only person at a rope rescue incident who can initiate motion of the rope system *or* restart the rope system if stopped or re-set. (The RGL may delegate this function to the Entry Team Leader.)

Technical Safety Officer (TSO):

Reports directly to the Rescue Group Leader.

Meets NFPA 1521, Standard for Fire Department Safety Officer **and** meets technician level standards for rope rescue under NFPA 1670 and 1006.

Performs a continuous hazard analysis and risk assessment. Provides direction with respect to the overall safety of personnel. (1670)

Ensures scene security.

Ensures that the appropriate PPE is utilized and equipment to provide protection from those hazards to which personnel are exposed or could be exposed is provided. (1670)

Ensures passport accountability and maintains an ongoing awareness of the location and condition of all members. (1500)

Is aware of and approves the action plan and ensures that the plan is adhered to. Is aware of and approves the back-up contingency plan.

Ensures that medical care at a minimum level of basic life support (BLS) is provided. (1670)

Is present at the pre-entry briefing with the entry team.

Ensures that all rope systems have been safety checked by the Rigging Team Leader then double-checked prior to operation by the TSO.

Ensures that the Entry Team has been safety checked by the Entry Team Leader then double-checked by the TSO prior to deployment.

Ensure that the Entry Team is properly equipped, properly secured, and all equipment and medical supplies necessary for the treatment and packaging of the patient(s) is present and secured.

Rigging Team Leader (Rigger):

Reports directly to the Rescue Group Leader.

Meets technician level standards for rope rescue under NFPA 1670 and 1006. The Rigging Team Leader should be the person on location who possesses the most experience and knowledge of rope based rescue systems.

Assists the RGL in determining:

1. The type of rope system(s) to be utilized.
2. The location from which the rope system(s) are to be based from.
3. Selecting the location and type of the anchor point(s).

Responsible for direct supervision and safety of personnel assigned to the Rigging Team. (Main Line and Belay Line Team).

Understands the action plan and communicates the plan to personnel assigned to the Rigging Team.

Responsible for the engineering, construction, and operation of all rope based systems utilized during the operation. This responsibility includes “visualizing” the integrity of the rope system(s) in motion, and its effect or potential effect to all personnel who depend on the rope system(s) for their safety as well as to personnel working on or around the rope system(s).

Determines a contingency plan prior to the initial operation of the rope system(s) that addresses the utilization of additional rope systems in case of an emergency. This plan shall be worked out in advance with the RGL and approved by the TSO.

Ensures that all rope systems have been safety checked then double-checked by the TSO prior to operation.

Entry Team Leader (ETL):

Reports directly to the Rescue Group Leader.

Meets technician level standards for rope rescue under NFPA 1670 and 1006.

Responsible for direct supervision and safety of all personnel on the Entry Team and Backup Team.

Understands the action plan and communicates the plan to personnel assigned to the Entry Team and Backup Team.

Responsible for ensuring that all personnel on the Entry Team and Backup Team (if utilized) have proper PPE and have the ability to communicate with the Entry Team Leader or RGL.

Responsible for ensuring that the Entry Team is properly secured to the rope system(s) prior to deployment.

Ensures that any necessary PPE and/or medical equipment necessary for the patient is available and properly secured prior to deployment.

Maintains an ongoing awareness of the location and condition of all Entry Team members.

Ensures that the Entry Teams PPE and their attachment to the rope system has been safety checked and approved by the TSO prior to deployment.

The properly secured Entry Team Leader should position himself/herself in such a manner as to have continuous line of sight (if at all possible) with the Entry Team as well as with the Main and Belay Line Teams to facilitate communicating the starting, stopping, re-setting, and speed of the rope systems.

The Entry Team Leader (or RGL) is the only person at a rope rescue incident who can initiate motion of the rope system *or* restart the rope system if stopped or re-set.

The RGL may elect to perform the duties of Entry Team Leader in addition to the role of RGL. This may occur on a simplistic rope rescue evolution *or* in the event that a sufficient number of rope rescue based, technician level personnel are not available to support all positions that require the presence of technician level personnel.

Support Team Leader:

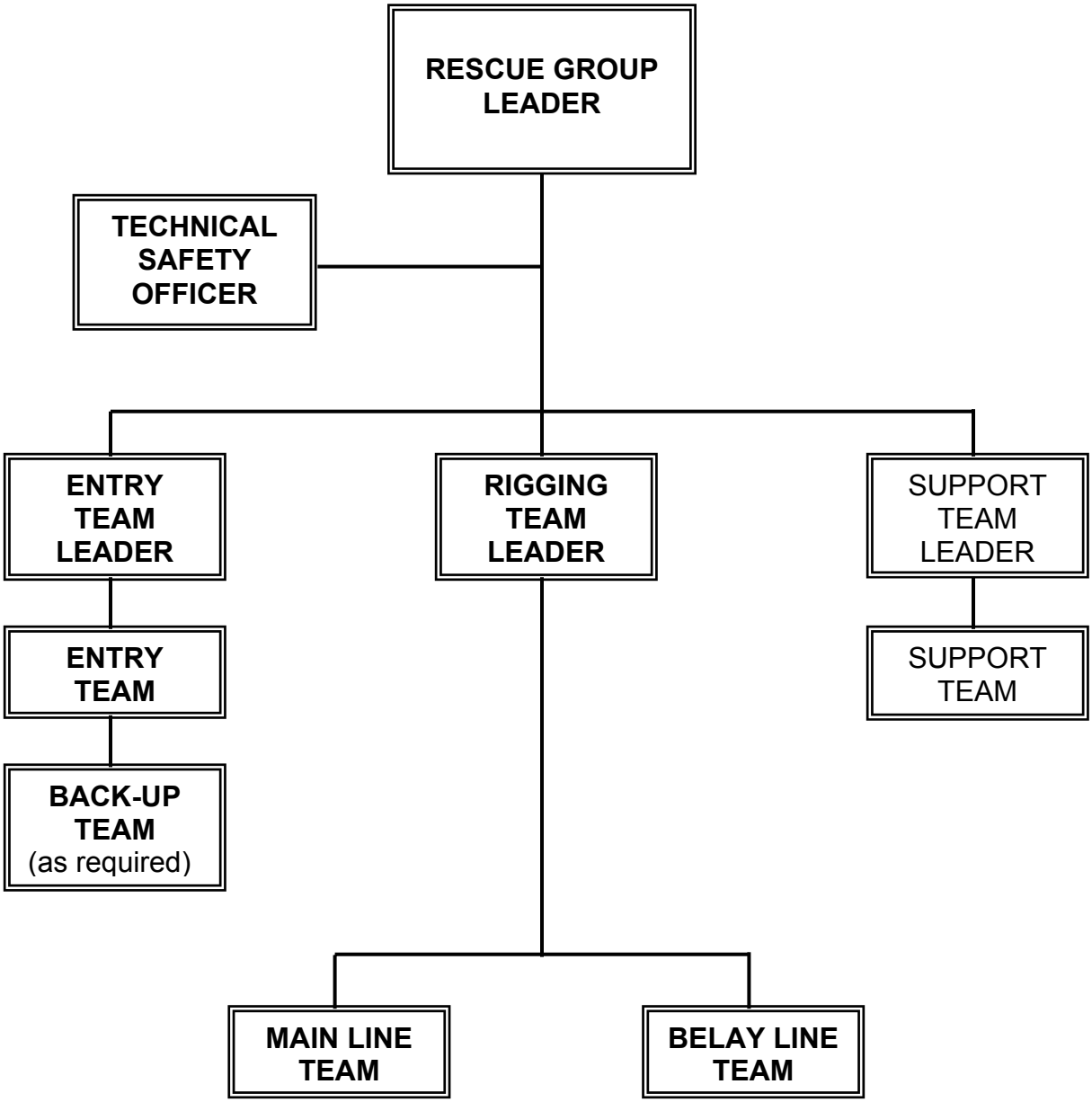
Reports directly to the Rescue Group Leader.

Responsible for direct supervision and safety of all personnel on the Support Team.

Responsible for completing assignments given by the RGL that supports the overall technical rescue incident. These assignments may include but are not limited to:

1. Providing scene security.
2. Removing brush, trees, or any obstacles that may hinder the rope systems.
3. Securing utilities.
4. Setting up an equipment staging area.
5. Acquiring equipment from apparatus necessary to support the technical rescue incident.
6. Providing edge protection as required.
7. Provide staffing for the Haul Team.

Zone 3 Technical Rope Rescue Flow Chart



Bold type requires technician level personnel for the designated position or the leader of the designated team

Communications

General information:

Clear verbal communication consisting of defined, understandable terminology is required in any rope rescue evolution to ensure safety and efficiency. To avoid confusion and the possibility of conflicting verbal orders, all verbal communication relative to movement of a rope system involving live loads shall come from only one delegated person.

The Rescue Group Leader (RGL) is ultimately responsible for initiating, maintaining, and controlling incident communications. During rope rescue evolutions, the Entry Team Leader who is properly secured and has a visual connection (if physically possible) with the Entry Team, Main Line Team, and Belay Line Team controls the verbal initiation, operation, resetting, and conclusion of movement of the rope systems. The Rescue Group Leader may choose to retain the role of Entry Team Leader as far as controlling the movement of any rope system, if it is either a simplistic operation, **or** if a sufficient number of technician level personnel are not readily available to fill all required positions thus prompting multi-tasking by the RGL.

System readiness verification:

"Ready": Command given and acknowledgement received prior to any movement of a live load to ensure that personnel assigned to the Main Line, Belay Line, and the Entry Team are prepared. Example: From Entry Team Leader, "Main Line ready to raise?" reply from Main Line Team, "Main Line ready".

Verbal communication regulating the movement of rope systems:

"Raise": Command given that places a rope system into motion that will bring the load towards the anchors. This evolution most typically is performed with a haul system providing mechanical advantage to ease raising the load.

"Lower": Command given that places a rope system into motion that will lower the load away from the anchors. This is accomplished with a lowering system that protects the load from falling out of control.

"Stop": Command given to halt movement of the rope systems. This command is unique to verbal communications impacting movement of rope systems as **anyone** can give the "stop" command at any time. Once a "stop" command has been issued, only the person designated to control rope movement (RGL or ETL) can place the rope system back in motion.

“Stop – Set”: Command given when a haul system is ready to be reset. This command will stop movement on the raise and prompt the Belay Line Team to set their prussiks in anticipation of the Main Line resetting.

”Reset”: Command given for the Main Line Team to reset their hauling system and the Belay Line Team to ensure the load is held static during the reset.

“Slow”: Command given to slow the speed that the rope system is moving either in a raise or lower.

“Up”: This command is utilized to remove slack from a rope system. This command most often is given to the operators of a belay line due to the nature of a belay line not being tensioned while the rope system is in motion. The rope that is required to be brought “up” may be identified verbally by the ropes color as opposed to its function, to aid simplicity. Example: From ETL to Belay Line Team, “Up on blue”. Using voice inflection or saying “up” multiple times indicates a faster speed for removing slack is required. Example: From ETL, “UP, UP, UP On Blue”.

“Down”: This command is typically used to create slack in a rope system. The “down” command functions as an opposite to the “up” command. Using voice inflection or saying “down” multiple times indicates a faster speed for adding slack is required. Example: From Entry Team to ETL, “Down on red”, or “Down, Down, Down On Red”.

Verbal communication between a climber (or rappeller) and belayer:

“On Belay?”: Question directed from the climber to the belay person prior to the climber moving, asking if the belayer is ready.

“Belay On”: Answer by belayer to climber indicating the belayer is ready to provide a belay.

“Climbing”: Statement from climber indicating he/she is now moving.

“On Rappel”: Statement from rappeller indicating he/she is now rappelling away.

“Rappel Away”: Statement from belayer or ETL to rappeller acknowledging that the rappel has begun.

Safety and PPE

General Information:

The successful outcome of any technical rope rescue incident must be based on a foundation that applies and adheres to safety. Accidents and fatalities during technical rope rescues are predominately a result of either human error from the misapplication and/or improper use of equipment, or a communications error. A combination of highly trained personnel, clear communications, and a sound pre-deployment system safety check can help minimize the chance of accidents occurring.

Although the ultimate responsibility for safety at a technical rope rescue is assigned to the Rescue Group Leader and the Technical Safety Officer, it is the responsibility of all personnel present to remain vigilant for ensuring the safety of all that are present, at all times.

Communications:

Clear verbal communication consisting of defined, understandable terminology is required in any rope rescue evolution to ensure safety and efficiency. To avoid confusion and the possibility of conflicting verbal orders, all verbal communication relative to movement of a rope system involving live loads shall come from only one delegated person which is the Rescue Group Leader (or the Entry Team Leader if so delegated by the Rescue Group Leader). (See “Communications” section for details).

Any personnel on location may call for a stop in the movement of a rope based system for safety, equipment, or other related conditions at any time. The only person that has the authority to restart the rope system once stopped is the Rescue Group Leader (or Entry Team Leader if so delegated). (See “Communications” section for details).

System safety check:

Recognition that any rope based rescue system is no stronger than its weakest link prompts a thorough safety check of any rope system prior to deployment. These system checks are three fold and are performed by multiple persons to eliminate the potential for human error. The three tests are a “Critical Point Test”, a “Whistle Test”, and a “Touch Test”.

Critical Point Test:

A Critical Point Test requires that rope system in its entirety is looked at to insure that the failure of any one part of the rope system, either human or equipment, will not result in a total system failure (dominoe effect). A Critical Point Test can be performed by asking “What if” type of questions in regard

to the rope system, such as “What would happen if the Track Line failed”, or “What would happen if the Main Line anchor failed”.

Whistle Test:

The passing of a Whistle Test means that if in theory at any point a whistle were blown which signals all personnel to “let go” of the rope or equipment that they are operating, nothing catastrophic will occur to the live load that is depending on the rope systems for their safety. Some examples of equipment that allow passing of a Whistle Test are the use of a Belay Line and Prusiks that will capture the load if the team operating the Main Line slips and lets go of the Main Line while hauling up the live load, or a tandem Prusik on a Load Release Hitch situated towards the load on a Control Line lowering operation utilizing a Brake Bar Rack in the event a Track Line fails and imparts an impact load to the Control Line.

Touch Test:

The Touch Test is a verification of the integrity of the entire rope system with a hands on check of every component of the rope system from one end to the other prior to deployment. The requirement that the individual performing this task physically handle each component that he/she is examining focuses the examiners attention on the task and eliminates a “casual glance” type of inspection.

Redundant system check:

To reduce or eliminate the potential for human error, the above tests shall be performed by multiple persons. Some examples of this are that the Rigging Team Leader shall perform the three tests to the Main and Belay Line systems that he/she are in charge of, and the Technical Safety Officer will confirm the integrity of these systems by his/her own system safety check. The Entry Team Leader shall perform all three tests to the Entry Team, and the Technical Safety Officer will confirm the integrity of these systems by his/her own system safety check.

<u>Once all systems have been double safety checked, no change to the system will be allowed under any circumstance without the approval of the Technical Safety Officer, and all such changes that are approved of shall be double safety checked prior to deployment of the rope systems.</u>

PPE:

The Rescue Group Leader is responsible for ensuring that the appropriate PPE is utilized and equipment to provide protection from those hazards to which personnel are exposed or could be exposed is provided. The selection of PPE shall be approved by the Technical Safety Officer.

PPE must protect personnel from any effect that the environment will impose. Head protection shall be provided to any personnel on location that may be exposed to injury to the head resulting from impact or a fall. All helmets used for such purposes shall meet applicable ANSI Z89-1 standards.

Eye protection shall be provided to all personnel that can be impacted by an eye injury at the scene. Eye protection provided to personnel shall meet the applicable ANSI standards.

Foot protection for personnel shall be provided by steel toed boots with an environmentally compatible tread.

Hand protection for personnel will be of a type that balances cut and abrasion protection while still allowing finger dexterity to operate or participate on rope systems.

