



ROPE RESCUE TECHNICIAN

INSTRUCTOR
and STUDENT
GUIDE

January 2015



ROPE RESCUE TECHNICIAN



Rope Rescue Technician Instructor and Student Guide



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COURSE REFERENCES

California State Fire Training

Low Angle Rope Rescue Operational Training Manual

California State Fire Training

Rescue Systems 1 Training Manual

NFPA 1006

Standard for

Technical Rescuer Professional Qualifications
2013 Edition

NFPA 1500

Standard on

Fire Department Occupational Safety and Health Program
2013 Edition

NFPA 1670

Standard on

Operations and Training for Technical Search and Rescue Incidents
2009 Edition

NFPA1983

Standard on

Life Safety Rope and Equipment for Emergency Services
2012 Edition

FIRESCOPE

Urban Search and Rescue Operational System Description ICS-US&R-120-1

California Division of Occupational Safety and Health

California Code of Regulations Title 8, Subchapter 7. General Industry Safety Orders Group 1.
General Physical Conditions and Structures Article 4. Access, Work Space, and Work Areas
3270.1 Use of Rope Access Equipment



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We wish to acknowledge and thank the members of the following committees. Without their hard work and dedication, this course would not be possible.

Low Angle Rope Rescue Operational Curriculum Development Committee

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PREFACE

The Rope Rescue Technician curriculum provides required training as outlined in the FIREScope Urban Search and Rescue Operational System Description ICS-US&R-120-1 to the Heavy Operational Level and nationally recognized standards such as NFPA 1006 and 1670.

This curriculum prepares the student for:

Man-made incidents

- Weapons of mass destruction (WMD)
- Terrorist actions
- Chemical, Biological, Radiological, Nuclear, Explosives (CBRNE)

Natural disasters

- Earthquakes
- Floods
- Other catastrophes

Throughout the presentation guide, instructors and students will realize that there may be more than one way to rig complex rope rescue systems. It is acceptable to rig systems differently than portrayed in the presentation guide as long as functional equivalence is maintained.

Functional equivalence shall be defined as equipment and/or techniques that are conceptually the same as portrayed in the presentation guide yet may have minor changes in rigging details. Functional equivalence entails maintaining concepts such as a two rope system, human haul teams (versus mechanical winches), redundancy at appropriate points, and an acceptable level of safety. Minor rigging changes might include removing unused parts of an RPM system, replacing tandem prussiks with mechanical devices (e.g. "540" or "MPD"), or using various types of load releasing hitches.

NFPA 1983 (2012) Annex 3.3.35, states that "an organization at the operational level performing simple rescues might require the higher margin of safety offered by general use equipment" while a "highly trained or specialized organization performing the more complicated rescue might benefit from the lighter weight of technical equipment [and] due to their higher level of training, can maintain an acceptable level of safety and efficiency for the specified operation."

One of the most important aspects of the technician's job is to analyze the comparative advantages and disadvantages of system changes. At the Rope Rescue Technician level,



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there are acceptable trade-offs and there is no single best way to rig a system. As stated above, “maintain an acceptable level of safety and efficiency for the specified operation.”

In the true sense of having redundant systems, each item in a system must be backed up-starting at the anchor continuing to the load. This is strived for when creating two-line systems. There may be times when it is not possible or practical to construct a perfectly redundant system. The rigger operating at the “Technician” level must be able to identify potential single point(s) of attachment, analyze any issues, and determine whether or not the single point of attachment is acceptable. For example, if an anchor is “bombproof” (i.e. freeway concrete column) and the rigger believes that it is prudent to use it to attach both the main and belay lines, then that anchor is truly a single point of potential failure. The rigger in this example has identified the anchor as a single point of attachment, analyzed any issues, and made the decision based upon knowledge, training and experience to use the single point of attachment. The critical analysis of each component is based on the minimum breaking strength of the item, its position in the system, any anticipated force multipliers, and the load itself. All this information will be compared to the acceptable safety margins the Authority Having Jurisdiction has in place.



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CHAPTER 1: COURSE INTRODUCTION

TERMINAL LEARNING OBJECTIVE

The student will be able to identify the course goals, planned activities to achieve those goals, and the requirements for successfully completing the Rope Rescue Technician course.

ENABLING LEARNING OBJECTIVES

1. Describe the course, including course objectives, syllabus, and calendar of events.
2. Demonstrate rescuer and victim safety during all Rope Rescue Technician exercises.
3. Select and use all personal protective equipment.
4. Describe the student evaluation process.

COURSE OBJECTIVES

The student will:

- Understand regulations and standards for high angle rope rescue
- Identify the hazards associated with high angle rope rescue
- Demonstrate the ability to plan, organize, operate, and command at high angle rope rescue incidents
- Demonstrate the ability to select and use rope rescue equipment necessary in high angle rope rescue
- Identify, select, and use appropriate personal protective equipment
- Demonstrate the use of various types of victim removal and packaging systems
- Participate and be evaluated in high angle rope rescue scenarios

COURSE OVERVIEW

This five-day course is designed to meet or exceed certification requirements for Rope Rescue Technician (RRT) based on the current editions of NFPA 1670 (2009) and NFPA 1006 (2013). The minimum requirements found in these documents may change. If the minimum requirements change, the minimum requirements for this course will change accordingly. Upon completion of this course, the student will have demonstrated competence in all the Job Performance Requirements associated with Rope Rescue Technician.

SAFETY

Performing work while suspended by ropes has the potential for injury and even death. All SOG's, SOP's, Department Practices and Procedures, etc. must be adhered to while training or performing rope rescue work. In California, the California Code of Regulations (CCR) Use of Rope Access Equipment is the standard. This section of the CCR establishes



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safety requirements for rope access. While training for rope rescues, this section is applicable and must be read and understood before attempting any training for rope rescue. However, under the section (a) "Scope and Application," emergency search and rescue operations are specifically named as exempt.

SYSTEM SAFETY CHECKS

Safety is the most important aspect of our job. While training or executing an actual rope rescue, the safety of our personnel and the patient is paramount. During rigging, check each piece of equipment as it is placed into the system. If anything is suspect, pull it out and replace it. Prior to placing a live load on the system, perform a safety check on all equipment from the anchor to the harness.

A proper system safety check consists of physically checking the system to ensure proper rigging, performing a load test prior to life-loading the system, and verbally confirming these actions. The verbal confirmation must be announced and acknowledged.

LOCK OUT TAG OUT

Lock Out Tag Out (LOTO) is the safety procedure which ensures that a potential energy source is rendered safe and inoperative. The source is secured, normally with a lock of some sort, and then an identifying tag is placed on it to warn others of the status of that piece of equipment. The need for LOTO arises in a rope rescue evolution whenever a system component, team member, or victim may come in contact with a potential energy source.

Two examples of when there is a need for LOTO:

- An apparatus being used as an anchor.
- A tower rescue with live electrical wires.

STATIC SYSTEM SAFETY FACTOR

A rope system contains many parts, and each part has a minimum breaking strength. Find the weakest "link" in the system and ratio that to the known or anticipated load. This number is known as the Static System Safety Factor. For example, if the weakest component in a system has a minimum breaking strength of 600lbf and the load exerts 600lbf, then the Safety Factor would be 1:1. This would not be an acceptable Safety Factor since theoretically at 601lbf the system would break (and the load would fall). Some rescue teams concerned with weight of their gear use the lightest pieces possible. Subsequently, components found in their systems have a lower minimum breaking strength. Their acceptable System Safety Factors may be 4:1 or 5:1. Other rescue teams may be less concerned with the weight of their equipment and can therefore have a higher System Safety Factor, for example 10:1. In either case, before a live load is placed, every rope system must be analyzed and must meet or exceed the AHJ's predetermined System Safety Factor.