Response and Operation Phase

General information:

The successful outcome of a technical rope rescue incident is dependent upon all personnel working within the Incident Management System (IMS) under direction of the Rescue Group Leader who in turn reports to the on scene Incident Commander (IC). The Incident Management System provides safety, accountability of personnel, communications, direction, an action plan and set roles, each with delegated responsibilities.

This section, “Response and Operations Phase”, details actions and responsibilities during a response to a technical rope rescue incident, from the role of the first arriving unit, through single and multiple rope system evolutions.

First arriving unit:

The role of the first arriving unit to a rope rescue based incident includes:

1. Perform a scene size up to determine exactly what the incident entails.
2. Stabilize the incident by providing site control and scene management to prevent additional accidents.
3. Establish command in order to initiate incident organization ***or***
4. Pass command in the event immediate action is required commensurate with your level of training.
5. Declare on air that the incident involves technical rope rescue.
6. Determine if operations will commence under a Rescue or Recovery Mode.
7. Perform a Risk/Benefit Analysis.
8. Call for internal assistance appropriate to your jurisdictions policies.
9. Request dispatch of a Zone 3 Technical Rescue Team.

Scene size up:

Performing a scene size up will help determine the scope and magnitude of the incident and provide direction on the best approach for formulating an action plan. Many factors may impact the simplicity or complexity of a technical rescue involving rope rescue, and information gathered during the scene size up may include but is not limited to:

1. Determine the number and location of patients.
2. Determine how best to provide scene security.
3. Determine the stability of the ground relative to the area surrounding and above the patients’ location.
4. Determine the impact of environmental factors.

5. Determine any impact from exposure to utilities.
6. Determine access points to the patient(s).
7. Determine location and type of anchors available to be utilized.
8. Determine the slope profile.
9. Determine the needs of the patient(s).
10. Determine how best to meet the needs of the patient(s).
11. Determine Rescue or Recovery Mode.
12. Perform a Risk/Benefit Analysis.
13. Determine equipment required/ equipment available.
14. Determine resources required/ resources available.

Awareness level operations:

Jurisdictions operating under awareness level training for rope rescue should limit operations at a technical rescue requiring rope rescue to functions as outlined above under the heading of “First arriving unit”. The exception to this statement is that the first arriving unit must establish command only and not pass it to perform immediate rescue unless they are trained to do so.

Determining patient needs:

Determination of patient needs begins by making contact with the patient and/or witnesses. This contact will provide crucial information necessary in order to formulate an action plan. The immediate needs of a patient are two fold; first determine if the patient is injured or not and second, determine if the patient is in a stable position.

If a patient is injured, try to ascertain the extent and severity of the injuries. This information is vital not only in dictating the course of patient care; it also starts the clock for weighing out how rapid of a retrieval is required. If a patient is in a precarious position and exposed to the possibility of a secondary fall, immediate action from the rescuers proportionate to their level of training will be required.

Rescue/Recovery Mode:

Making a determination if operations will commence under Rescue or Recovery Mode **shall** be ascertained prior to initiating operations. This determination will affect the urgency and pace of the incident. If a determination is made to operate in the Rescue Mode, it is based on the belief that there is a viable patient that must be retrieved, but only at a pace reflective of the ability of the rescuers to safely perform the operation proportionate to the level of training that they have received.

A Recovery operation is based on the recognition that the patient is not viable. A recovery operation is a more calculated event conducted at a slower pace when a sufficient number of trained personnel are available to safely mitigate the event. The safety of all rescuers is of paramount importance; therefore no undue exposure of risk to rescuers is acceptable at any time for the recovery of a body.

Risk/Benefit Analysis:

Determination to operate in the Rescue Mode **shall** be accompanied by a Risk/Benefit Analysis. A Risk/Benefit Analysis is based on weighing the degree of risk that rescuers will be exposed to vs. the benefits to be gained for taking those risks. A Risk/Benefit Analysis therefore measures the ability of the rescuers to resolve the exposure to danger that the patient faces, but only at a pace that balances the safety of the rescuers to the necessity to limit the amount of time that the patient is exposed to danger.

Slope profile:

Evaluation of the slope in its entirety is necessary to help determine how best to retrieve the patient in a sloped environment. This “slope profile” includes the blending of information relating to the angle of the slope, what the surface of the slope consists of, and the run out of the slope. (Example: a slope of 30 degrees with a dry dirt surface may be easily walked up unassisted, if the same 30 degree slope runs out over a cliff or has a wet grass or loose gravel surface, a different approach will be required due to the differences of the slope profile.)

Low angle rescue:

A low angle slope can be defined by angle as a slope between 0 and 30 degrees. In rope rescue, this is an environment in which a rope may be required, but serves the function as a belay only and not to haul the rescuers and patient up slope. On a low angle slope, all of the weight of the load from the rescuers and patient is on the ground and if the rescuers slipped without a rope present, they would not be impacted by injuries from an uncontrollable fall.

The use of a single rope may be utilized on a low angle slope to provide support to a litter team. This scenario most typically comes into play for a litter team retrieving a packaged patient from a vehicle accident down an embankment that needs minimal support to assist footing and to regain the top of the embankment. If a low angle slope is impacted by a hazardous run out and/or an unstable surface, a Risk/Benefit evaluation should require the use of a two-rope system.

The number of rescuers that may be utilized as part of a litter team on a low angle rescue is between four and six. Four litter tenders (two per side), is the most typical arrangement for carrying a patient with the addition of a fifth member, if available or necessary, at the tail of the litter to provide additional assistance as required. Six members may be necessary for a very heavy patient; however the use of six litter tenders (three per side) typically can cause more difficulty than benefit as the additional litter tenders may hamper extrication due to stepping on one another's feet and/or throwing each other off balance as they attempt to coordinate synchronized movement.

Medium angle rescue:

A medium angle slope can be defined by angle as a slope between 30 and 45 degrees. In rope rescue, this is an environment in which a two-rope system protects the rescuers from falling and also provides assistance to the rescuers in regaining the top of the slope. On a medium angle slope, the majority to all of the weight of the load from the rescuers and patient is still on the ground, and the two-rope system prevents falling down slope, as well as assisting the rescuers with regaining the top of the slope.

The use of a two-rope system is required for a medium angle rescue. One rope (Main Line) provides fall protection to the rescuer or litter team during a lowering operation and also with mechanical advantage assistance to personnel operating the Main Line to return the litter team to the top. The second rope (Belay Line) acts as a redundant line in case of Main Line failure, and also as a necessary belay when the Main Line is in motion or resetting.

The number of rescuers that may be utilized as part of a litter team on a medium angle rescue is either three or four dependent on slope profile. Four litter tenders (two per side), may be utilized on shallower angled slopes on a medium angle rescue. As the slope becomes steeper, or the footing is so poor that the load from the rescuers and patient is transferred more from the ground to the rope system, the number of litter tenders must drop to three (one per side and one on the tail end of the litter), to lessen the amount of load that impacts the rope system. All rescuers and the patient are connected at two points on the system.

High angle rescue:

A high angle slope can be defined by angle as a slope between 45 and 60 degrees. In rope rescue, this is an environment in which a two-rope system protects the rescuers from falling and is usually required to allow the rescuers to regain the top of the slope. On a high angle slope, the weight of the rescuers and patient is predominately focused onto the rope system. If the rope system was not present, an uncontrollable fall could possibly

impact the rescuers and/or they would not be able to regain the top of the slope on their own.

The use of a two-rope system (Main and Belay Line) is required for a high angle rescue. The only exception to a two-rope system for a high angle rescue falls under the need to perform an immediate rescue and only in extenuating circumstances as detailed below under “Immediate access of a patient”.

The number of rescuers that may be utilized as part of a litter team on a high angle rescue is three. Three litter tenders positioned one per side and one on the tail end of the litter provides balance in supporting the weight of the patient in the litter and maintains minimal impact potential from the load upon the rope systems. All rescuers and the patient are connected at two points on the system.

Vertical rescue:

A vertical angle slope can be defined by angle as a slope greater than 60 degrees to completely vertical. In rope rescue, this is an environment in which a two-rope system protects the rescuer and patient from a fall certain to cause injury or death, and the rope system is the only way possible for the rescuer and patient to regain the top of the slope. In vertical rescue, the weight of the rescuer and patient is completely reliant upon the rope system.

The use of a two-rope system (Main and Belay Line) is required for vertical rescue. The only exception to a two-rope system for vertical rescue falls under the need to perform an immediate rescue and only in extenuating circumstances as detailed below under “immediate access of a patient”.

The number of rescuers that may be utilized as part of a litter team on a vertical rescue is zero, one, two, or three. If a litter is oriented horizontally with the rope systems attached above the litter, only one tender is necessary to keep the litter from striking the vertical wall and/or to maintain the patient’s airway. If the litter is oriented horizontally and suspended from a high line or from a high pick point (such as an aerial apparatus) and the patient does not require the medical support, the decision to not utilize a tender may be dictated by a Risk/Benefit Analysis. The use of a tag line attached to the litter may be necessary to prevent the litter from spinning back and forth around the ropes that the litter is suspended from. A maximum of two persons (rescuer and patient) are allowed on a litter oriented horizontally with the rope systems attached to a harness above the litter.

Two litter tenders may be utilized in unique circumstances positioned one per side on a very steep angled slope, or in areas with limited space such as airshafts. The rope systems in such cases will be attached at the head of the litter. The location of the two litter tenders in this situation is slightly towards the tail end of the litter from centerline of the litter, in balance with the rope, which holds the head of the litter up. Three litter tenders may still be utilized on a slope that is transitioning between high angle and vertical if the support of the additional person is necessary. The rope systems in such cases will still be attached at the head of the litter.

Transitioning angle rescue:

If the slope transitions in angle, the number of litter tenders allowed on the system may be dictated by what the greatest impact will be to either the litter tenders or to the rope system. (Example: if a high angle slope of 60 degrees culminates with a short stretch of vertical before the top of the slope, three litter tenders will be required to support the litter up the 60 degree slope and the rope system will still easily support the litter tenders over the short vertical segment.

Immediate access of a patient; single rope system:

If a patient is seriously injured and/or in imminent danger of falling down slope causing further injury or the possible death of the patient, consideration to deploy a single technician level trained rescuer ("Medic") to access the patient immediately may be necessary.

The decision to deploy immediately to access a patient may be made only after a Risk/Benefit Analysis reveals that there is going to be a time lag involved in which additional resources and/or equipment will not arrive in time to support a two-rope, properly staffed rope system before the patient is seriously impacted by the event.

The decision for immediate deployment to access a patient shall at no time exempt personnel from performing a pre-deployment safety check of all rope system components, attachments, and the PPE of personnel.

Considerations for immediate access of a patient on a single rope system:

The Medic who is making immediate access to a patient must be technician level trained and be specifically trained to perform the function that the Medic is attempting. The Medic shall be outfitted at all times in proper PPE to include head, eye, hand, foot protection, and the proper harness. The Medic should also be equipped with basic life supporting first aid supplies, a helmet and harness for the patient as well as enough basic equipment for attaching the patient to the Medics line to prevent the patient from falling.

Prior to deployment, an action plan must be considered relative to what actions will be taken once the patient is accessed. If a patient is seriously injured prompting immediate access and/or the mechanism of injury supports not moving the patient without proper packaging, the Medics role will be only to access, secure, and provide basic life support while awaiting the arrival of a litter team operating off of a two-rope system.

Once the patient is secured and as personnel become available to construct a two-rope system and provide a litter team, the Medic can provide valuable information to the Rescue Group Leader regarding the condition of the patient, request additional first aid supplies as required, and provide routing instructions for the Litter Team. Once the Litter Team accesses the patient, the Medic can transfer over to and become part of the Litter Team and discard the original Medic Line.

If the Medic is attempting immediate access because the patient is in a precarious position and exposed to a fall, the role of the Medic will be to secure the patient and await extraction *or* continue on a single line lower or rappel with the patient. This type of operation, commonly referred to as a single line pick off, may **only** be performed if the Medic is technician level trained **and** experienced in single line pickoffs, **and** only if a Risk/Benefit evaluation makes this type of operation feasible.

Lowering operation for patient access, single rope system:

If the Medic is being lowered, the person operating the lowering system shall be technician level trained. The operator of the lowering system should lower the Medic with a Brake Bar Rack. A Figure 8 Plate should not be utilized on a single line lower as the Figure 8 Plate may not provide sufficient friction to hold the weight of a rescuer and the patient once the patient is added to the system.

Performing an operation in which the Medic is lowered to the patient, the patient secured, and then the lower continuing of both the Medic and patient together to safety may be considered, but only under unique circumstances. This type of operation should be attempted **only** if the Medic and the person operating the lowering system are trained for this evolution, and **only** if a Risk/Benefit evaluation makes this type of operation feasible.

Pre-deployment safety checks of all rope system components, attachments, and the PPE of personnel **shall** be performed prior to activation of the lowering system.

Rappelling operation for patient access, single rope system:

If the Medic is rappelling to access the patient on a single line, he/she may rappel with either a Brake Bar Rack or a Figure 8 Plate as a descent device. A Figure 8 Plate utilized as a rappel device must be self-belayed by the addition of a single prusik also attached to the Medics harness.

A decision by the Medic to rappel and perform a single line pick off of the patient should be considered only in unique circumstances. This type of operation may be attempted **only** if the Medic is trained to perform a single line pick off, and **only** if a Risk/Benefit evaluation makes this type of operation feasible.

Special consideration must be given to the rappel device utilized for a single line pick off as both Figure 8 Plates and Brake Bar Racks have distinct advantages as well as disadvantages. A Figure 8 Plate that is self belayed by adding a single triple wrapped prussik above the 8 plate will protect the Medic from falling if the Medic loses contact of the rope with the braking hand, but may not supply adequate friction to control the weight of both the Medic and the patient unless the rope is double wrapped through the 8 plate. If a Brake Bar Rack is utilized, bars can be added to provide sufficient friction to accommodate both the Medic and the patient, but you cannot add a self-belaying triple wrapped prussik to a Brake Bar Rack and properly operate both the rack and the prussik.

Pre-deployment safety checks of all rope system components, attachments, and the PPE of personnel **shall** be performed prior to the Medic rappelling.

Lead climbing:

Lead climbing is the process in which a rescuer must climb in an upward, downward, or horizontal direction to access an injured or stranded civilian. During a lead climb, the rescuer is either self-belayed or belayed by a person qualified to do so. Scenarios that may require lead climbing includes cranes, power or communication towers, bridge girders, industrial settings, or even in trees not accessible by other means.

Tower rig:

A tower rig is a means for the rescuer to be self-belayed and allows the rescuer to move rapidly to access a patient while being protected from a fall. The rescuer in proper PPE provides a self-belay by attaching the middle of a piece of yellow webbing with a Girth Hitch to their harness, and each end of the yellow webbing cumulating with an Overhand on a Bight with the size of the bight large enough to accommodate a carabiner.

As the rescuer climbs, he/she ensures that one of the carabiners is at all times connected either directly over a smaller diameter structurally significant object (such as a ladder rung), or with the webbing looped around the object and the carabiner connecting back on its own web.

The rescuer performing a lead climb with a tower rig must bring PPE for the patient to include fall protection, necessary first aid equipment, and any equipment required to facilitate extraction as directed from the action plan.

Pre-deployment safety checks of the PPE of the Medic, and the tower rigging **shall** be performed prior to the Medic deploying.

Tower Rig

Lead climbing with bottom belay:

Lead climbing with a bottom belay is most frequently applied in a wilderness scenario involving rock climbing. This type of lead climbing may come into play in urban rescue on scenarios in which the intervals of places that may allow attachment for a tower rig are spaced too far apart.