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PERSONAL PROTECTIVE EQUIPMENT

Personal Protective Equipment (PPE). The equipment provided to shield or isolate a person from the chemical, physical, or thermal hazards that can be encountered at a specific rescue incident. PPE can include: helmet, gloves, long sleeve shirt, long sleeve pants, leather boots, eye protection, ear protection, and a life safety harness.

STUDENT TASK BOOK

The RRT student task book is designed to accompany this course and serve as a tracking method for completion of all Job Performance Requirements, skills, and evolutions. The evaluating instructor will sign the task book. The student will keep the task book for their own personal records.



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CHAPTER 2: ROPE RESCUE EQUIPMENT

TERMINAL LEARNING OBJECTIVE

The student will demonstrate the proper use of the equipment used in the Rope Rescue Technician course.

ENABLING LEARNING OBJECTIVES

1. Describe the use/misuse of the rope rescue equipment.
2. Describe the inspection/maintenance of the rope rescue equipment.
3. Use, inspect, and maintain all rope rescue equipment.

ROPE RESCUE EQUIPMENT

Each piece of rope rescue equipment has the potential to hold someone's life. Rope rescue equipment shall be used, cared for, inspected, and maintained per the manufacturer's guidelines. NFPA and the CCR set forth expectations for equipment inspection and maintenance and a Rope Rescue Technician is expected to be able to do the following:

- Inspect and maintain rescue equipment.
- Perform pre-service and post-service inspection procedures.
- Keep maintenance records.
- Place items subject to replacement out of service per the manufacturer's guidelines.

NEW EQUIPMENT

ETRIER

Description:

This is a sewn piece of webbing.

Use:

An etrier may be used as a “ladder” in certain situations.

Inspection, Care and Maintenance:

Per the manufacturer’s guidelines



Figure 2-1. Etrier with attachment loops

DOUBLE BYPASS LANYARD WITH SHOCK ABSORBER

Description:

If the need arises to climb up to the patient (ie. climb up a tower to rescue a stranded worker), then a double bypass lanyard with shock absorber may be an appropriate choice for fall arresting. There are two connectors (one on each lanyard) that attach to a suitable anchor point. The lengths of the lanyards vary by product (2 foot pictured). A shock or energy absorber may be attached.

Use:

When accessing a victim above any anchor point, the bypass lanyard offers a secure way to approach while climbing up and maintaining at least one anchor point for fall protection

Inspection, Care and Maintenance:

Per the manufacturer's guidelines



Figure 2-2. Double Bypass Lanyards with shock absorber

MINI MECHANICAL ADVANTAGE SYSTEM

Description:

A typical setup may include 50' of 8mm accessory cord running through two double sheave pulleys.

Use:

Any time the need arises for mechanical advantage.

Inspection, Care, and Maintenance:

Per the manufacturer's guidelines



Figure 2-3. Mini Mechanical Advantage

SWIVELS

Description:

Two rated connection points attached in-line with one another that possess the ability to rotate upon that axis.

Use:

Any time the need arises to remove twist out of a rope system

Inspection, Care, and Maintenance:

Per the manufacturer's guidelines



Figure 2-4. Swivels (NFPA “G” Rated and “T” Rated)



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EQUIPMENT STANDARDS FOR ROPE RESCUE TECHNICIAN

Description	Up to 12 students or 1 squad	Each subsequent 12 person squad
Anchor Plate *	6	6
Backboard	1	See Endnote A
Descent Control Device *	8	8
Carabiners (locking)*	40	40
Commercial Class III Harness	6	6
Commercial Victim Seat Harness	1	1
Edge Protection	See Endnote B	See Endnote B
Ascenders	4 See Endnote C	0
Load Releasing Device	6 See Endnote D	4 See Endnote D
Low stretch/static kernmantle rescue rope 150 foot * (12.5 mm)	5 See Endnote E	5 See Endnote E
Low stretch/static kernmantle rescue rope 20 foot * (12.5 mm)	2	0
Pickets, steel (or equivalent)	Optional	Optional
Prusik Loop, Short (8mm)	10	10
Prusik Loop, Long (8mm)	10	10
Pulley *	15 See Endnote F	15 See Endnote F
Rescue litter	1	1
Rescue litter pre-rig	See Endnote G	See Endnote G
Sledge hammer	See Endnote H	See Endnote H
Spider straps	Optional	Optional
Tie ropes (12.5mm)	14	0



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Description	Up to 12 students or 1 squad	Each subsequent 12 person squad
Webbing, green * 1" x 5'	12	12
Webbing, yellow * 1" x 12'	12	12
Webbing, blue * 1" x 15'	12	12
Webbing, orange * 1" x 20'	12	12
Knot passing pulley *	1	0
Pick off strap *	2	0
Etriers	2 See Endnote I	0
Double bypass lanyard	Optional	Optional
Mini MA system	See Endnote J	See Endnote J
Artificial High Directional	See Endnote K	See Endnote K
Swivels *	Optional See Endnote L	Optional See Endnote L
Equipment to Belay a Falling Load	See Endnote M	0

ENDNOTES

*** Indicates must meet NFPA 1983 "G" rating**

A. 1 backboard per site.

B. Edge protection can be manufactured (rope rollers, etc) or improvised (split fire hose, etc). There shall be adequate amounts of edge protection available for concurrent running scenarios.

C. While Gibbs Ascenders™ are acceptable, handled ascenders are preferred.

D. Commercial or field assembled (with webbing or cordelette) complete with General Use carabiners. These carabiners are in addition to the amounts specified under the carabiner and prusik categories.



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- E. Each rope of the two-track highline must be one continuous length of rope. If your highline span is greater than 150 feet you must acquire longer ropes to span the gap. You may also need a longer reeve line rope.
- F. 5 of the 15 pulleys must be single sheave prusik minding. 2 of the 15 should be double sheave prusik minding. Subsequent squads may not require additional double sheave pulleys.
- G. Commercial or field assembled complete with General Use carabiners and prusiks, if field assembled these carabiners and prusiks are in addition to the amounts specified under the carabiner and prusik categories.
- H. If pickets are used a sledge hammer is required.
- I. Can be commercial or field assembled from one inch tubular webbing.
- J. If performing the optional litter scoop evolution, a mini MA system will be needed to lower and raise the foot end of the litter. Can be commercial or improvised.
- K. Can be a commercial (Arizona Vortex™, Terradaptor™) or improvised high directional (4x4 lumber). If concurrent highline stations are being run, one additional artificial high directional per highline must be provided.
- L. “G” rated pulleys that have a built in swivel will satisfy this requirement.
- M. This can be accomplished by having a person perform a hard, unexpected jerk on the belay system.

ADDITIONAL NOTES

1. Instructors at “Agency Specific” classes that use the CMC MPD™, Traverse 540 Rescue Belay™, and other similar devices may use these devices during the class.
2. Instructors at “open enrollment” classes should continue to show “traditional” methods of lowering & raising to their students (i.e RPM). This does not mean that devices like the CMC MPD™, Traverse 540 Rescue Belay™, and other similar devices cannot be shown to students.