The rescuer, outfitted in proper PPE, is connected by his/her harness to dynamic life safety rope that is belayed by an experienced person. As the rescuer climbs, he/she places fall protection by means of pre-tied webbing loops Girth Hitched around objects with the rope running through a carabiner attached to the webbing. The rescuer should try to limit the interval that fall protection is placed typically not exceeding 5' (allowing a maximum of a 10' fall). During a long lead climb, the rescuer may be hampered by a combination of the weight of the rope pulling on the harness, and the friction applied as the rope moves through the fall protection.

The life line utilized to protect the rescuer during a bottom belayed lead climb **shall** only be dynamic kernmantle rope. Static rope does not allow enough stretch in it during a fall to slow the effect of impact forces applied to the rescuer.

The belay system protecting a rescuer on a bottom belayed lead climb shall be provided by a Tandem Prusik Belay connected to a LRH to help provide shock absorption and allow the belay to pass the "whistle test". Tests have shown that the type of impact loads that may be applied on belays of a falling lead climber in which the belay method utilizes a Muenter Hitch or Figure 8 Plate may overwhelm the belayer.

The rescuer performing a bottom belayed lead climb must bring PPE for the patient to include fall protection, necessary first aid equipment, and any equipment required to facilitate extraction as directed from the action plan.

Pre-deployment safety checks of all rope system components, attachments, and the PPE of personnel **shall** be performed prior to commencement of a lead climb.

Two-rope systems:

The utilization of a two-rope system (Main and Belay Line) provides the safest means for rescuers operating at a technical rescue that requires rope rescue to access a patient(s) in an efficient manner. The use of a two-rope system during a rope rescue is a requirement at all times with the exception of simplistic low angle rescues, lead climbing, and under extenuating circumstances as outlined above under "Immediate access of a patient; single rope system".

The successful operation of a two-rope system is dependent upon the coordination of personnel, equipment and the components that comprise two-rope systems all working together under the direction of the Rescue Group Leader and his/her staff.

Main Line:

The Main Line provides the rescuer and/or litter team with access to a patient, provides both the rescuers and patient with protection from a fall, as well as assistance in regaining the top in an angled or vertical environment.

The Main Line bears the weight of the load imparted by the rescuers, the patient, and all equipment used as part of the patient extraction.

The actual set up and operation of a Main Line rope system for raising and lowering a rescuer and/or litter team shall be performed by a technician level person. The exception to this is for low angle Main Line rope systems, where in such cases an operations level person may be utilized. (See NFPA 1670 for details).

Proper set up and operation of a Main Line is a product of the factors listed immediately below under “Two rope system components”.

Belay Line:

The Belay Line provides a back up safety line to the Main Line. The Belay Line is not loaded unless there is a Main Line failure and as such, slack in the Belay Line has to always be at a minimum to prevent shock loading in the event of a Main Line failure.

The actual set up and operation of a Belay Line rope system shall be performed by a technician level person.

Proper set up and operation of a Belay Line is a product of the factors listed immediately below under “Two rope system components”.

Two-rope system components:

The components that make up a two-rope system include:

1. Personnel working under the direction of assigned staff positions (See “Roles and Responsibilities” section for details).
2. Sound anchors (See “Anchor Points” and “Anchor Systems” section for details).
3. Two-rope system (See “Main and Belay Line Systems” section for details).
4. Communications comprised of common terminology (See “Communications” section for details).
5. Equipment that is properly applied and properly maintained (See “Rope Rescue Equipment” section for details).
6. The application of safety during a rope rescue that encompasses the entire event.

Single rescuer access to an ambulatory patient on a two-rope system:

To rescue an ambulatory patient, the technician level trained rescuer ("Medic") in proper PPE and equipped with an extra helmet, harness, and attachment gear for the patient may perform a "pick off" from a two-rope system.

The Medic attaches his/her harness to the Main Line with a direct tie in using a Figure 8 on a Bight with a proper back up knot.

The Medic attaches his/her harness to the Belay Line with a direct tie in using an Inline Figure 8, or a Longtail Bowline. The Belay Line terminates with a Figure 8 on a Bight with a proper back up knot. Only about 3' to 4' of line between the knots on the Belay Line is necessary.

Once the patient has been accessed, the Medic will outfit the patient in a harness, and attach the belay lines tail to the patients harness. This will provide initial fall protection for the patient. The patient may now be provided with a helmet, eye protection and wound care as required.

The Medic must now attach the patient to the Main Line. This is accomplished by attaching a prusik to the Main Line above the Medics tie in point with a pick off strap, web loop, or Purcell Prussik. This strap, web loop, or Purcell Prussik will then be connected to the patients harness, and all slack removed.

The Medic now needs only to tend to the patient while being raised or lowered to safety.

Pre-deployment safety checks of all rope system components, attachments, and the PPE of personnel shall be performed prior to activation of this system.

Yoke attachment to the head of a litter:

The yoke positioned at the head of the litter that allows attachment of the Main and Belay Lines may be configured by using a piece of green or yellow webbing that is wrapped multiple times around the main frame at the head of the litter, a steel "O" ring is placed into the webbing, and the webbing secured with an Overhand Bend (Water Knot). The webbing is then pulled from the center forming the yoke. Be sure that the interior angles of the yoke do not exceed 90 degrees. The "O" ring will be the connection point for the Main and Belay Line and may be utilized in place of a carabiner if desired, since a carabiner is not necessary for this connection point.

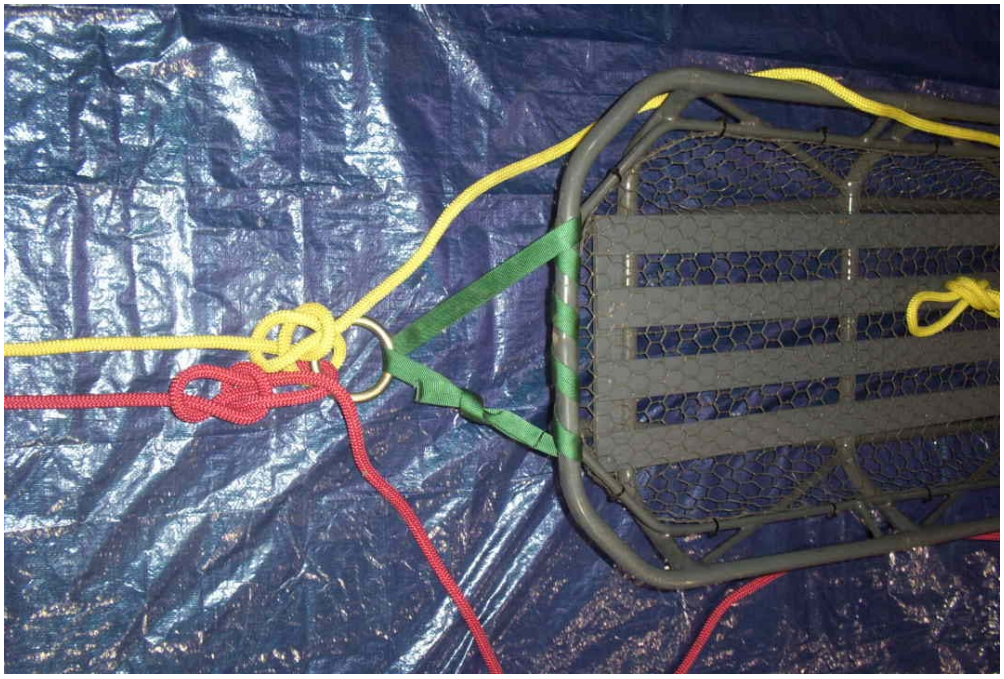
Another option for a yoke positioned at the head of the litter is to use a commercially available low angle evac stretcher harness designed specifically for this application. The harness used for this purpose must meet NFPA 1983 standards.

Two-rope system attachment to the head of a litter:

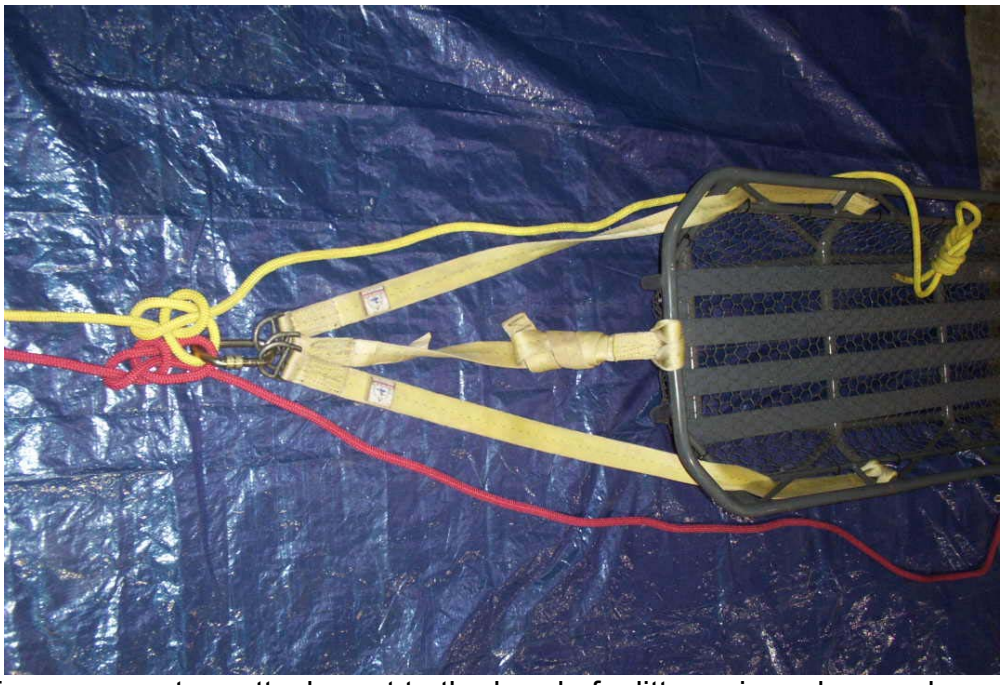
The Main and Belay Lines can be attached to the yoke by configuring them into two interlocking Longtail Bowlines or with two inline Figure 8's. The "interlocking" of the two Bowlines to the steel "O" ring and to each other, ensures the critical ultimate attachment of all the Tenders and the patient to both the Main and Belay Lines and also allows easy adjustment to the length of the tails by simply moving the rope through the knot(s).

The tail from the Main Line will cumulate with a Figure 8 on a Bight with a proper back up knot that is attached to the patients harness. The tail from the Belay Line also cumulates with a Figure 8 on a Bight with a proper back up knot and is the attachment point for the Tender located at the tail of the litter. The reason that the Main Line is ultimately attached to the patient and not to the Tender at the tail of the litter is because the Belay Line is not "loaded", thus the Tenders on the Belay Line can make adjustments to the length of the Belay Line as necessary even under load.

When using a commercially available low angle evac stretcher harness for the yoke, the attachment of the Main and Belay Line may still be accomplished by two interlocking Longtail Bowlines or inline Figure 8's, with a carabiner utilized in place of the steel "O" ring.



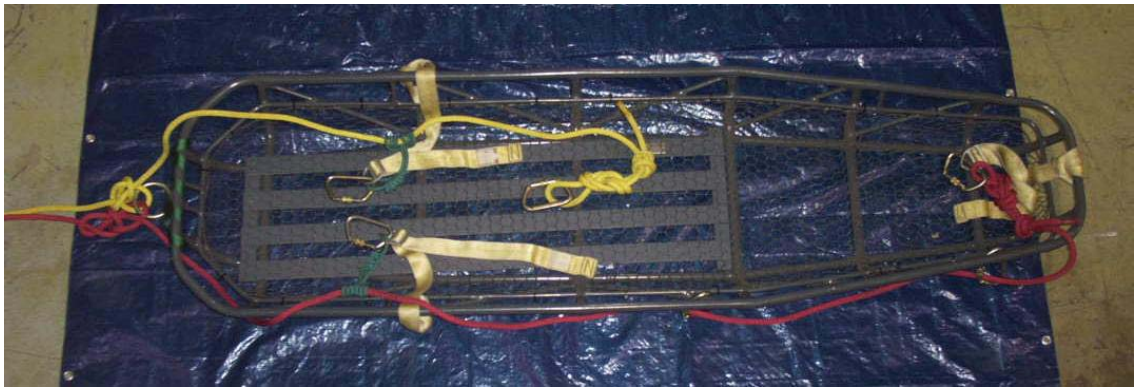
Two-rope system attachment to the head of a litter using webbing and a steel “O” ring for the yoke. (Bowlines shown tied loose for picture clarity).



Two-rope system attachment to the head of a litter using a low angle evac harness for the yoke. (Bowlines shown tied loose for picture clarity).

Litter Tender attachment to the litter:

The litter Tenders are connected to the litter by each Tender using an adjustable stretcher tender strap or a Purcell Prusik. The Tenders in addition to their connection to the litter are also attached to either the Main or Belay Line. The Tender at the tail end of the litter, as discussed above, is attached directly to the end of the Belay Line while the Tenders located on the side of the litter are connected one to the Main Line, and the other to the Belay Line by means of a Double Wrap Prusik connected to their harness.



Litter Tender attachment for three rescuers on the litter using stretcher tender straps.

Harness attachment above a litter (Vertical Rescue):

The harness that is attached above a litter for a vertical rescue may be fashioned from life safety rope with each individual leg adjustable with a single Prusik, or by utilizing a commercially available vertical evacuation harness. A commercial harness used for this purpose must meet NFPA 1983 standards.

The harness legs must be adjusted side to side to ensure that the litter remains level once suspended. The front to back adjustment of the harness legs should provide a slight “head up” orientation for the patient. This adjustment may be made be rigging the harness legs so that the “O” ring that the harness is connected to is positioned approximately above the location of the patients navel once the harness legs are tight.

The harness once loaded should be test suspended to allow final adjustments to the legs of the harness.

Two-rope system attachment above a litter:

The Main and Belay Lines can be attached to the litter harness by configuring them into two interlocking Longtail Bowlines or with two inline Figure 8’s. The “interlocking” of the two Bowlines to the steel “O” ring on the

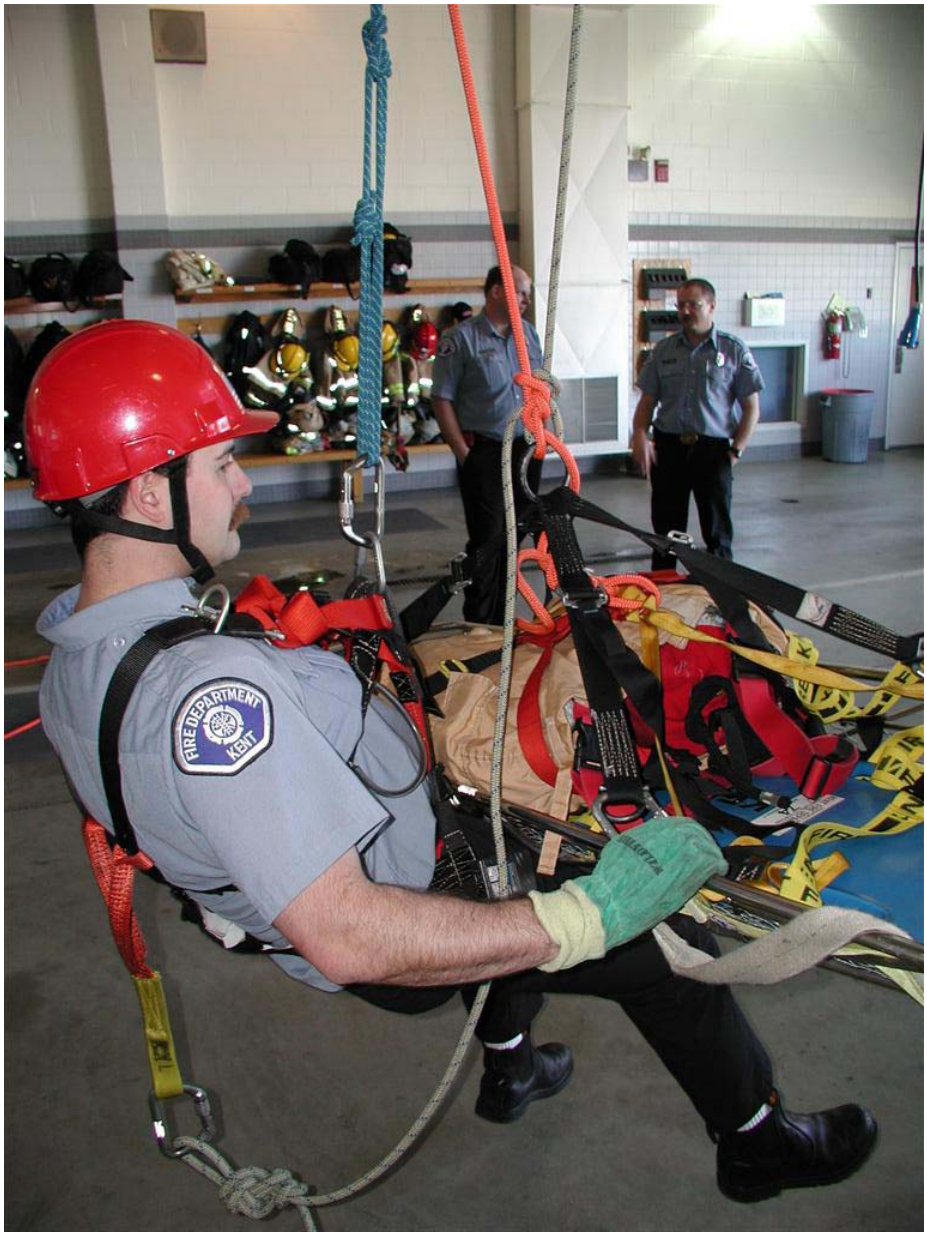
harness and to each other ensures the critical ultimate attachment of the Tender and the patient to both the Main and Belay Lines.

The tail from the Main Line will cumulate with a Figure 8 on a Bight with a proper back up knot that is attached to the patients harness. The tail from the Belay Line also cumulates with a Figure 8 on a Bight with a proper back up knot and is one of the attachment points for the Tender. The Tender has an additional connection to the Main Line above the harness “O” ring with a Purcell Prusik *or* with an with an ascender on an Etrier connected to a separate Tender Line that is attached to the harness “O” ring.

Litter Tender attachment to the litter for vertical rescue:

Two options are available for the Litter Tender for connection to a two-rope system for vertical rescue. One option is for the Tender to attach to the Main Line above the litter harness with a Purcell Prusik that is also connected to the Tenders harness collection point. The tail from the Longtail Bowline or inline Figure 8 on the Belay Line provides the secondary attachment to the system for the Tender. An Etrier may also be connected to the harness “O” ring to allow the Tender to stand in to relieve pressure from his/her harness, or to make adjustments to the Purcell Prusik.

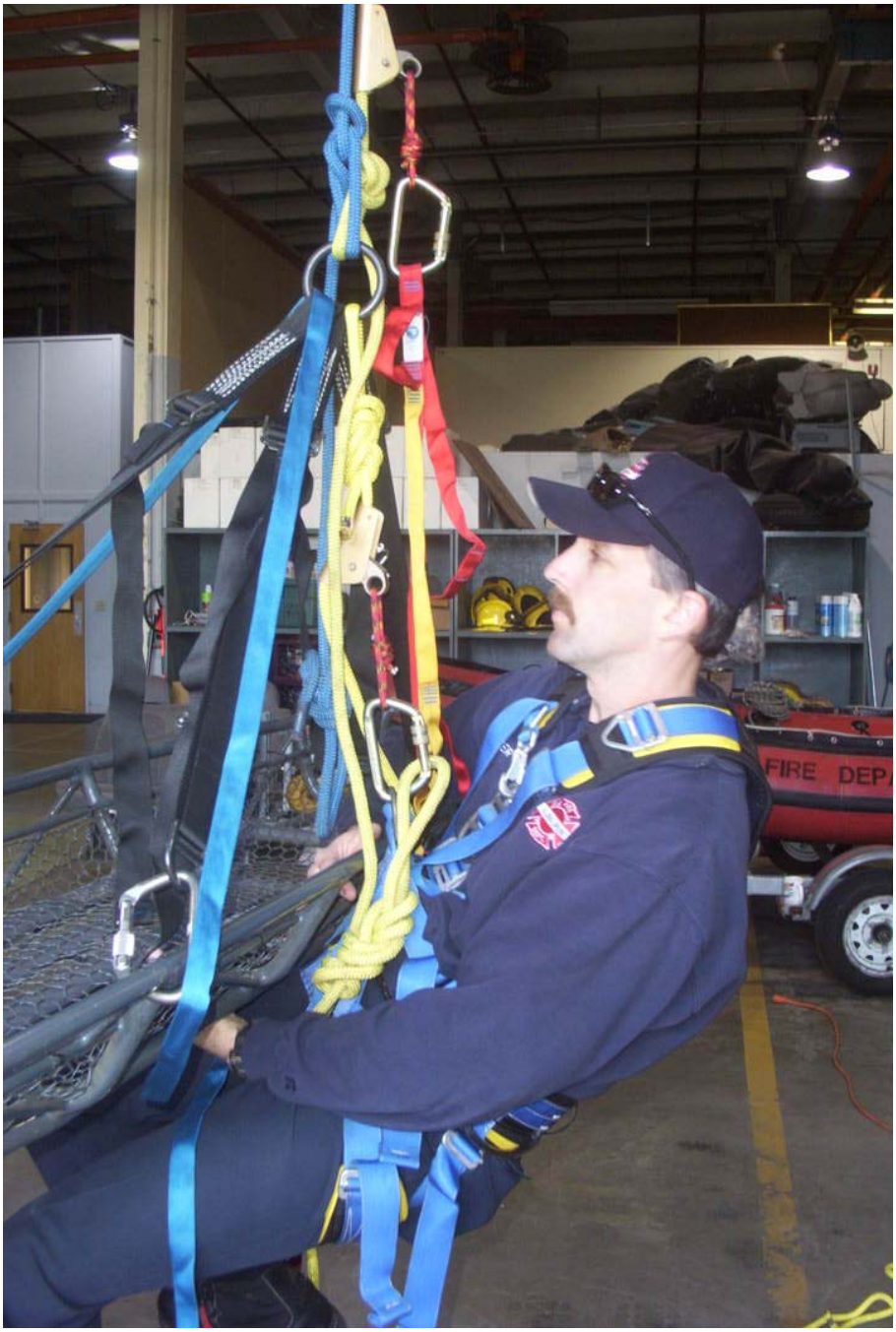
The second option for the Tender is to connect to the Tender Line which is a separate line that comes with the CMC vertical evac harness attached to the harness “O” ring. The Tender may connect to the Tender Line with a mechanical ascender attached to the Tenders harness, and an Etrier connected to the Tender Line with a mechanical ascender. (See “Ascending rope with an Etrier” under the “Ascending and Descending Fixed Ropes” section for details). The tail from the Longtail Bowline or inline Figure 8 on the Belay Line provides the secondary attachment to the system for the Tender. The Tender may also attach the Etrier to the Main Line above the stretcher harness instead of the Tender Line if so desired.



Tender attachment with a Purcell Prusik to the Main Line and tail from the Belay Lines Longtail Bowline.

Addition of Etrier to the harness “O” ring for the Tender.

Tender attachment to Tender Line using mechanical ascenders and an Etrier.



Option using Etrier attached directly to the Main Line instead of the Tender Line.

Patient packaging in a litter:

The accessed patient, who has been provided with a helmet, harness, and eye protection, should be placed into the litter onto a backboard. The securing of a patient to a backboard will help facilitate transfer of the patient from the litter once the rope rescue evolution is over.

Once the patient is secured to the backboard in the litter, the patient (and backboard) are then secured to the litter by means of "Interior" and "Exterior" lashing.

Interior lashing is an "X" lash made with two pieces of yellow webbing. Each web is Girth Hitched at the webbings center to the patients harness collection point. The legs of one web should pass over each of the patient's shoulders, and are tied off with a Round Turn and two Half Hitches to the vertical posts of the litter. The second piece of webbing is secured the same as the first, except at a point just below the collection point of the patients harness.

Exterior lashing is fabricated by placing the center of either a piece of red or black webbing at the midline of the litter, across the patients shins. Lace the web strands towards the patients head by going around or through the litters vertical posts (similar to lacing a shoe up). Finish below neck level on one of the strands with a Round Turn and two Half Hitches around a vertical post. Back tension this strand through the system, and secure the other end similar to the first.

Patient packaging in a litter:

Patient airway management line:

To help assist the Tender with managing the airway of a patient who is secured flat on their back in a litter, an airway management line may be

added. This line is fashioned from a piece of webbing that is attached to the rail of the litter opposite to that of the Tender. The webbing runs up through the “O” ring, then down towards the Tender cumulating with a loop on the end large enough for the Tenders foot to fit into. To manage the patient’s airway in the event the patient vomits, the Tender need only place a foot into the webbing loop, step down, and the litter will roll up on edge allowing the Tender to manage the patient’s airway.

Highline systems:

Highline systems are rope systems that allow movement of a rescuer and/or litter along a horizontal or angled plane, and may also be designed to facilitate vertical movement of the rescuer and/or litter from any position upon that horizontal or angled plane.

Highline systems are considered the most complex of rope systems as they typically require more equipment and personnel involvement to assemble and operate then any other rope system. Due to the combination of a highline rope system being personnel and equipment heavy, along with the total dependency of the safety of the rescuer on the highline system, the highest degree of scrutiny of the assembly and operation of the system in its entirety is required.

The successful operation of a highline system is dependent upon the coordination of personnel, equipment and the components that comprise highline systems all working together under the direction of the Rescue Group Leader and his/her staff.

The set up and operation of a horizontally oriented Highline system involves personnel, equipment, and tasks performed from each “end” of the Highline system. To simplify the identification for these two locations, the terminology “near side”, and “far side” are utilized. The “near side” designator is applied to the location in which operations are based and the rescuer and/or litter is deployed from. The “far side” operation is where the Highline is extended to and typically involves fewer personnel and equipment. On Highline systems that angle to the ground from an anchored location above, the terminology “top” and “bottom” are used.

Highline system components:

The components that make up a highline system include:

1. Personnel working under the direction of assigned staff positions (See “Roles and Responsibilities” section for details).
2. Sound anchors (See “Anchor Points”, “Anchor Systems” section and below for details).
3. The Highline rope system itself. (Detailed below).

4. Communications comprised of common terminology (See "Communications" section for details).
5. Equipment that is properly applied and properly maintained (See "Rope Rescue Equipment" section and below for details).
6. The application of safety during a rope rescue that encompasses the entire event.

Track Line(s):

The Track Line is the rope(s) that the load is suspended from and determines the path of the litter or rescuer. Track Lines can be single or doubled, and may be oriented horizontally or angled up or down.

The effective practical span of Track Lines should not exceed 300'.

A load suspended from a horizontal Track Line can adversely impact the anchors that support the Track Line two ways. First, wide critical angles amplify the loads effect to the anchors and second, movement of the load on the Track Line can cause fluctuations of several hundred pounds at the anchor points. Because of these factors, the highest degree of scrutiny must be given in regard to the stability of the anchors being utilized for the Track Line.

To help minimize the impact of wide critical angles, the Track Lines need only be tensioned sufficiently for the load to safely clear all obstacles.

Due to the high loading that Highline systems subject to the Track Line anchors, a maximum of two persons (rescuer and patient), shall be allowed to be suspended from the Track Lines.

Single Track Lines:

The use of a single Track Line is frequently utilized when the Track Line angles steeply to the ground from its anchored position above. Due to the steep orientation of the Track Line, the load is mostly captured by the Control Lines therefore removing the necessity of doubling the Track Line. When a Track Line is set up for this type of operation, the use of multiple Control Lines (Main and Belay) is recommended to prevent the possibility of an uncontrolled descent of the load.

Double Track Lines:

The highest degree of safety for a Track Line system is reached when two Track Lines are utilized. Multiple Track Lines when tensioned equally splits the weight of the load between the two lines thus minimizing the impact that the load imparts onto the ropes.

Multiple Track Lines can be anchored expeditiously and most effectively from one “bombproof” anchor. The utilization of separate anchors for each Track Line for the purpose of backing up each other is not typically necessary as the Control Lines can be designed to capture the load in case of a Track Line failure (See “Control Lines” below). If separate anchors for each Track Line are utilized, the location of each anchor should be aligned in reasonable proximity to allow both Track Lines to break over the edge along the same plane and right next to each other.

In order to allow the load being applied on the Track Lines to be evenly distributed between the two lines, both of the Track Lines should be from the same manufacturer, be of similar construction and length, and be tensioned equally (see “Anchoring and tensioning of Track Lines” below).

Anchoring and tensioning of Track Lines:

The far side Track Line is anchored with full strength tie offs to minimize equipment usage and most importantly, to help reduce rope strength reduction from knot application such as when an anchor is connected to with a Figure 8 on a Bight. (The Figure 8 on a Bight has a knot efficiency of 80% to 85%, thus reducing the 9000 lb breaking strength of ½” life line by 1350 to 1800 lbs.)

Once the Track Lines are properly tensioned, the near side Track Lines are each held in place by tandem Triple Wrapped Prusiks. The two Triple Wrapped Prusiks that hold tension on the Track Lines also act as a suedo dynamometer as the Prusiks will begin to “slip” at around 1500 lbs of force.

Tensioning of the Track Lines can be accomplished by applying a 2:1 TMA (theoretical mechanical advantage) to each of the Track Lines with a single tensioning rope in the following manner:

1. The end of the tensioning rope is secured to the tensioning ropes anchor and its anchor plate with a Figure 8 on a Bight.
2. The tensioning rope is brought up to the first Track Line and connects to the first Track Line through a pulley attached to the Track Line with a Triple Wrapped Prusik.
3. The tensioning line is pulled back towards its anchor plate where it passes through a second pulley attached to the anchor plate, then is pulled back towards the second Track Line.
4. The tensioning line is connected to the second Track Line by a third pulley attached to the second Track Line with a Triple Wrapped Prusik, exactly like the connection to the first Track Line.
5. Tension the Track Lines and secure the tensioning line.

Track Line tension may be adjusted as necessary while in operation. Coordination of a Track Line adjustment must be carefully orchestrated by

the Rescue Group Leader with all safeties in place that will allow passing of a “whistle test” once the operation commences

Tensioning system for Track Lines.

Control Lines:

Control Lines allow the rescuer and/or litter to be moved along the Track Lines. Since a horizontally oriented Track Line is not excessively tensioned, a sag in the Track Line occurs as the load approaches the center of the span. Due to this sag, the Control Lines function as a lowering operation from one side down to the center of the span (called the near side Control Line), and a raising operation from the center of the span up to the far side anchor (called the far side Control Line).

When Control Lines move a load past mid span and back, the near side lowering operation will have to be converted to a raise to bring the load back up to the near side. Conversely, if the load passes mid span, the “far side” raising operation will have to be converted to a lower to support a belay of the load back to mid span.

The lowering side of the Control Line is set up the same as a “Main Line Lower” by using a Brake Bar Rack with the addition of Tandem Prusiks on a Load Release Hitch placed ahead of the rack towards the load. The raising side of the Control Line can be set up the same as a “Main Line Raise” by using a 3:1 TMA configured from the Control Line, or more expeditiously by

using a Pig-Rig attached to the Control Line. A set of Tandem Prusiks are also utilized in this system, as detailed next.