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CHAPTER 3: KNOTS, BENDS, AND HITCHES

TERMINAL LEARNING OBJECTIVE

The student will identify and properly tie knots, bends, and hitches.

ENABLING LEARNING OBJECTIVES

1. Tie a tensionless hitch.
2. Tie optional knots, bends, and hitches as required.

GENERAL

Knots, bends, and hitches can be categorized in the following 5 ways:

1. End-of-line loop: figure 8 on a bight, figure 8 follow through.
2. Midline loop: *alpine butterfly, *longtail bowline.
3. Securing rope around desired objects: clove hitch, round turn and two half hitches
*tensionless hitch, *Munter hitch.
4. Joining rope or webbing together: figure 8 bend, overhand bend, double overhand bend.
5. Gripping rope: three wrap prusik hitch.

*denotes newly introduced knots.

TENSIONLESS HITCH (Required)

The tensionless hitch should be considered when the entire strength of the rope is needed. For example, when setting the track line for a highline, the tensionless hitch should be considered since it will retain up to 100% of the rope strength if constructed properly. A suitable anchor should be chosen. The anchor should be at least 8x the diameter of the rope so that as the rope turns around the object it will retain its full strength. The anchor must be stronger than the minimum breaking strength of the rope. Edge protection must be added as necessary to protect the rope.

There are three factors to consider regarding the tensionless hitch and its ability to function properly- force applied, friction coefficient, and angular contact. All three must be present for the tensionless hitch to perform properly and each factor will vary depending upon the situation:

Force applied- as with all other hitches, if the force applied is released, the hitch will begin to lose contact with the object it is wrapped around and could potentially fall apart. The more force applied to the tensionless hitch, the better it will grasp.

Friction coefficient- this term refers to how “sticky” the surface of an object is. Tree bark from an oak tree is likely to have a higher friction coefficient than the surface of a structural pole.

Angular contact – one complete wrap of an anchor is considered to be 360 degrees. The more wraps of the anchor results in more degrees of contact. Four wraps (1,440 degrees) is a good place to begin when considering how many wraps are necessary.

The tensionless hitch is completed when it is tied off upon the working line with either a figure 8 follow through or a figure 8 on a bight connected with a carabiner.

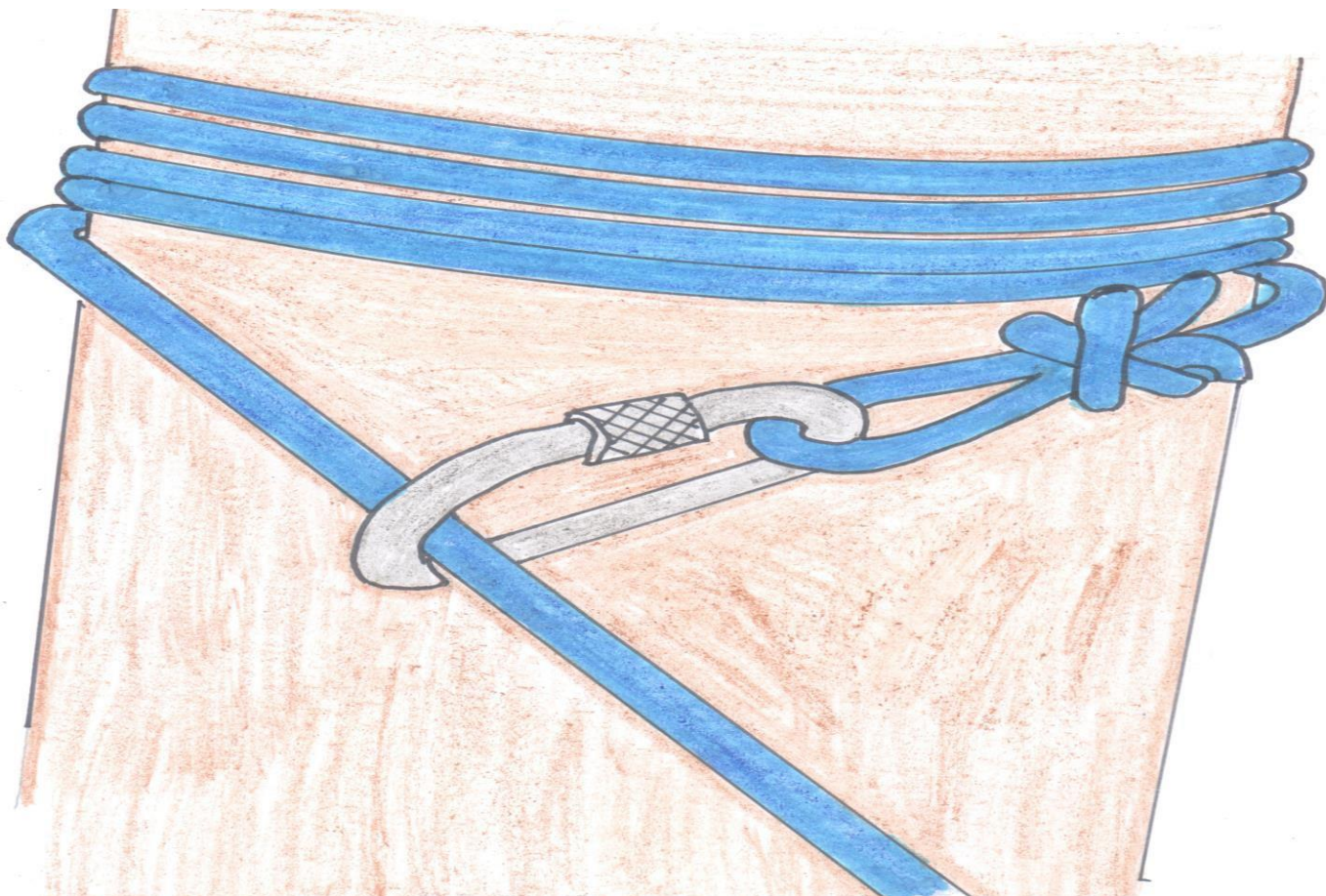


Figure 3-1. Tensionless Hitch

ALPINE BUTTERFLY

This knot serves as a multidirectional midline loop. It has a higher knot efficiency than other midline loops and can be tied a variety of ways making it a preferred knot for this application.

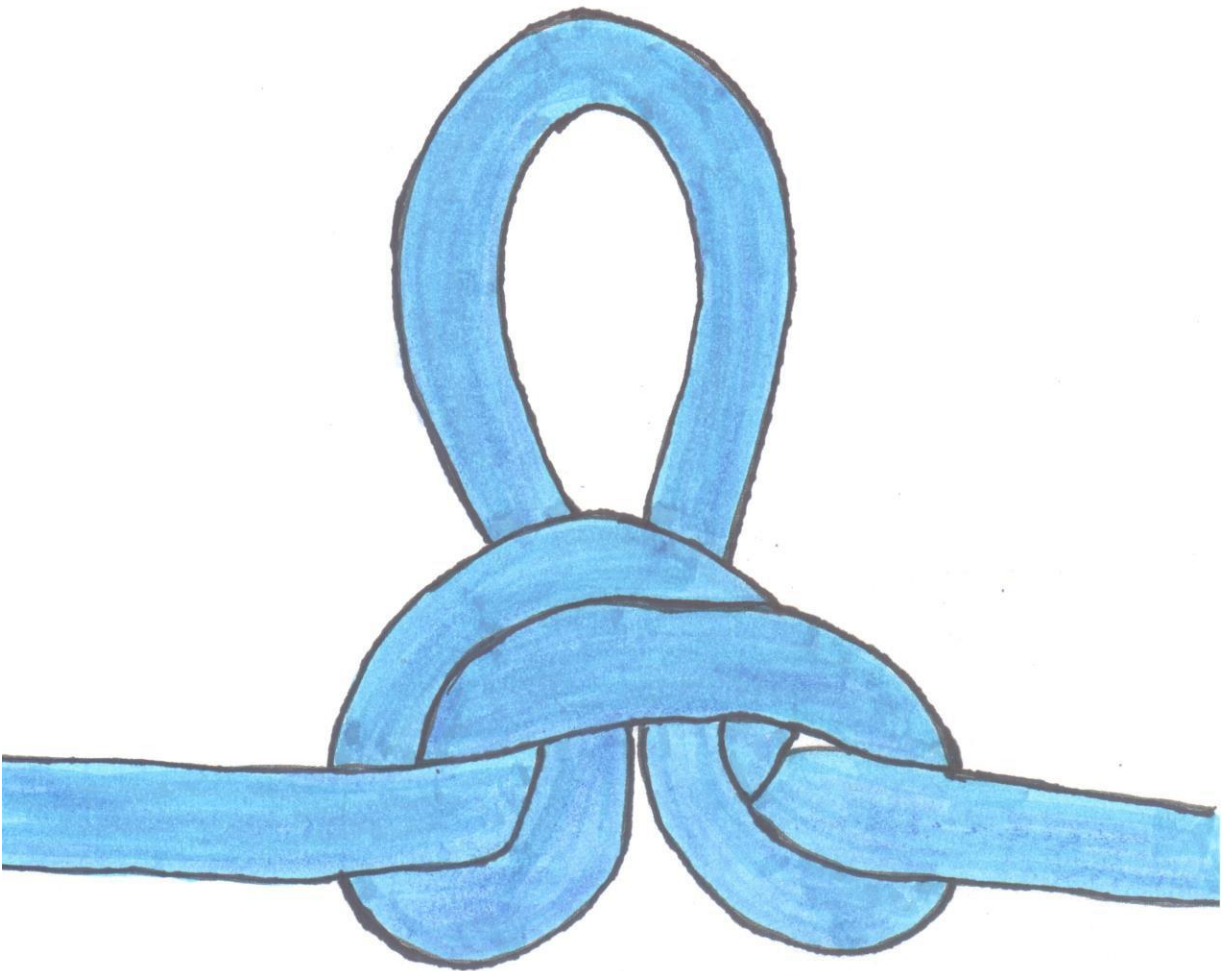


Figure 3-2. Alpine Butterfly

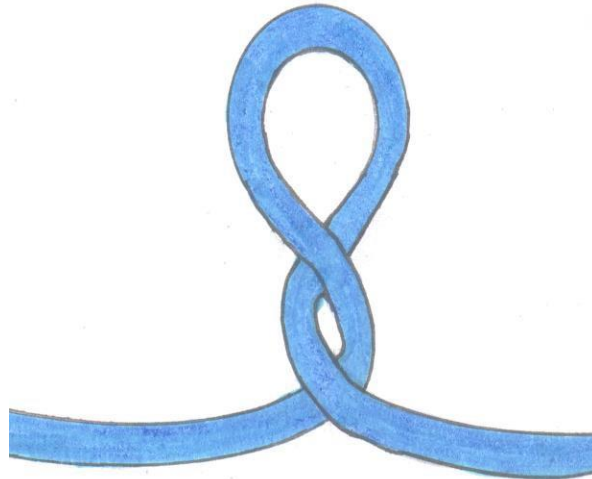


Figure 3-3a. Tying the Alpine Butterfly, Step 1

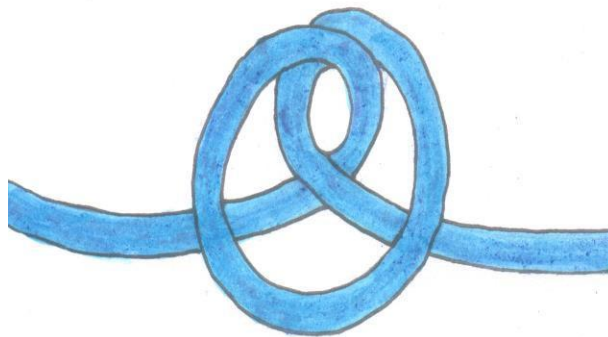


Figure 3-3b. Tying the Alpine Butterfly, Step 2

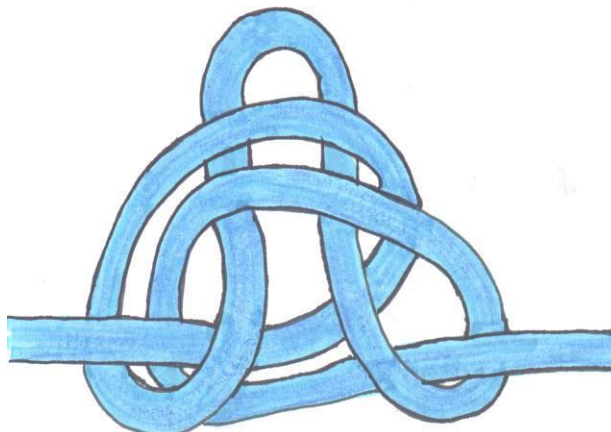


Figure 3-3c. Tying the Alpine Butterfly, Step 3

LONGTAIL BOWLINE

This knot may be used to secure the mainline and/or belay to the litter rigging in the vertical environment. The added longtail can provide an attachment point(s) to the rescuer.



Figure 3-3. Longtail Bowline

MUNTER HITCH

This hitch is a running hitch which can be used to provide friction to the line via the wraps around the carabiner. It is also used in a radium release hitch.



Figure 3-4. Munter Hitch



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CHAPTER 4: ANCHOR SYSTEMS

TERMINAL LEARNING OBJECTIVE

The student will demonstrate anchor selection and anchor system construction.

ENABLING LEARNING OBJECTIVES

1. Describe system safety factors, critical angles, and force multipliers.
2. Describe considerations when selecting anchors.
3. Describe the types of anchors.
4. Construct the required anchor systems.

ANCHORS

An anchor is a component used either alone or in combination with other anchor points to create an anchor system capable of sustaining the potential load. Anchors can be man-made, (i.e. an apparatus or guardrail piling) or natural such as a boulder or tree. Ideally the anchor should be bombproof. A bombproof anchor is a term used to describe an anchor capable of sustaining the potential forces exerted on the rope rescue system without the possibility of failure.

SINGLE POINT ANCHOR

A single point anchor is an anchor that relies on a single point to support the entire load. A properly constructed single-point anchor will meet the following criteria:

- The strength of the anchor should meet or exceed the potential forces and its location should not interfere with rescue operations.
- The anchor inspection and loading is critical, prior to being placed into service.
- If a potential anchor cannot support the load, select another, or construct an anchor system that will support the load.