In addition to the role of moving the load along the Track Lines, the Control Lines also may serve as a back up safety in case of a Track Line failure. In order to function as a back up safety for the Track Lines, the Control Lines must adhere to the following:

1. The Control Lines must have anchors separate of the Track Line anchors. (To account for a Track Line anchor failure).
2. The depth of the span must be sufficient enough for the Control Lines to capture the load prior to the load "bottoming out". (The capture distance of the Control Line is approximately equal to 1/5 the span).
3. Tandem Prusiks rigged to a Load Release Hitch (LRH) must be located on the near side "lowering" Control Line, positioned towards the load from the Brake Bar Rack. On the far side "raising" Control Line, Tandem Prusiks may be positioned at the change of direction pulley when the far side Control Line is set up like a 3:1 TMA "Main Line Raise" (see "Main and Belay Line Systems" section) or the Tandem Prusiks may be located on the far side Control Line at its anchor if using a Pig-Rig for a haul system. The LRH and Tandem Prusiks will act as a shock absorber and capture the load if the Track Line fails and imparts an impact load onto the Control Lines.

The Control Lines may be suspended from the Track Lines by Girth Hitching Prusiks around the Control Lines at about 30' intervals, then making attachment to the Track Lines with a carabiner.

A single Control Line may be utilized in place of separate near and far side Control Lines, but will only work if the single Control Line is longer than twice the span.

With the exception of an obvious "bombproof" anchor, the anchors utilized for the Control Lines should be separate to that of the Track Lines. This separation from the Track Line anchor's is especially relevant if you are depending on the Control Line to back up a Track Line failure. (Failure of the Track Line system occurs most frequently due to failure of its anchor, not to the Track Line itself).

The connection of the Control Lines to the rescue carriage is detailed below under "Rescue Carriage".

Rescue Carriage:

The carriage that moves the rescuer and/or litter along the Track Lines must have a sheave diameter and width suitable to accommodate multiple Track Lines. Pulleys that meet this is need are knot passing pulleys and the Kootenay Carriage. The design of the Kootenay Carriage includes one

larger hole that can accommodate up to three carabiners suitable for attaching the Reeving Line, and a hard tie for the rescuer while moved along the Track Lines, as well as two additional smaller holes for the attachment of the Control Lines. A knot passing pulley used for a rescue carriage may have an anchor plate attached to its single hole to provide the additional connection points for the Control, Reeving Lines, and rescuer attachment during transport.

A single Triple Wrapped Prusik (sometimes referred to as a “soft interface”) is placed onto each Control Line located where the Control Line connects to the carriage that the rescuer and/or litter is suspended from. The Control Line is allowed to “droop” at this connection point, with the Triple Wrapped Prusik taking all of the tension that the lower or raise systems on the Control Line imparts. The Triple Wrapped Prusik acts as a dynamometer and gives all personnel a visual confirmation if excessive forces are being applied to the Control Line, as the Prusik will begin to slip at around 1500 lbs of force.

If a single Control Line is utilized, the connection to the carriage may be accomplished by two inline Figure 8’s with two single Prusiks added to act as the dynamometer.

Reeving Line:

The Reeving Line allows vertical movement of the rescuer and/or litter at any position along the Track Lines.

The Reeving Line is operated from the near or top side position. Lowering of the rescuer and/or litter is accomplished by a brake bar rack with the addition of a single Prusik attached to a Load Release Hitch connected on the load side of the brake bar rack. The addition of the LRH and Prusik allows the system to pass the “whistle test” during operation and allows change over from a lowering system to raising system.

The raising system may be formed from a 3:1 TMA on the Reeving Line, or more expeditiously with a Pig-Rig attached to the Reeving Line. The single Prusik and LRH utilized for the lowering operation is left in place during the raising operation to allow passing of a whistle test as well as securing the load during a reset of the hauling system.

Attachment of a litter on a Reeving Line:

The attachment of the litter, Tender, and patient onto a Reeving Line is accomplished the same as outlined above under Two Rope Systems. The exception to this is that there is only the one Reeving Line in place of the Main and Belay Line set up. The Reeving Line connects to the “O” ring on the litter harness with either a Longtail Bowline or an inline Figure 8 with the

tail connecting to the Tenders harness. The patient is connected to the Reeving Line with a Purcell Prusik or webbing and a Prusik.

Highline System components: 1: Kootenay Carriage 2: Double Track Lines 3: Near Side Control Line 4: Far Side Control Line 5: Reeving Line 6: Transport Line for Rescuer or litter.

Example of a tactical set up sequence for a horizontal Highline:

Determine the location of the Highline and select suitable anchors. Due to the high loads that horizontal Highlines impart on anchors, the Track Line anchor must be “bombproof”.

Determine the means of getting the ropes across to the far side. If a messenger line is utilized propelled by a line throwing gun, ensure the safety of all personnel prior to deployment.

If multiple Track Lines are utilized, three rope ends will need to be hauled across by the far side personnel (two Track Lines and the far side Control Line). If hangers are going to be utilized to support the far side Control Line, they may also be sent across with the three ropes.

Secure appropriate anchors for the near and far side Track Lines. The Far side Track Lines will be secured by full strength tie offs. The near side Track Lines are held in place each with tandem Triple Wrapped Prusiks after tensioning.

The tensioning system is rigged on the near side (see “Anchoring and tensioning of Track Lines” above for details). Pretensioning is provided by one person operating the 2:1. Final tensioning may be adjusted so that the weight of the rescuer, litter, and patient clears all obstacles.

The Control Lines anchors for the near and far side must be separate to that of the Track Lines if the Control Lines are to function as a back up in case of Track Line failure. Using the same anchor for both the Track Line and Control Line may be utilized **only** if the anchors are positively “bombproof” and suitable multiple “bombproof” anchors are not present.

The near side control line is set up the same as a “Main Line Lower” with a brake bar rack and tandem Triple Wrapped Prusiks on a LRH connected on the load side of the rack. The far side Control Line is set up the same as a “Main Line Raise” with the addition of tandem Prusiks. The tandem Prusiks and tandem Prusiks on the LRH act as a shock absorber, capturing the load in case of a Track Line failure, and also allows passing of a whistle test.

The rescue carriage is set onto the Track lines. The near and far side Control Lines are connected to the carriage side holes with a Figure 8 on a Bight into a carabiner. A single Triple Wrapped Prusik is added to the connection to act as a visible dynamometer via a “droop” in the Control Line at the carriage connection. If a single Control Line is utilized for both sides, two inline Figure 8’s may be utilized with two Triple Wrapped Prusiks added for the above reason. (Note; if a single Control Line is utilized, it must be longer than twice the span).

A pulley is connected with a carabiner to the carriage for a change of direction to the rescuer and/or litter if a Reeving Line is utilized. During transport along the Track Lines via the Control Lines, the rescuer and litter are tied directly to the carriage with a piece of webbing. Additional protection is provided by a Triple Wrapped Prusik on a LRH that is attached

to the Reeving Line. Once the rescuer is positioned along the Track Line at a location where the lowering operation will commence, the Reeving Line will have to perform a short raise to allow the rescuer to disconnect himself/herself from the transport webbing.

Once the rescuer has secured the patient, and the rescuer and patient are raised with the Reeving Line up to the carriage, the rescuer shall reconnect the transport webbing prior to the Control Lines moving the carriage.

Anchor Points

General information:

All anchors must be able to hold the anticipated load that will be applied to it, in the direction the load will be applied from. A significant safety factor shall be included to compensate not only for the anticipated load, but also for unanticipated loads, dynamic loads, shock loads, and stress from the application of hauling systems.

Ensure that a direct line is set between the anchor and the load to prevent a pendulum of the load.

In the absence of an obvious “bombproof” anchor, the primary anchor shall be backed up by a secondary anchor to provide support. This backup anchor must be in line with the primary anchor and the load, and must also act to counter the type of force that the load is applying to the primary anchor. (See “Anchor Systems” below for details).

Ensure that the “critical angle” between the rigging legs that connect the anchor to the load or in any system component is 90 degrees or less. (An exception would be in High Line Systems). Evaluate force vectors between the anchor and the load and the type of force that will be applied to the anchor where the load connects.

Anchor slings used to secure an anchor must be NFPA 1983 approved and have sufficient extension to prevent side loading to the connecting carabiner.

1” nylon tubular webbing used to secure an anchor should be configured as a Multiloop (Wrap 3 pull 2) or as a 3-Bight in order to maximize the available webbing strength to help comply with NFPA 1983 standards. (8093 lbf. minimum breaking strength). The Overhand Bend (Water Knot) securing the webbing together on a Multiloop must be against the anchor on the load side. Ensure that the webbing on a 3-Bight has sufficient extension to prevent side loading to the connecting carabiner.

All anchors must be inspected to identify any sharp or abrasive edges that may damage software and provide padding for protection of the same.

Test the anchor prior to the application of its intended load by “pre-loading” to test the alignment and reaction of the system components.

The Rigging Team Leader (RGL) and the Technical Safety Officer (TSO) must approve the anchor and connecting components prior to application of the intended load.

Using a vehicle as an anchor:

All vehicles utilized as an anchor point must be secured by having the keys removed, brakes set, and wheels chocked.

The weight of the vehicle and the surface the vehicle sits on must provide sufficient mass and friction to prevent the vehicle from sliding once the load is applied.

Ensure that any anchor point utilized on a vehicle is one that is either specifically designed for that purpose or is positively structurally significant.

Avoid exposing software to any fuel, grease, oil, or contaminate.

Using a tree as an anchor:

Ensure that any tree utilized as an anchor is solid (alive) and has sufficient girth to safely hold the expected load.

Ensure that the root system of the tree is not too shallow of depth, and that the supporting soil is not water saturated in such a manner to make the question of stability an issue.

Secure the anchor down low on a tree if possible to maximize the strength of the tree and prevent the load from applying a leverage force to the trees base. If the tree is of sufficient girth, a balance may be sought between keeping the anchor low on the tree for the above reason, and elevating the anchor to provide a better angle to the load and/or keeping the rope system from digging through the earth when moving.

If a tree is deemed not “bombproof”, use a backup anchor for support that will act to counter the type of force that the load is applying to the primary anchor. The backup anchor must be located directly behind the primary anchor, in line with the load. (See “Anchor Systems” below for details).

Secure a tree to utilized as an anchor with either a NFPA 1983 approved anchor strap, or webbing configured as a Multiloop or as a 3-Bight in order to retain sufficient strength in the webbing to comply with NFPA 1983 standards for minimum strength requirements of auxiliary equipment.

Ensure that anchor points secured with either webbing configured as a 3-Bight or an anchor strap, has sufficient extension to prevent side loading of the carabiner that the load attaches to. If sufficient extension is not possible to prevent side loading, substitute for a Multiloop or use a tri-link.

Webbing configured as a Multiloop (Wrap 3 pull 2)

Anchor strap

Webbing configured as a 3-Bight

Using a rock as an anchor:

Ensure that any rock utilized as an anchor has sufficient mass to hold the expected load and that the ground surrounding the rock is solid and not water saturated.

Pad all sharp edges in which software will be positioned against.

Particular attention must be given to the anchor strapping, as it may be prone to “popping” off of the top of a rock or slipping under the rock. Separate rope systems may have to be placed to prevent these potential occurrences.

Using structural members as an anchor:

Structural members are numerous in industry and “bombproof” anchors are either readily available or are easy to backup to provide additional support.

Pad all sharp edges including “square” shaped anchors such as girders or beams to protect software.

Structural members must be thoroughly inspected for corrosion, cracks, damage and the manner that the structural member is attached to ground or other members. (Example: Inspection of the anchor bolts that attach a sound steel member to a concrete floor with as well as an inspection of the stability of the concrete at the point the members connect).

Visualize the type of force that will impact the structural member once the load is applied and determine if the structural member can withstand that force. (Example: Will an anchor tied high on a vertical member apply a leverage force to the anchors base).

Using pickets as an anchor:

Pickets may be utilized in an anchor poor environment, but should be assessed carefully in regard to their ability to safely hold a large load due to the variety of factors that directly impact a pickets holding power. These factors include the type of material the picket is made from, how the pickets are arrayed, depth the pickets are driven into the soil, the type of soil, compactness of the soil, and the moisture content of the soil.

Pickets should be driven 2/3 of their length into the ground at a 15 degree angle away from the load.

Pickets must be oriented in line with the load and they may be bundled together to provide additional strength.

Lash pickets together with rope or webbing by tying a clove hitch to the base of the rear picket, go up and around the top of the forward picket, and continue with four to six wraps between the pickets finishing with a round turn and two half hitches on the forward picket. The hitches securing the lashing to the pickets should be located below the wraps on the forward picket to prevent the wraps from sliding down and above the wraps on the rear picket to prevent the wraps from sliding up.

Place a stake between the wraps and tension the pickets by twisting the wraps until the forward picket just begins to move back. Drive the stake into the ground to maintain tension. (aka a “Windlass”).

Tests were performed to determine the holding power of pickets in “loamy soil of average compactness” with the following results:

1. A single picket held 700 pounds.
2. Pickets configured as 1:1 held 1,400 pounds.
3. Pickets configured as 1:1:1 held 1,800 pounds.
4. Pickets configured as 3:2:1 held 4,000 pounds.

Be aware that gravel mixtures and clay type soil can reduce the holding power of pickets by 10% and river clay and sand may reduce the holding power of pickets by 50%.

Be aware that the process of “twisting” webbing to provide the necessary tension in the windlass that permits distribution of the load throughout the picket system may damage the webbing by stressing the fibers with the application of a tension (tearing) force. This type of damage may not be readily apparent in the webbing upon inspection after the windlass is disassembled. Prudence dictates that webbing utilized to make a windlass in a picket system should be removed from service after use.

Picket system configured as 1:1:1

Anchor Systems

General information:

In the absence of a single “bombproof” anchor point that can be solely relied upon to guarantee the ability to safely hold the projected load, two options may be available. The first option is to support the primary anchor with a secondary “backup” anchor located immediately behind the primary anchor and in line with the load. The second option is to utilize multiple anchor points forming a load distributing anchor system that will evenly distribute the load between the available anchors and redistribute the load among the anchor points if one of the anchor points should fail.

If the only anchor points available to use are of “questionable” strength, thus prompting a decision to use multiple anchor points tied together to create a load distributing anchor system, considerable risk may occur. The risk is that should one or more of the “questionable” anchor points fail, the redistribution of the load among the remaining “questionable” anchors could cause failure of the entire anchor system since you are now carrying the load with fewer “questionable” anchor points than what you began with. Another potential problem is that the creation of dynamic forces that happens when a weak anchor point fails will impact the remaining “questionable” anchors when the load attempts to redistribute and may cause the collapse of the entire anchor system.

Backup anchors:

A backup secondary anchor utilized to support a primary anchor must be rigged to counter the type of force that the load is applying to the primary anchor. (Example: If the load is applying a shear or leverage force to the primary anchor, the backup anchor must counter this effect with the same type of force).

The rigging between the backup secondary anchor and the primary anchor must include a connection to the primary anchors rope based system. This will allow the backup secondary anchor to capture the load should the primary anchor fail or move.

The backup anchor must be located directly behind the primary anchor and be in line with the load.

The rigging between the primary and secondary backup anchor is known as a “Tieback”. A Tieback may be rigged as follows:

1. Secure each anchor with an anchor strap or webbing (remember to intertwine this webbing with the existing webbing on the primary anchor). Place a carabiner into the webbing on each anchor.

2. Tie a figure 8 on a bight in the back tie rope and place it in the carabiner connected to the primary anchor webbing.

3. Run the rope through the backup anchors carabiner, back through the primary, and then bring back towards the back up anchor.

4. Secure the rope with a single, triple wrap prusik attached to the backup anchors carabiner. Secure the carabiner gates.

5. Tension to apply a counter force to the load. (Note: the backtie applies a 3:1 theoretical mechanical advantage).

A Tieback

Load distributing and load sharing anchor systems:

Load sharing anchor systems are designed to tie two or more anchors together to distribute the weight of the load between the anchors. Due to the nature of how load sharing anchors are rigged, the load will only be equalized when the load remains inline with the shared anchors. Any shift in the direction that the load applies to the anchors can result in the entire weight of the load shifting to one of the anchors only. Due to this fact, load sharing anchor systems should generally not be utilized.