MULTI POINT ANCHOR SYSTEM

A multi-point anchor system is two or more anchors rigged to provide a connection point capable of sustaining the potential load.

A properly constructed multi-point anchor system will consist of the following criteria:

- The anchor system should meet or exceed the potential forces and not interfere with rescue operations.
- Prior to being placed into service, it is critical that the anchor system be inspected and test loaded.
- The load will be distributed between more than one anchor point.

Multi point anchor systems are predominately constructed in two ways: load distributing and load sharing. When utilizing a multi point anchor system, avoid exceeding the critical angle.

CRITICAL ANGLE

The critical angle is an internal angle in a system of 120 degrees or greater that results in an amplification of a force applied to the system. The angle which results from wrapping a multi point anchor system must be noticed and calculated. At 120 degrees, the load carried is equal to what is being placed upon the two anchors. When the angle is greater than 120 degrees, the load placed upon the two anchors will exceed the load being carried. Conversely, when the angle is less than 120 degrees, the two anchors each carry less than the load.



Figure 4-1. Two examples of 120 Degree Critical Angle

90 degrees keeps the load on a multi-point anchor less than a single point anchor would encounter (approximately .7x the load on each anchor). Even in a single point anchor the internal angle should be 90 degrees or less. 90 degrees is an easy angle to determine in the field and it will make it easier on the anchor(s).

When the internal angle is 120 degrees or greater the load on each anchor is greater than it would be on a single point anchor, thus creating a force multiplier.

TENSIONED ANCHOR SYSTEMS

Mechanical advantage systems can be used in a couple of different ways to assist the rigger in proper anchor selection.

1. To create anchors in places exactly where you want them- e.g. Focused Floating
2. To increase the integrity of already existing anchors- e.g. Back tied

FOCUSED FLOATING ANCHOR SYSTEM

If your system requires a multidirectional anchor in a very specific location, but there is nothing there, a rigger can create one in free space. Using multiple anchors attached by various lines to a single collection point, the rigger can tension a suitable anchor in just about any place.

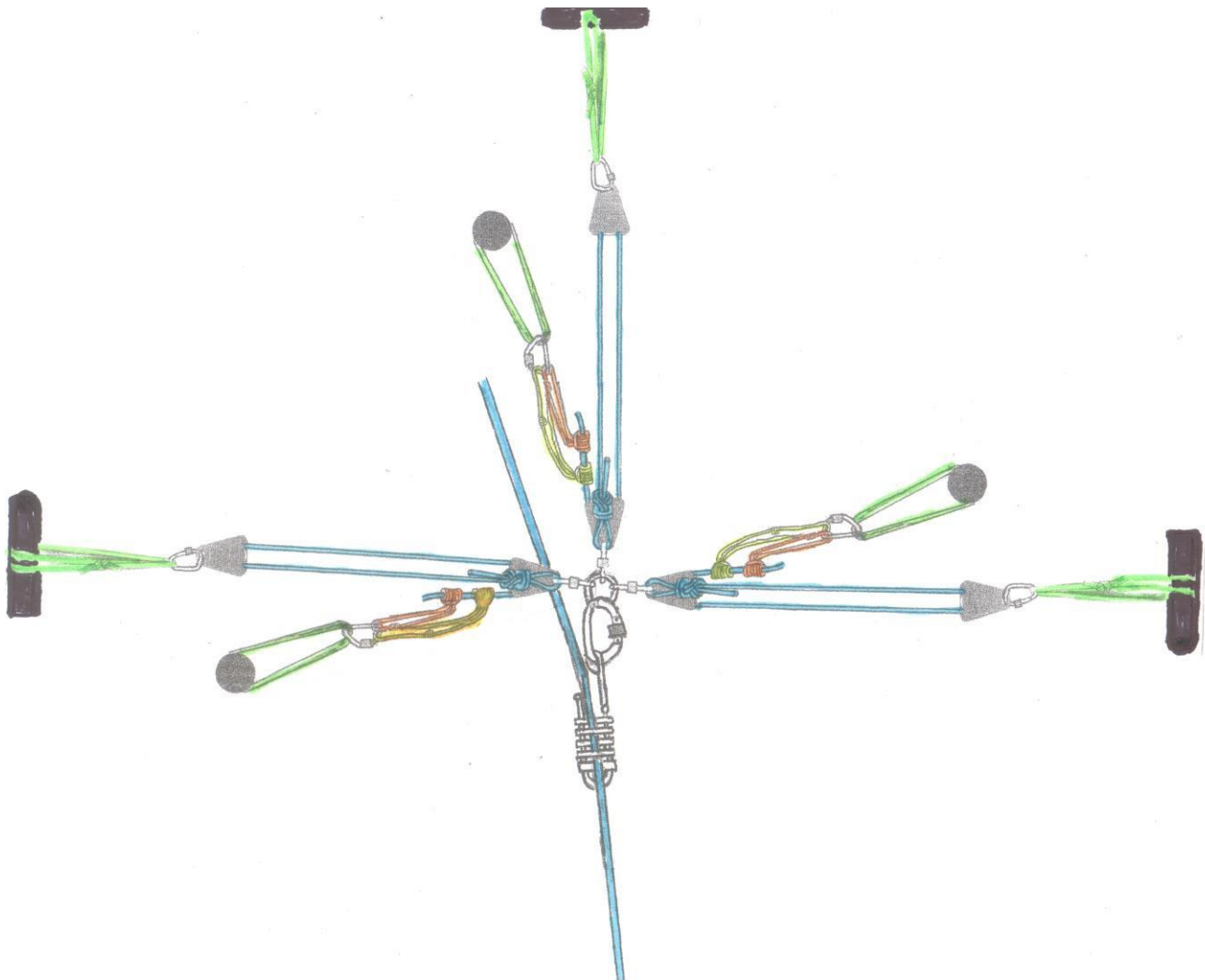


Figure 4-2. Focused Floating Anchor (rigged for a rack lower).

BACK TIED

In the event that the anchor selected is in the correct position but is of marginal integrity, another anchor inline and behind that anchor can be selected to support the initial anchor. The secondary anchor can be tensioned to the primary anchor. This creates a component which is likely to be stronger than if both anchors were selected independently.



Figure 4-3. Back tied anchor.



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CHAPTER 5: HIGH ANGLE VICTIM PACKAGING

TERMINAL LEARNING OBJECTIVE

The student will package a victim in a high angle environment.

ENABLING LEARNING OBJECTIVES

1. Package an ambulatory victim in a commercial victim harness.
2. Package an ambulatory victim in an improvised webbing harness.
3. Package a non-ambulatory victim in a rescue litter.

Proper packaging of victims is essential for a safe rope rescue operation. Rescuers must have the knowledge, skill, and ability to assess the level of injury, select the most appropriate means for packaging, and effectively secure it on a victim in the high angle environment.

When training at heights above two feet in the vertical or free space environment, the “victim” must be wearing an NFPA Class III harness with the appropriate level of protection from falls. The “rescuer” may place an NFPA Class II Victim Extrication Device (or improvised harness) over the NFPA Class III harness to allow “rescuers” to practice less than optimal methods of packaging while remaining safe in the training environment.

COMMERCIAL VICTIM PELVIC HARNESS

There are a variety of commercially manufactured victim pelvic harnesses on the market. All models attach quickly and securely around the waist and thighs or under buttocks, no matter where or how the victim is positioned. The design allows the harness to be put on without the victim having to step into the harness. This is particularly helpful if the person is only supported by their hands and feet.

When faced with the practical complications in the high angle rescue environment, the rope rescue technician may need to take quick actions to secure and package a victim. While the optimal victim harness would be an NFPA Class III Victim Extrication Device, less optimal methods may be required. The use of an NFPA Class II Victim Extrication Device is a common and appropriate selection in most instances.

The donning, use, care, and maintenance should be performed according to the manufacturer’s instructions, but the general method follows. Practice with this method should allow you to modify the steps to meet unusual situations.

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1. Open the bag and completely remove the harness. Hold the waist buckle in one hand, and the waist V ring in the other hand.
2. Reach around and clip the waist V-Ring into its buckle. Center the waist loop to the victim's front and tighten the waist belt snugly.
3. Pull the leg loops down, between the legs, and to the outside of the victim's body.
4. Clip the V-Rings into the buckles of the matching color. Pull the ends to tighten so the leg loops fit snugly. If you are concerned about the buckles slipping, tie an overhand knot in the end of all the straps.
5. Check the following:
 - The V-Rings are securely clipped into each buckle.
 - The harness is snug and not pinching or binding.
 - The buckles are not causing the victim any discomfort.



Figure 5-1. Commercial Victim Harness

When faced with the practical complications in the high angle rescue environment the rope rescue technician may need to take quick actions to secure and package



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a victim. While the optimal victim harness would be an NFPA Class III Victim Extrication Device less optimal methods may be required. The use of an NFPA Class II Victim Extrication Device is a common and appropriate selection in most instances.

IMPROVISED VICTIM PELVIC AND CHEST HARNESSSES

Improvised methods for capturing the victim such as webbing may be used in extreme situations only. Due to the smaller surface area of contact with 1" webbing as compared to the padding and webbing found on commercially made harnesses (often 1-3/4" or greater), it is not advised to use 1" webbing on a person unless other clear and present risks outweigh the damage which can be done. An improvised harness may also be used only after exhausting all rescue-specific commercially made harnesses, as in the case of a multiple victim extraction. When training with an improvised webbing harness ensure that the safety of the "victim" is paramount and that the victim shall be at a maximum height (per Cal OSHA recommendation) of two feet above grade.

When training at height more than two feet above grade the victim must be wearing an NFPA Class III harness, the rescuer may place an NFPA Class II Victim Extrication Device or improvised harness over the NFPA Class III harness to allow rescuers to practice less than optimal methods in the training environment.

RESCUE LITTERS

Rescue litters serve several purposes during rope rescue operations. They provide victim stabilization, protection, and a method for rescuers to easily manage the rescue load during extrication. The rescue litter also provides a foundation to which ropes are attached for raising and lowering a victim in a high angle environment. A litter can be either tended or untended, depending on factors such as necessity for patient care, difficult obstacles, or terrain.

The rescue litter by itself does not provide spinal immobilization. A victim requiring cervical spine immobilization should first be properly secured to a backboard, in accordance with local EMS policy, and then placed and secured inside the litter.

Rescue litters should be inspected regularly for bends, cracks, broken welds, and damage or wear to any plastic. Cleaning can be performed with mild soap and water. Decontamination can be accomplished as per department policies. All attachment options for the litter must be in accordance with the manufacturer's recommendations.



ROPE RESCUE TECHNICIAN



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ROPE RESCUE TECHNICIAN



CHAPTER 6: TRAVEL RESTRICTION

TERMINAL LEARNING OBJECTIVE

The student will demonstrate the selection, construction, and use of travel restriction for rescuers.

ENABLING LEARNING OBJECTIVES

1. Construct a travel restriction system.
2. Attach a rescuer to a travel restriction system.

TRAVEL RESTRICTION

The purpose of a travel restriction system is to eliminate the possibility of a fall while still allowing the necessary degree of movement for rescuer(s) to perform their assignment. A travel restriction system shall be used any time a rescuer is within 6 feet of an unprotected edge (per Cal OSHA). The travel restriction system will consist of an anchor, approved harness, lifeline, and related hardware and software adjusted to limit travel.

The travel restriction system should be used when there is a possibility of a fall and rigged to allow the movement of rescuers only as far as the sides of the working level or working area.

COMPONENTS OF A TRAVEL RESTRICTION SYSTEM

- An anchor that is capable of supporting at least twice the maximum anticipated dynamic load.
- An appropriate length of lifeline attached to the anchor and rescuer. One or both ends of the lifeline should be adjustable.
- While a NFPA Class III harness is preferred, an NFPA Class II harness is acceptable for use in travel restriction.

HOW TO CONSTRUCT A TRAVEL RESTRICTION SYSTEM

- Select an appropriate anchor.
- Secure lifeline to anchor.
- Secure lifeline to harness.
- Place lifeline adjustment as needed.

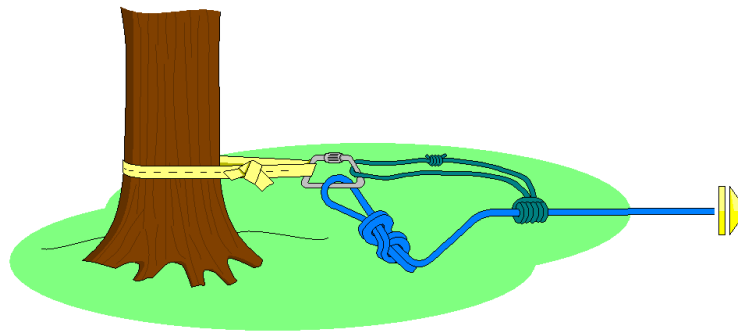


Figure 6-1. Travel restriction with adjustment at anchor.

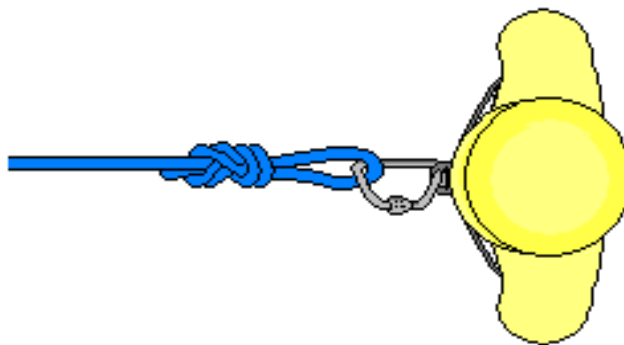


Figure 6-2. Non-adjustable attachment at the rescuer.

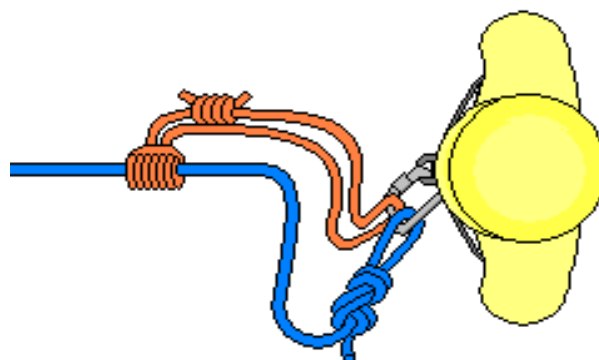


Figure 6-3. Adjustable attachment at rescuer.