Load distributing anchor systems are also designed to tie two or more anchors together to distribute the weight of the load evenly between the anchors. If there is a shift in direction of the load, or a failure of one of the anchor points, the load will be redistributed equally among the remaining anchor points.

Load distributing anchor systems must be tied in a manner that keeps the actual load distributing system itself small in size. This is accomplished by extending from each anchor point to the small load distributing system rather than making the load distributing system large enough to connect to each anchor point. The reason for this is if you are using a large loop type load distributing system and one of the anchor points fails, the load will drop the length of the slack in the collapsed leg creating a large dynamic force that will impact the remaining anchor points.

Keep all interior angles in a load distributing system less than 90 degrees.

Load distributing anchor systems may be assembled with either webbing tied correctly in a loop formation or by using life safety rope configured with a Double Loop Figure 8 knot with one of the two loops made larger to connect from the anchor points to the small loop of the Figure 8.

Webbing utilized for a load distributing anchor system generally works well for tying two anchor points together. When tying more than two anchor points together, sometimes the overhand bend used in tying the webbing together into a loop can cause the redistribution of the load to go slowly or with difficulty. In these cases, the use of a load distributing anchor system made from life safety rope configured by a Double Loop Figure 8 on a Bight, will allow a smoother transition of weight distribution if one of the anchor points fails.

Load sharing anchor system

Load sharing anchor system with load shift

Two point load distributing using webbing.

Two point load distributing with load shift.

Three point load distributing using webbing.

Two point load distributing using life safety rope configured with a Double Loop Figure-8.

Three point load distributing using life safety rope configured with a Double Loop Figure-8.

Full strength tie off anchor:

Full strength tied off anchors are simplistically made, quick to assemble, and retains most of the strength in the rope (on larger diameter anchors). Full strength tied off anchors are most often utilized as a means of securing a “far side” anchor for Track Lines on either a Highline system or as a Track Line across a river for a boat based platform. The full strength tie off can be secured using no hardware by using a Figure 8 follow through or with one carabiner attached to a Figure 8 on a Bight as shown below.

Full strength tied off anchor.

Main and Belay Line Systems

Construction of a Main Line Lowering System:

- Secure the anchor with 1” tubular webbing or an anchor strap.
- Anchors secured with 1” tubular webbing should be tied with either a Multiloop (Wrap 3 pull 2) with the overhand bend located against the anchor on the load side, or as a 3-Bight. Ensure that the “critical angle” between the legs of the anchor strap or webbing is less than 90 degrees. (This is especially important when utilizing an anchor strap or 3-Bight configured with webbing to prevent side loading of the carabiner).
- Attach an anchor plate to the anchor webbing with a carabiner positioned with the gate up and secured. Note: An anchor plate is not a requirement for this system, but is typically left here since the plate is where the hardware required for a Main Line bag is attached and stored.
- Attach the brake bar rack to the anchor plate with a carabiner positioned with the gate up and secured.
- The Main Line, with a proper end knot(s), should be laid out to the point of where it will break over the edge. This end knot is the tie in point for a Litter or Rescuer.
- The Main Line with all slack removed, is then run through the brake bar rack and “racked tight” meaning it is properly rigged and tied off until staffed.
- The remaining rope end (in the bottom of the rope bag) should be attached to the anchor plate with a carabiner *or* have a bulky end knot present to help ensure that the Main Line isn’t accidentally run out through the brake bar rack.
- Prior to use, the Main Line shall be double safety checked and approved first by the Rigging Team Leader, then by the Technical Safety Officer who is qualified to do so under NFPA 1670 and NFPA 1006.
- Once safety checked by the Rigging Team Leader and Technical Safety Officer, the Main Line shall not be altered prior to operation without approval by the Rigging Team Leader and Technical Safety Officer.

Main Line Lowering System

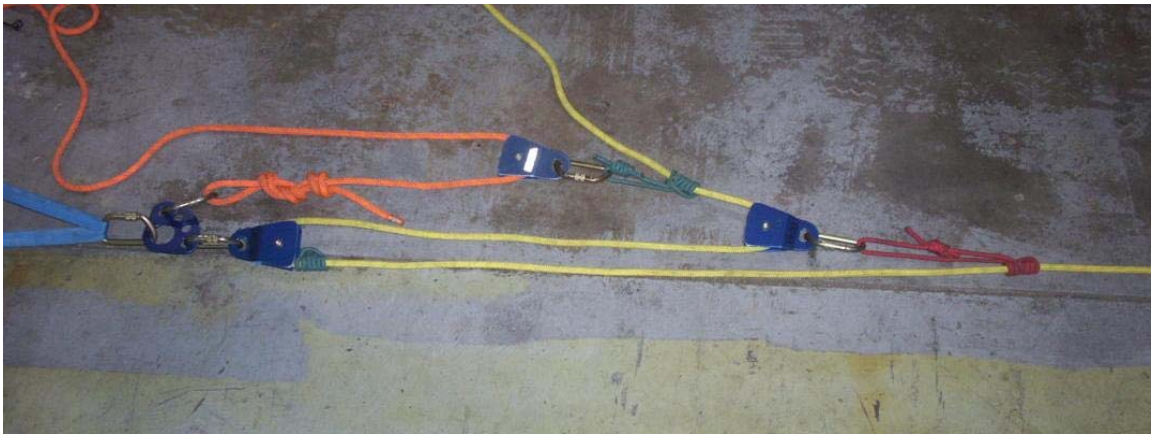
Construction of a Main Line Raise 3:1 System:

- Secure the anchor with 1” tubular webbing or an anchor strap.
- Anchors secured with 1” tubular webbing should be tied with either a Multiloop (Wrap 3 pull 2) with the overhand bend located against the anchor on the load side, or as a 3-Bight. Ensure that the “critical angle” between the legs of the anchor strap or webbing is less than 90 degrees. (This is especially important when utilizing an anchor strap or 3-Bight configured with webbing to prevent side loading of the carabiner).
- Attach an anchor plate to the anchor webbing with a carabiner positioned with the gate up and secured. Note: An anchor plate is not a requirement for this system, but is typically left here since the plate is where the hardware required for a Main Line bag is attached and stored.
- Attach a Triple Wrap Prusik onto the Main Line and insert the end of this prusik into a carabiner attached to the anchor plate.
- Take a bight in the Main Line on the anchor side of the Triple Wrap Prusik and place a Prusik Minding Pulley (PMP) into the bight. Attach the PMP to the anchor plate in the carabiner holding the Triple Wrap Prusik. Secure the carabiner positioned with the gate up.
- Place a PMP and locking carabiner into a second bight on the Main Line. Insert a Triple Wrap Prusik attached onto the Main Line into the carabiner connected to this PMP and secure the gate. **Note:** Both prusiks must be on the same “leg” of the “Z” if connected correctly.
- Prior to use the Main Line shall be double safety checked and approved first by the Rigging Team Leader, then by the Technical Safety Officer who is qualified to do so under NFPA 1670 and NFPA 1006.
- Once safety checked by the Rigging Team Leader and Technical Safety Officer, the Main Line shall not be altered prior to operation without approval by the Rigging Team Leader and Technical Safety Officer.

Main Line Raise 3:1 System

Additional mechanical advantage:

Additional mechanical advantage may be applied to the Main Line 3:1 as deemed necessary. This additional mechanical advantage may be applied expeditiously by simply attaching a 2:1 system to the output of the 3:1, thereby increasing the mechanical advantage to 6:1.

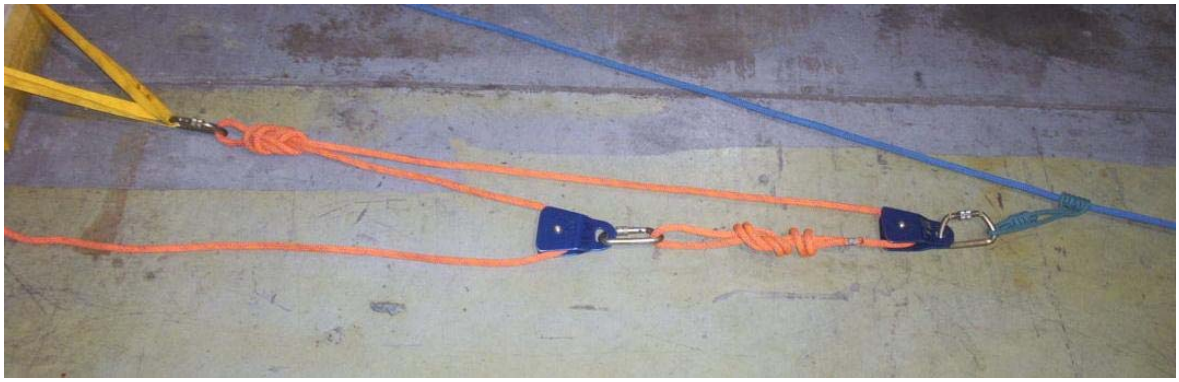


6:1 MA

Pig Rig:

A Pig Rig (short for piggy back) may be utilized for a rapid conversion from a lowering to a raising operation when the Pig Rig is applied directly to a lowering or safety line, to haul a knot past the hardware on a Main Line raise (See “Technique for knot passing on a Main Line Raise” below), or anywhere that rapid additional mechanical advantage is required.

Pig Rigs may be configured multiple ways using different pulley configurations to provide various mechanical advantages. The most common Pig Rig configurations used in Zone 3 rope rescues are pictured below.



Pig Rig using two Prusik Minding Pulleys to provide 4:1 MA

Pig Rig using a double sheave pulley and two separate pulleys to provide 4:1 MA
Note: an additional double sheave pulley may replace the separate single pulleys

The 4:1 Pig Rig shown above turned end for end provides 5:1 MA.

Construction of a Tandem Prusik Belay System:

- Secure the anchor with 1” tubular webbing or an anchor strap.
- Anchors secured with 1” tubular webbing should be tied with either a Multiloop (Wrap 3 pull 2) with the overhand bend located against the anchor on the load side, or as a 3-Bight. Ensure that the “critical angle” between the legs of the anchor strap or webbing is less than 90 degrees. (This is especially important when utilizing an anchor strap or 3-Bight configured with webbing to prevent side loading of the carabiner).
- Attach an anchor plate to the anchor webbing with a carabiner positioned with the gate up and secured. Note: An anchor plate is not a requirement for this system, but is typically left here since the plate is where the hardware required for a Belay Line bag is attached and stored.

- Attach a Load Release Hitch (LRH) to the anchor plate with its carabiner positioned with the gate up and secured.

- The Belay Line, with a proper end knot, should be laid out to the point of where it will break over the edge. This end knot is the tie in point for a Litter or Rescuer.

- Attach two Triple Wrap Prusiks (one long and one short) onto the Belay Line with the longer prusik towards the load. Insert both prusiks into the carabiner on the load side of the LRH.

- Place a bight in the Belay Line above the two Triple Wrap Prusiks. Place a Prusik Minding Pulley (PMP) into the bight and place into the carabiner with the two Triple Wrap Prusiks. Secure the carabiner positioned with the gate up.

- The remaining rope end (in the bottom of the rope bag) should be attached to the anchor plate with a carabiner *or* have a bulky end knot present to help ensure that the Belay Line isn't accidentally run out through the PMP.

- Prior to use the Belay Line shall be double safety checked and approved first by the Rigging Team Leader, then by the Technical Safety Officer who is qualified to do so under NFPA 1670 and NFPA 1006.

- Once safety checked by the Rigging Team Leader and Technical Safety Officer, the Belay Line shall not be altered prior to operation without approval by the Rigging Team Leader and Technical Safety Officer.

Operation of a Tandem Prusik Belay:

The operation of a Tandem Prusik Belay during a lowering operation must be accomplished in a manner that guarantees the successful capturing of the load in the event of a Main Line failure. As such, the operation is not a function of merely holding the Tandem Prusiks open as the Belay Line passes through, but is an orchestrated event requiring the coordinated hand movements from the belayer. Direction for a lowering belay is as follows:

1. Hold the two Prusiks in a gloved hand, palm down.
2. Grasp the rope with the other hand on the load side, palm down and up against the other hand.
3. Pull 12"-18" of slack through and orient both hands "thumbs up" with the slack you pulled through forming a loop in the air between your hands.
4. As the lowering operation pulls the slack out of the loop, your hands will be guided back into the palm down orientation. As this occurs, again slide your hands together and pull 12"-18" of slack and repeating the process.

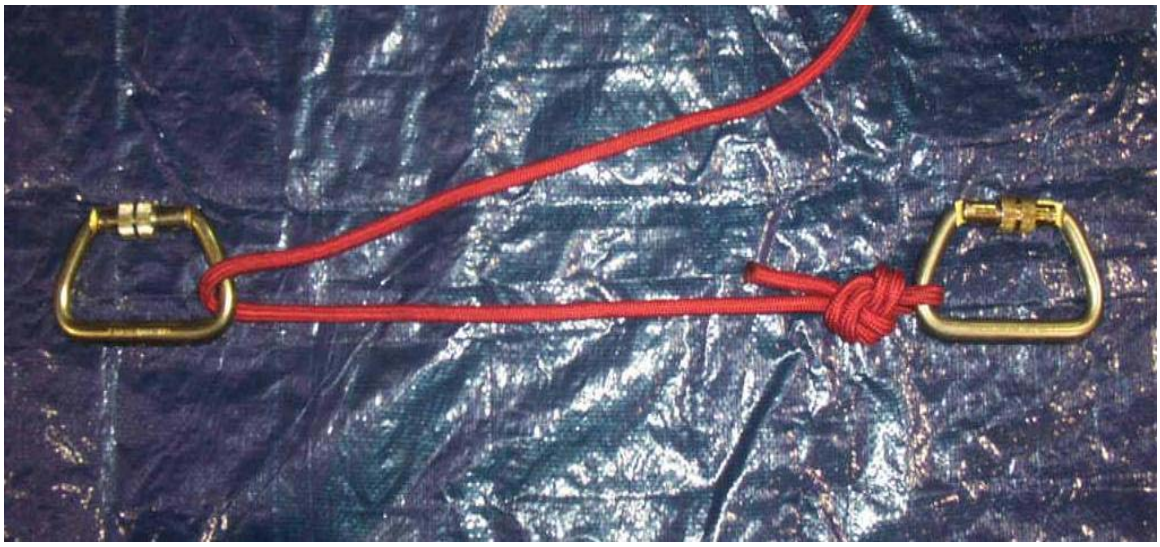
5. The rope moving through the Prusiks should make an audible sound as it passes.

Operation of Tandem Prusiks on a lowering operation.

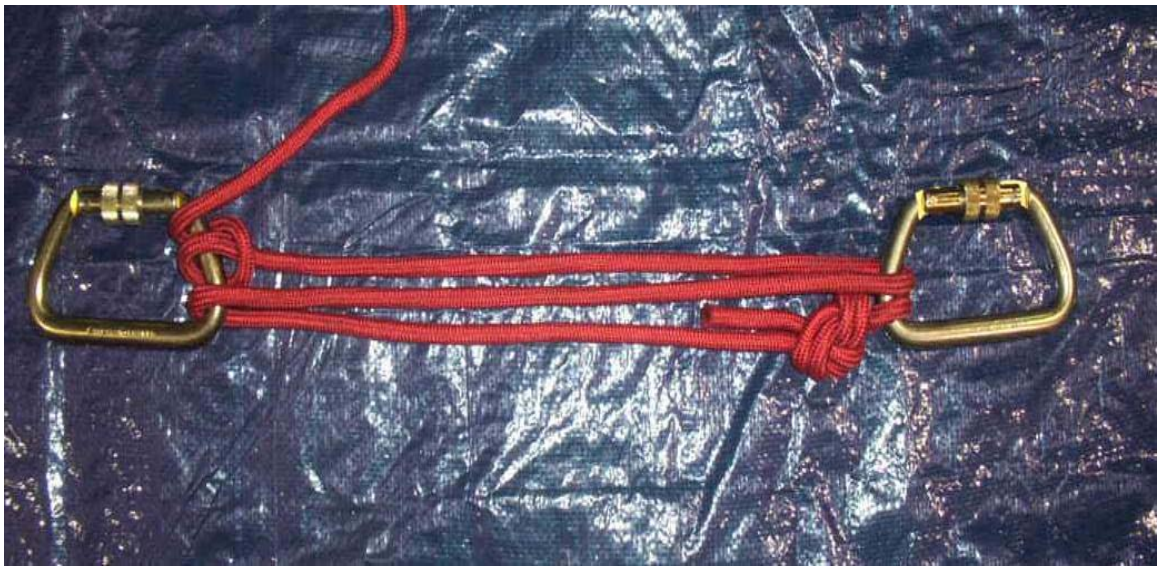
Tandem Prusik Belay System

Detail of the Radium Load Release Hitch (LRH):

A Load Release Hitch (LRH) provides a load release mechanism in rope systems and also may provide a degree of shock absorbsion. LRH's are made from 33' of 8mm Prusik line.