ROPE RESCUE TECHNICIAN



CHAPTER 7: BELAY SYSTEMS

TERMINAL LEARNING OBJECTIVE

The student will demonstrate proper technique to belay a load in the event of a failure of the main line.

ENABLING LEARNING OBJECTIVES

1. Define key points regarding the operation of a belay.
2. Catch a load with a belay.

An important part of ensuring safety is the utilization of a belay line to catch the load in the event of a failure of the main line. The belay line is ideally attached to a separate anchor and exists independent of the main line. In the event of a mainline failure, the load will transfer to the belay.

KEY POINTS REGARDING THE OPERATION OF A BELAY SYSTEM

- The entire operation is only as safe as the belay system and its operator.
- Personnel operating the belay line must be competent. These skills are perishable and their maintenance requires regular hands-on practice under the supervision of a qualified person.
- Minimize any slack in the belay system.
- Keep thumbs from underneath the belay line.
- The rescue package can only move as fast as the belayer can effectively move line through the system.
- AHJ may choose to use other means for belay systems. Alternate belay systems must be functionally equivalent to the tandem prusik belay system.

BELAY LINE CONFIGURATIONS

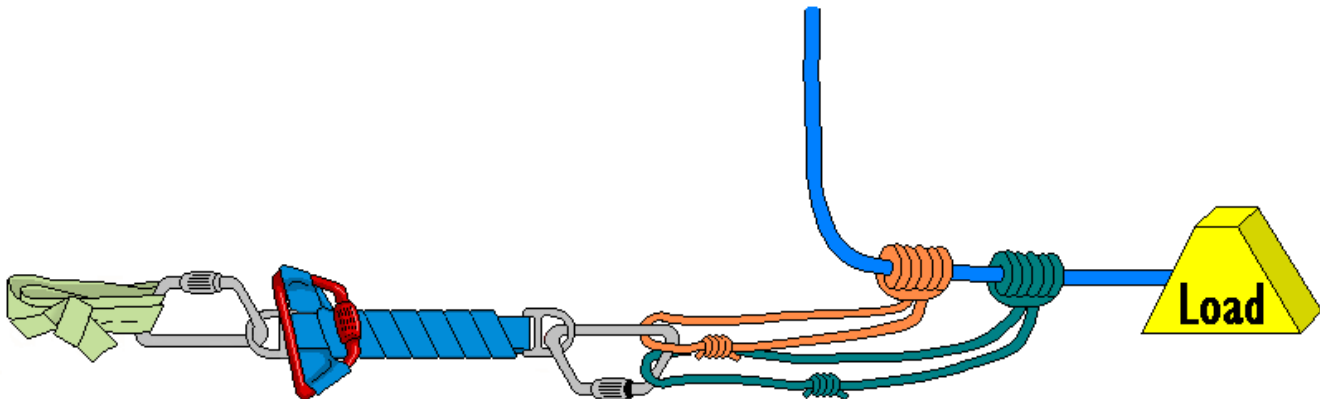


Figure 7-1. Tandem prusik belay configuration without PMP.

Pros: can be used for either lowering or raising operations.

Cons: can be tiresome on long raises.

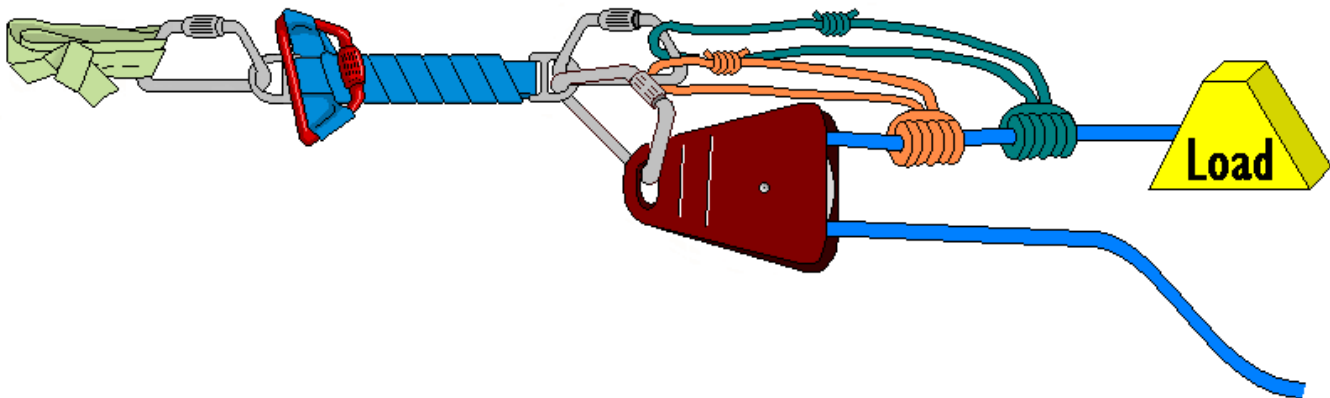


Figure 7-2. Tandem Prusik Belay Configuration with PMP.

Pros: Effective on long raises.

Cons: Uses more equipment.

SYSTEM VARIATIONS

It is common to see the basic belay system configuration utilized during lowering operations and the belay line system with the prusik minding pulley utilized during retrieval operations.

CHAPTER 8: MAIN LINE SYSTEMS-LOWERING AND RAISING

TERMINAL LEARNING OBJECTIVES

The student will demonstrate how to construct a lowering system and convert to a raising system using simple and compound mechanical advantage.

ENABLING LEARNING OBJECTIVES

1. Describe system safety factors, critical angles, and force multipliers.
2. Construct and operate a lowering system.
3. Convert a lowering system to a raising system using a compound 9:1.
4. Construct and operate a simple 5:1 "pig rig".

LOWERING SYSTEMS

The diagram below illustrates a tandem prusik belay with the main line running through a brake bar as a friction device.

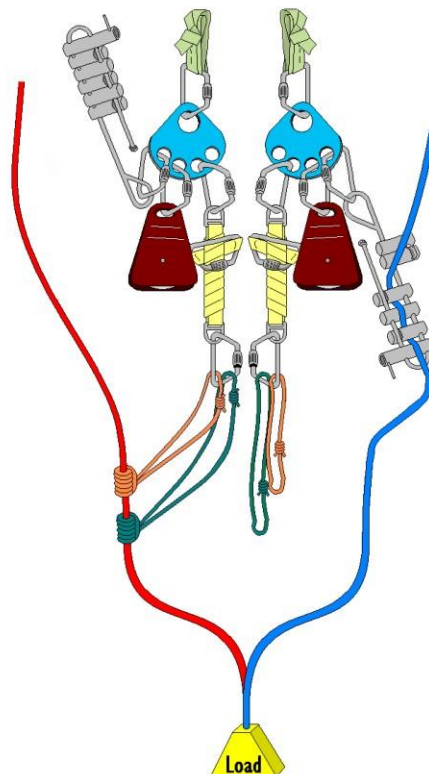


Figure 8-1. Lowering System

CONVERSION OF A LOWERING SYSTEM TO A RAISING SYSTEM

This diagram illustrates a tandem prusik belay. The main line has been converted from a lowering system to a simple 3:1 raising system. The raising system that is utilized will be based on the amount of rescuers on scene. It is better to use a lower mechanical advantage (MA) system (a 3:1 versus a 5:1) if there are sufficient personnel. It will allow the rescue to be done with fewer resets and in less time.