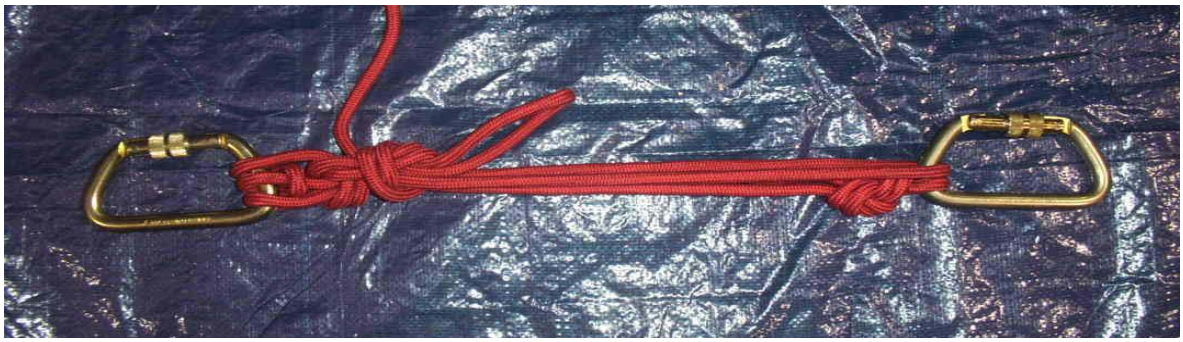


1. Tie a Figure 8 on a Bight in the end of the Prusik line (No backup necessary). Place into the load side carabiner against the carabiners spine.
2. Bring the line around through the anchor side carabiner.



3. Bring the line back around through the load side carabiner.
4. Place a Munter Hitch on the anchor side carabiner, with the in-feed of the line towards the gate side of the anchor carabiner.

5. Place a Half Hitch around the strands between the carabiners made from a Bight in the line. This Hitch will ride against the Munter Hitch.



6. Complete by tying an Overhand on a Bight against the Half Hitch. The extra line may be daisy chained or stored in a small bag.

Detail of the Munter Hitch.

Changing from a “lower” to a “raise” on the Main Line:

- Stop the lower
- Place a “Triple Wrap Prusik” on the Main Line on the load side of the brake bar rack.
- Attach the prusik to the anchor plate with a LRH or a green sling as a jumper.
- Lower on the brake bar rack until the prusik “sets”.
- Disengage the brake bar rack and replace with a PMP and a prusik.
- Build the rest of the 3:1 system.
- Raise the load.

Changing from a “raise” to a “lower” on the Main Line:

- Stop the raise
- Place a “Triple Wrap Prusik” on the main line on the load side of the normal brake prusik that is attached to the anchor PMP.
- Attach a LRH between the jumper prusik and the anchor plate.
- Once the load is secured to the prusik on the LRH, remove the PMP and prusik at the anchor plate, and rig in the brake bar rack attached to the anchor plate.
- Lower the load with the LRH until the brake bar rack takes up the load.
- Disengage the LRH and continue the lower.
- **Note:** If you know in advance that you will have to change from a “raise” to a “lower”, rig the PMP and brake prusik that is attached to the anchor plate on a LRH.

Changing from a “raise” to a “lower” or a “lower” to a “raise” on the Belay Line:

The Belay Line does not need to alter its layout when a change is made in the rope system from either a “raise” to a “lower” or a “lower” to a “raise”.

Technique for knot passing on a Main Line lower:

- Secure the load ahead (on the load side) of the brake bar rack with a Triple Wrap Prusik connected to the anchor plate with a LRH. **Note:** allow at least 12” between this prusik and the brake bar rack.
- Lower the load through the rack onto the prusik until it “sets”.
- Detach and re-rig the brake bar rack with the knot between the rack and the prusik.
- Lower the load on the LRH until once again it is taken up by the rack.
- Disengage the prusik on the LRH and continue the lower.

Technique for knot passing on a Belay Line lower:

- Place a second set of tandem prusiks and a PMP onto the Belay Line on the anchor side of the knot. Attach to the anchor plate with a second LRH. Once the second set of tandem prusiks, PMP, and LRH are engaged, disengage the original set and continue the lower.
  Technique for knot passing on a Main Line Raise:
- **Method 1:** Attach a piggyback system of similar mechanical advantage to the Main Line and haul the knot past the anchor system. The primary system may be discarded or re-engaged at this time. **Note:** Make sure that you maintain the brake system on the primary system while using the piggyback, or you will not be able to reset the piggyback system.
- **Method 2:** Move the knot past each pulley or obstacle by using a jumper sling and a prusik. This will result in several short resets.

Technique for knot passing on a Belay Line Raise:

- Place a second set of tandem prusiks and a PMP onto the Belay Line on the load side of the knot. Attach to the anchor plate with a second LRH. Disengage the first set of tandem prusiks, PMP, and LRH.

Ascending and Descending Fixed Ropes

Ascending rope with a Purcell Prusik:

Attach a Purcell Prusik to the main line either directly or with a mechanical ascender.

Attach a long prusik to the main line, either directly or with a mechanical ascender above the Purcell Prusik. Clip the long prusik into your harness's collection point with a carabiner.

Slide the long prusik attached to your harness up the rope until snug, then sit back into your harness.

Stand into the Purcell Prusik relieving the tension to your harness, and slide the long prusik attached to your harness up the rope until snug. Sit back into the harness.

Slide the Purcell Prusik up the rope and again stand into it allowing you to slide the long prusik further up the rope.

Alternate sliding the Purcell Prusik and long prusik up the rope by placing your weight onto one or the other thus allowing the non-tensioned member to slide freely up the rope.

To ensure safety, a belay line should be provided to the person ascending the rope. An alternate means to safety the person ascending is to connect the Purcell Prusik to the harness in addition to the long prusik, thus making two points of attachment from the harness to the rope.

The rescuer shall be outfitted in proper PPE and safety checked prior to ascending the rope by a NFPA 1670 rope rescue technician level person.

Ascending rope with a Purcell Prusik.

Ascending rope with an Etrier:

Attach an Etrier to the main line with a mechanical ascender.

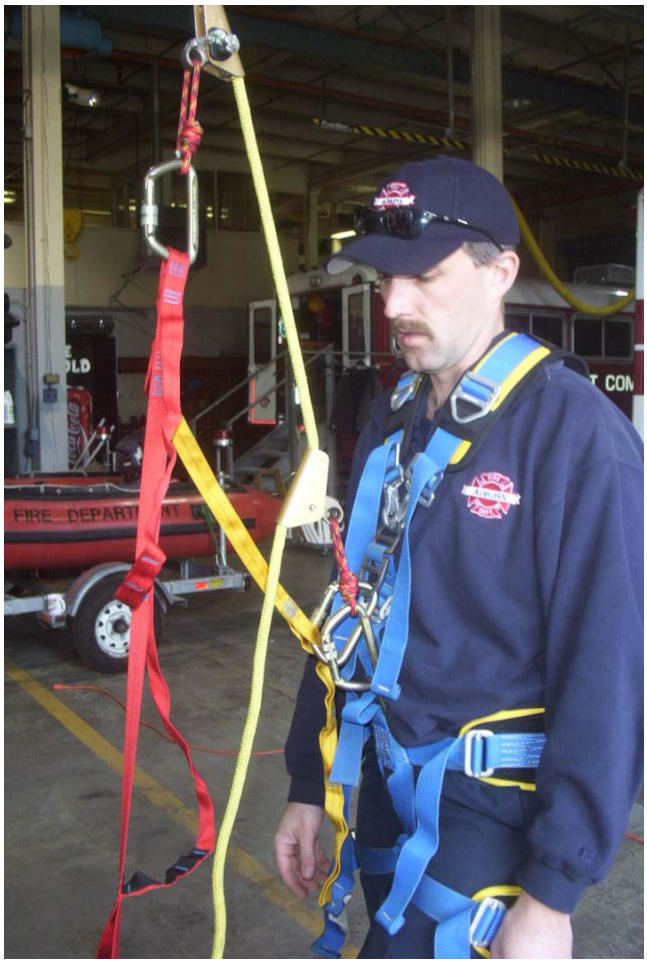
Attach a second mechanical ascender to the main line below the first ascender. The second mechanical ascender will attach directly to the collection point on your harness.

To provide two means of attachment to the rope, a short jumper is required from the top ascender with the Etrier on it, back to your harness. (Most commercial Etriers have a sewn loop for this purpose).

To ascend the rope, alternate your weight back and forth between your harness, or by standing in the Etrier thus allowing the non-tensioned member to be slid up the rope. (Same process as using Purcell Prusiks.)

To ensure safety, a belay line should be provided to the person ascending the rope.

The rescuer shall be outfitted in proper PPE and safety checked prior to ascending the rope by a NFPA 1670 rope rescue technician level person.



Ascending rope with an Etrier.

Ascending rope with two Etriers:

Attach two mechanical ascenders to the main line.

Connect one Etrier to each of the mechanical ascenders. Both ascenders must be connected to the collection point on the harness to provide two points of attachment to the rope.

Stands into one of the Etriers with one foot, and place the other foot into the second Etrier

To ascend the rope, alternate placing your weight between each foot thus allowing the non-tensioned Etrier to be slid up the rope.

Holding yourself upright while climbing up a rope can be fatiguing to your arms. To alleviate this problem, make an attachment to the rope or top Etier and your chest harness collection point.

To ensure safety, a belay line should be provided to the person ascending the rope.

The rescuer shall be outfitted in proper PPE and safety checked prior to ascending the rope by a NFPA 1670 rope rescue technician level person.

Descending rope with a Figure 8 Plate:

Connect a triple wrap prusik to the rope and place into the carabiner attached to your harness. This prusik will provide a self-belay to the rappeller. **Note:** If you are not trained in descending ropes with a self-belaying triple wrap prusik; a belay line must be added to protect the rappeller.

Stand facing the anchor with the rope on your right side (for right handed individuals). Hold the Figure 8 Plate with the large hole facing towards the anchor.

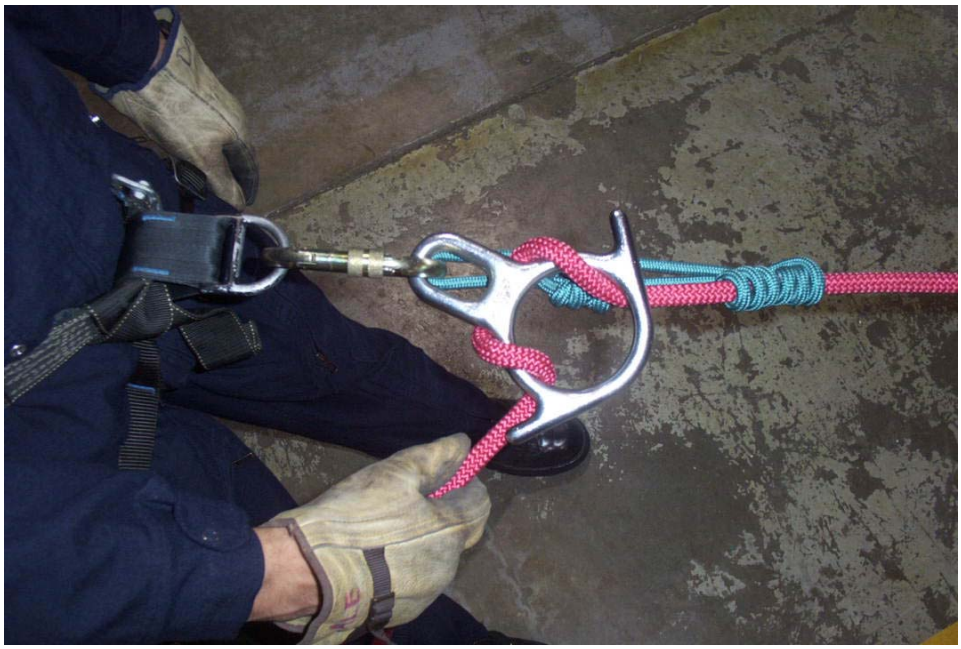
Take a bight in the rope between the triple wrap prusik and your harness, and bring the bight up through the large hole in the Figure 8 Plate, loop over the small end, and connect to the carabiner attached to your harness.

Take up excess slack in the rope by pulling it through the Figure 8 Plate.

In the absence of a self-belaying triple wrap prusik; attach a Belay Line to the rescuers collection point on their harness. Secure the carabiners.

Rappel speed may be controlled by holding the rope against your hip, with a slight bend around the hip toward the buttocks.

The rescuer shall be outfitted in proper PPE and safety checked prior to descending the rope by a NFPA 1670 rope rescue technician level person.



Descending with Figure 8 Plate and single Prusik.

Locking off with a Figure 8 Plate:

Begin a short distance above the point you wish to stop.

While holding the rope tight in your brake hand, let the brake hand move towards the Figure 8 Plate.

When the brake hand is about a foot away, make a dynamic move with the brake hand and smoothly draw the rope over the top of the Figure 8 Plate and wedge it down between the plate and the standing line in a counter clockwise direction (for right handed rappellers).

Hook the rope under the “ear” of the Figure 8 Plate, and apply a second wrap over the first. You may further secure the lock off by tying an Overhand Knot with a bight in the rope above the Figure 8 Plate.

An alternative to the above procedure is to bring the brake hand towards the Figure 8 Plate and loop it under the left ear of the plate and secure as above, but in a clockwise direction (for right handed rappellers).

Figure 8 Plate locked off.

Unlocking a Figure 8 Plate:

Untie the Overhand Knot, stabilize the Figure 8 Plate by holding the base of the plate in your left hand (for rappels rigged for right handers), and snap the two wraps off of the Figure 8 Plate ensuring that you move your brake hand back into braking position after the last wrap is disengaged.

Note on rappels with a Figure 8 Plate:

Generally it is safer for a rescuer to be lowered on a two-rope system rather than rappelling to access a patient. The exception to a two-rope lower is in the event of immediate rescue and is described further under “Immediate access of a patient” found in the “Response and Operation Phase” section.

Figure 8 Plates are designed primarily for use with a one-person load. If necessary, additional friction may be applied to a Figure 8 Plate by running the rope twice through the large hole of the Figure 8 Plate when rigging it.

Long rappels with a Figure 8 Plate may cause twisting of the rope below the rappeler as it enters the Figure 8 Plate through the rescuers brake hand thus slowing or even stopping the rappel. To prevent this twisting effect, long rappels should be performed with a brake bar rack

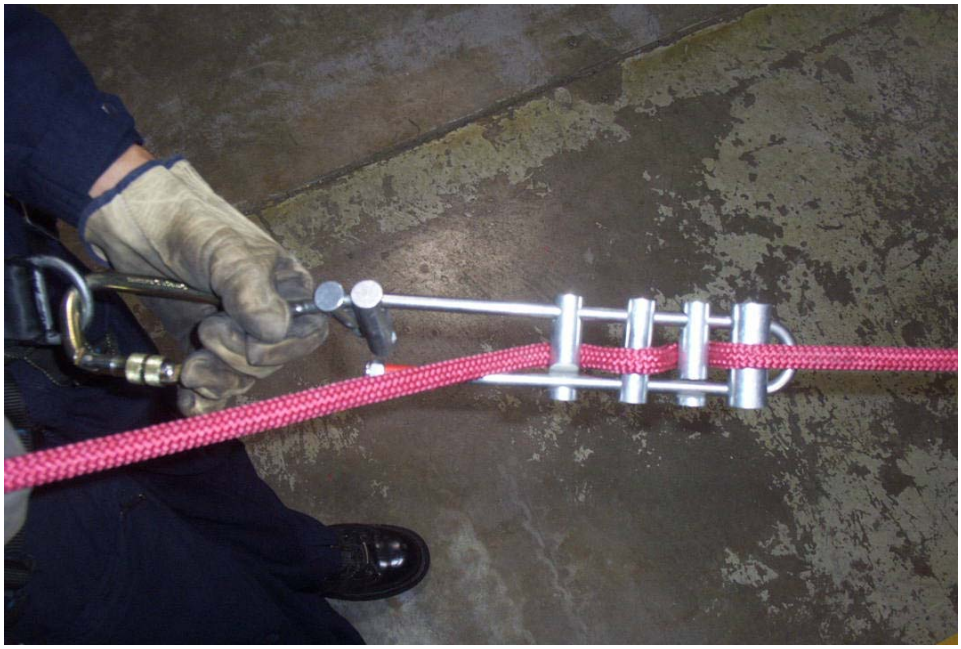
Descending rope with a Brake Bar Rack:

Connect the Brake Bar Rack to your harness with a carabiner.

While facing the anchor, rig the rope through the rack ensuring that the rope runs over the top of the lead bar and the rope alternates going over and under the bars which forces the bars it passes over into the closed position.

The number of bars utilized for a rappel is dependent on the weight and experience of the rescuer. Generally it is recommended that four bars be used for a rappel and all the bars be used initially if the rappeler is going over a vertical edge. Once situated over the edge, the rescuer can remove bars as necessary to provide the proper friction.

Controlling the speed of the rappel is achieved much the same as with a Figure 8 Plate with the brake hand holding the rope against the hip, with a slight bend around the hip toward the buttocks and by the other hand gripping the end of the lower bar between the thumb and forefinger and moving the bar down for a faster rappel, and up to slow the rappel. Adjustment of the other bars will also affect the rate of descent. The further the bars are spread apart, the more that friction is reduced and a faster descent will occur. Adding or removing bars to affect friction should be done from a stopped position.



Descending with a Brake Bar rack

Locking off with a Brake Bar Rack:

Begin a short distance above the point you wish to stop.

Slow the descent to a stop by pushing the bars together with your thumb and forefinger on the hand controlling the rack.

Bring the rope up in your braking hand compressing the bars and pull it down between the standing line and top of the rack. Make one more turn and secure the rope with an overhand either above the rack on the standing line or across the rack itself.

Brake Bar Rack locked off.

Unlocking a Brake Bar Rack:

Untie the Overhand Knot, stabilize the rack in your hand, and pull the two wraps off once again dropping the braking hand back into position.

Rope deployment for a rappel:

There are two methods of rope deployment for a rappel available and determination on which method is utilized is based on training and scenario criteria. The rappeler may toss the rope bag down slope prior to rappel if underbrush will not snag the rope, the deploying rope does not endanger the patient, or the rope will not be grabbed onto by the patient which will halt the rappel. The second method is to rappel with the rope bag on the rappelers back, pulling line out as the rappeler descends.

Rope Rescue Equipment

Life Safety Rope:

Life safety rope shall be ½" diameter static kernmantle, meet NFPA 1983 standards, and have the following minimum information affixed to both ends of the rope:

1. An identifier that matches the rope to its rope log.
2. Rope length.
3. Date the rope was placed in service.
4. Identity of the ropes end with an "A" or "B" designator.
5. Clear identification if the rope is dynamic.

A rope log that outlines the ropes history and usage shall be maintained for all life safety rope. Specifics of the rope log will include at a minimum:

1. The manufacturer.
2. Lot number.
3. Date manufactured and date placed in service.
4. Color of the rope.
5. Diameter and length.
6. Static or dynamic.
7. Minimum breaking strength.
8. History of rope (after use information.)
9. Inspection information.

All life safety rope shall be certified as "general use" approved per NFPA 1983 standards. (See life safety rope performance requirements below for "general use" specifications.)

Proper care, use, inspection, and maintenance of life safety rope shall follow the manufacturer's recommendations. All life safety rope shall be inspected after purchase and prior to being placed in service, after each use, and at least semi-annually.

All dynamic rope shall be clearly identified as "Dynamic Rope" both on the rope at each end as well as on its rope bag.

If a life safety rope has been utilized for purposes other than the support of live loads, or has been used in a situation that could not be supervised, or where potential damage may have occurred, it must be removed from service and destroyed.

All life safety rope removed from service as life safety compatible must be altered in such a manner that it cannot be mistaken as life safety rope. (Example: removing the end identifiers from a life safety rope past its service life for use as auxiliary line.)

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

Prusik Line:

Prusik line shall be 8mm diameter low stretch kernmantle with a minimum breaking strength of 2875 lbs.

The material used for the sheath on a prusik line may be non- compatible with the sheath on a life safety rope as far as its ability to provide adequate gripping strength beyond a single person load. Prusik line shall be tested for compatibility with the life safety rope that it is intended to be used on. The absence of such tests will prohibit mixing of one jurisdictions prusik line with the life safety rope of another jurisdictions.

Prusik line formed into a loop with a double overhand bend to be used for pulling, breaking, or as a ratchet may be custom sized to fit the pulleys they will be utilized with or assembled from prusik line that is 54" long for a "short" prusik, and 65" for a "long" prusik. The tails of the prusik line protruding from the double overhand bend must be no less than 2" in length.

Prusik line utilized for Load Release Hitches (LRH) may be formed from prusik line 33' in length.

Prusik line utilized for Purcell Prusiks may utilize prusik line 6mm in diameter and may be customized for long and short loops to fit the individual user.

Prusik line shall be inspected after purchase and prior to being placed in service, after each use, and at least semi-annually.

Due to the critical nature of using prusik line to support live loads, any prusik line showing minimal wear or damage should be removed from service. Any prusik line greater than six years old, whether used or not, shall be taken out of service or destroyed.

Webbing:

Webbing shall be 1” nylon tubular construction with a minimum breaking strength of 4000 lbs.

Webbing shall be color coded to indicate the following lengths:

1. Green - 5 feet
2. Yellow - 12 feet
3. Blue - 15 feet
4. Red - 20 feet
5. Black - 25 feet

Webbing shall be clearly marked to indicate the date that it was placed in service.

Webbing may be formed into loops by tying the ends together with an overhand bend (aka a water knot). The tails of the webbing protruding from the overhand bend must be no less than 2” in length.

Webbing shall be inspected after purchase and prior to being placed in service, after each use, and at least semi-annually.

Due to the critical nature of using webbing to support live loads, any webbing showing minimal wear or damage should be removed from service. Any webbing greater than six years old, whether used or not, shall be taken out of service or destroyed.

Anchor Straps:

All anchor straps must meet NFPA 1983 standards.

All anchor straps shall be clearly marked to indicate the date that it was placed in service, and the length of the anchor strap.

Anchor straps shall be inspected after purchase and prior to being placed in service, after each use, and at least semi-annually.

The manufacturer’s recommended shelf life of life for anchor straps shall be followed. If no shelf life is specified, anchor straps greater than six years old, whether used or not, shall be taken out of service or destroyed.

Life Safety Harnesses:

All harnesses shall meet NFPA 1983 standards. (See “Life Safety Harness User Information” below for information required by the manufacturer to the consumer.)

Component, performance, labeling, and testing requirements for harnesses are outlined in NFPA1983.

A Class 2 life safety harness is a harness that fastens around waist and around thighs or under buttocks and designed for rescue with a design load of 600 lbf. Class 2 harnesses are appropriate for protection of personnel working rope systems or to provide fall protection. A Class2 harness may be utilized for a rappel, but should not be utilized if there is a chance the user could become inverted.

A Class 3 life safety harness is a harness that fastens around waist, around thighs, or under buttocks, and over shoulders, and designed for rescue with a design load of 600 lbf. Class 3 harnesses may be permitted to consist of one or more parts. A Class 3 harness may be utilized for any rope rescue evolution, and is required if there is any chance that the rescuer may become inverted.

Due to the critical nature of using harnesses to support live loads, any harness showing minimal wear or damage should be removed from service. The manufacturer's recommended shelf life for harnesses shall be followed. If no shelf life is specified, harnesses greater than six years old, whether used or not, shall be taken out of service or destroyed.

Hardware:

All hardware shall meet NFPA 1983 standards for "general use" application.

Carabiners with the gate closed shall have a major axis minimum breaking strength of at least 8992 lbf.

Ascending Device (Rope Grab Device) shall withstand a minimum test load of at least 2473 lbf without permanent damage to the device or damage to the rope.

Decent Control Devises shall withstand a minimum test load of at least 4946 lbf without failure and shall withstand a minimum test load of at least 1124 lbf without permanent damage or visible deformation to the general shape of the devise or damage to the rope.

Portable Anchor Devises shall withstand a minimum test load of at least 8093 lbf without failure and shall withstand a minimum test load of at least 2923 lbf without permanent damage or visible deformation to the general shape of the devise.

Pulleys shall have a minimum tensile strength of at least 8093 lbf without failure and shall have a minimum tensile strength of at least 4946 lbf without permanent damage to the devise or damage to the rope.

Auxiliary Equipment shall have a minimum tensile strength of at least 8093 lbf without failure.

All hardware shall be inspected after purchase and prior to being placed in service, after each use, and at least semi-annually. Hardware shall be inspected to ensure that there is no undue wear, structural damage, or sharp edges to fixed or moving components and the equipment is maintained to manufacturer's specifications.

The service life of all hardware shall follow the manufacturer's recommendations.

NFPA 1983 2001 Edition Information

Life Safety Rope Performance Requirements:

All life safety rope shall be certified as "general use" approved per NFPA 1983 standards. General use life safety rope must meet the following requirements:

1. Has a minimum breaking strength of not less than 8992 lbf,
2. Has a minimum diameter of 1/2" and no greater than 5/8".
3. Has a minimum melting point of 400 degrees F.
4. All dyed life safety rope shall have a color fastness to washing of at least Class 2 color change.
5. Has a minimum elongation not less than 1% at 10% of breaking strength.
6. Has a maximum elongation that is less than 10% at 10% of the minimum breaking strength of the rope. (Example: maximum elongation of a 300' rope rated at 9000 lb. minimum breaking strength is 30' at 900 lbs.) **Note:** The Cordage Institute, which is recognized as industry standard for rope manufacturers, defines "static" life safety rope as a rope with a maximum elongation of 6% at a load of 10% of the ropes minimum breaking strength. "Low stretch" life safety rope is defined as a rope with an elongation greater than 6% but less than 10% of the ropes minimum breaking strength.

Reuse of Life Safety Rope:

The manufacturer shall provide direction for the user with information regarding the reuse of life safety rope. Reuse of life safety rope is allowable if at least the following conditions are met:

1. The rope has not been visually damaged.
2. The rope has not been exposed to heat, direct flame impingement, or abrasion.
3. The rope has not been subjected to any impact loads.
4. The rope has not been exposed to liquids, solids, gas, mists, or vapors of any chemical or other material that can deteriorate rope.

5. The rope passes inspection when inspected by a qualified person following the manufacturer's inspection procedures both before and after each use.

Life Safety Rope User Information:

The manufacturer shall provide information for the user regarding at least the following issues:

1. Inspecting the rope periodically according to the manufacturer's inspection procedure.

2. Removing the rope from service and destroying it if the rope does not pass inspection or if there is any doubt about the safety or serviceability of the rope.

3. Protecting the rope from abrasion.

4. Not exposing the rope to flame or high temperature and carrying the rope where it will be protected as the rope could melt or burn and fail if exposed to flame or high temperature.

5. Keeping the product label and user instructions/ information after they are removed / separated from the rope and retaining them in the permanent rope record; copying the product label and user instructions/ information and keeping the copies with the rope.

6. Referring to the user instructions/ information before and after each use.

7. Cautioning that, if the instructions/ information are not followed, what serious consequences could occur to the user.

Life Safety Harness User Information:

The manufacturer shall provide information for the user regarding at least the following issues:

1. Inspecting the harness periodically according to the manufacturer's inspection procedure.

2. Removing the harness from service and destroying it if the harness does not pass inspection or if there is any doubt about the safety or serviceability of the harness.

3 Not exposing the harness to flame or high temperature and carrying the harness where it will be protected as the harness could melt or burn and fail if exposed to flame or high temperature.

4. Repairing the harness only in accordance with the manufacturer's instructions.

5. Keeping the user instructions/ information after it is separated from the harness and retaining it in a permanent rope record; copying the user instructions/ information and keeping the copy with the harness.

6. Referring to the user instructions/ information before and after each use.

7. Cautioning that, if the instructions/ information are not followed, what serious consequences could occur to the user.

Auxiliary Equipment User Information:

The manufacturer shall provide information for the user regarding at least the following issues:

1. Inspecting the auxiliary equipment periodically according to the manufacturer's inspection procedure.

2. Removing the auxiliary equipment from service and destroying it if the equipment does not pass inspection or if there is any doubt about the safety or serviceability of the equipment.

3. Maintaining the auxiliary equipment in accordance with the manufacturer's instructions when metal components are subjected to corrosion or deterioration.

4. Returning auxiliary equipment to the manufacturer or to a qualified inspection person/ center if the equipment is dropped or impact loaded.

5. Not exposing the software auxiliary equipment to flame or high temperature and carrying the equipment where it will be protected as it could melt or burn and fail if exposed to flame or high temperature.

6. Repairing the auxiliary equipment only in accordance with the manufacturer's instructions.

7. Keeping the user instructions/ information after it is separated from the auxiliary equipment and retaining it in a permanent record; copying the user instructions/ information and keeping the copy with the equipment.

8. Referring to the user instructions/ information before and after each use.

9. Cautioning that, if the instructions/ information are not followed, what serious consequences could occur to the user.

Zone 3 Main and Belay Line Bag Inventory

General information:

The Main and Belay Line bag inventory represents the required minimum inventory that may be found on any apparatus in Zone 3 that carries rope rescue related equipment.

Jurisdictions may include additional equipment to customize their own Main and Belay Line bag inventories, but no such additional equipment shall be used in place of the outlined minimum inventory as reflected below.

Main Line Bag inventory:

Main Line bag red in color and clearly labeled “Main Line”.
7 - Steel Locking Carabiners.
3 - Prusik Minding Pulleys.
1 - Brake Bar Rack.
1 - Anchor Plate (more than four holes preferred).
1 - Anchor Strap.
1 - Black Webbing.
1 - Yellow Webbing.
4 - Long Prusiks.
3 - Short Prusiks.
33’ section of Prusik cord for a Radium Load Release Hitch (Note: The Radium Load Release Hitch may be pre-tied or stored loose).

Belay Line Bag inventory:

Belay Line bag yellow in color and clearly labeled “Belay Line”.
5 - Steel Locking Carabiners.
2 - Prusik Minding Pulleys.
1 - Anchor Plate (more than four holes preferred).
1 - Anchor Strap.
1 - Black Webbing.
1 - Yellow Webbing.
2 - Long Prusiks.
2 - Short Prusiks.
2 - 33’ sections of Prusik cord for a Radium Load Release Hitch. (Note: The Radium Load Release Hitch may be pre-tied or stored loose).