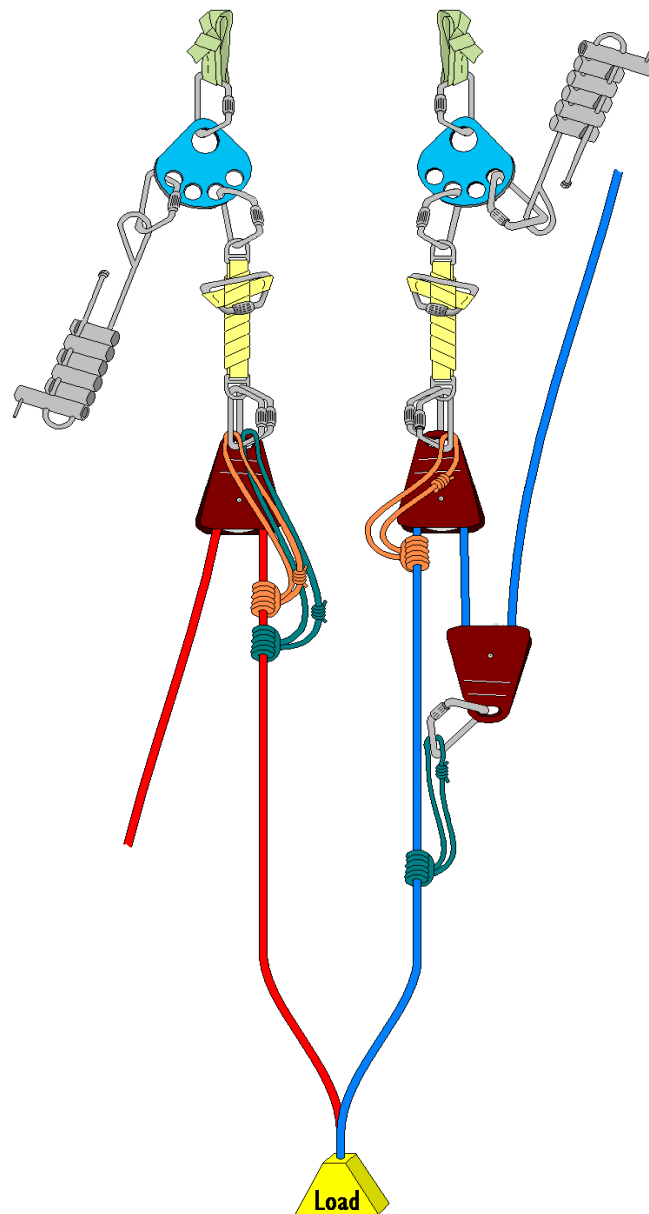


Figure 8-2. Lowering System Converted to Raising System

PIGGYBACK SYSTEMS

A “piggyback” or “pig rig” can be utilized for a variety of reasons. A pig rig can be used to pass a knot, unload a line that has inadvertently been loaded, or when the main line is too short to build a haul system. In the diagram below, the pig rig is a haul system independent of the main line or belay. The pig rig is attached to the main line in this instance because there is not enough line to build a haul system with the original main line.

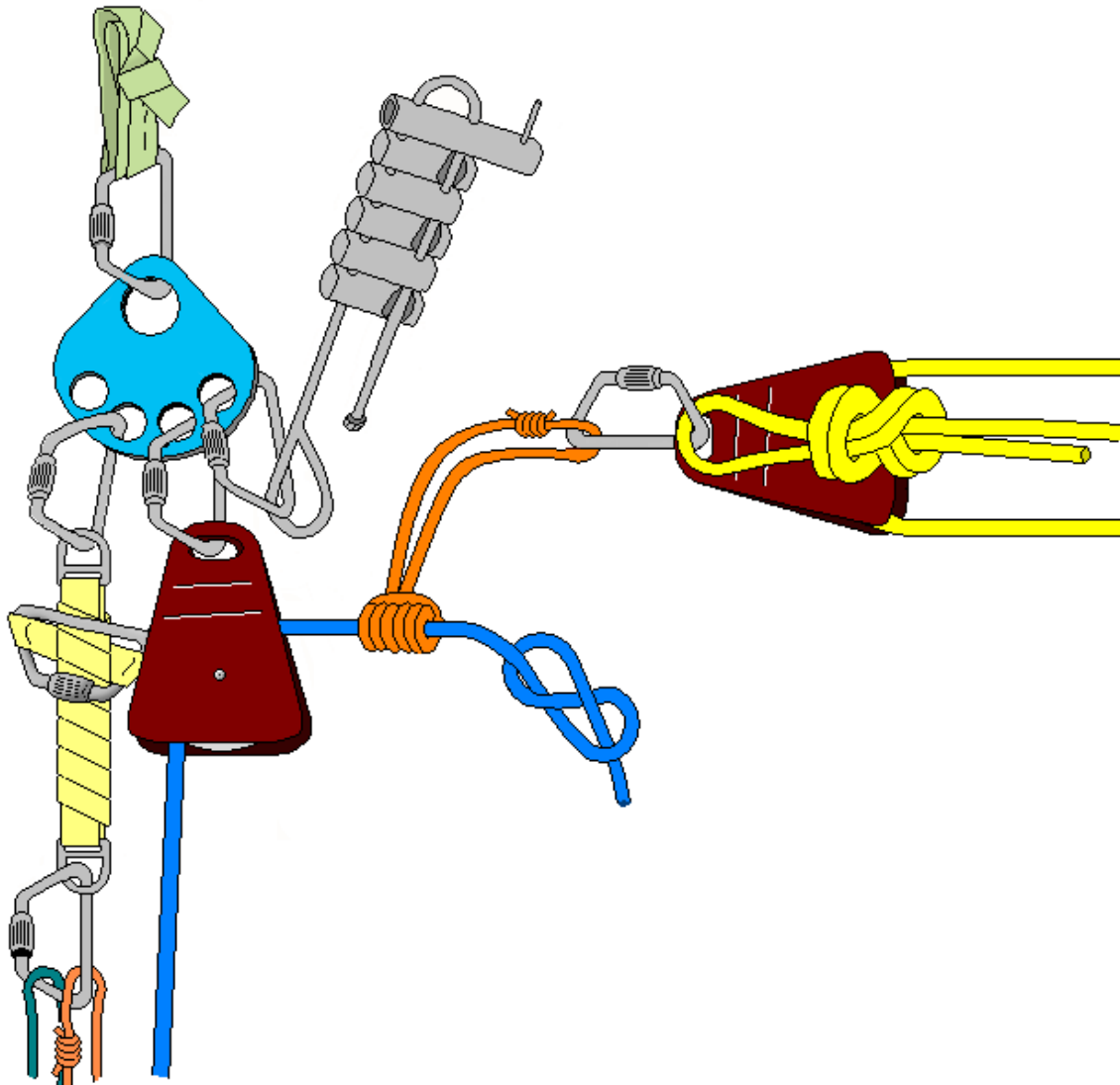


Figure 8-3. Piggyback System (3:1 on right)

COMPOUND MECHANICAL ADVANTAGE (MA)

A compound MA system is a simple system placed on a simple system. The illustration below is a compound 9:1 MA system. It is comprised of a simple 3:1, pulling on another simple 3:1 MA. To determine the total MA of a compound system, multiply the individual simple systems.

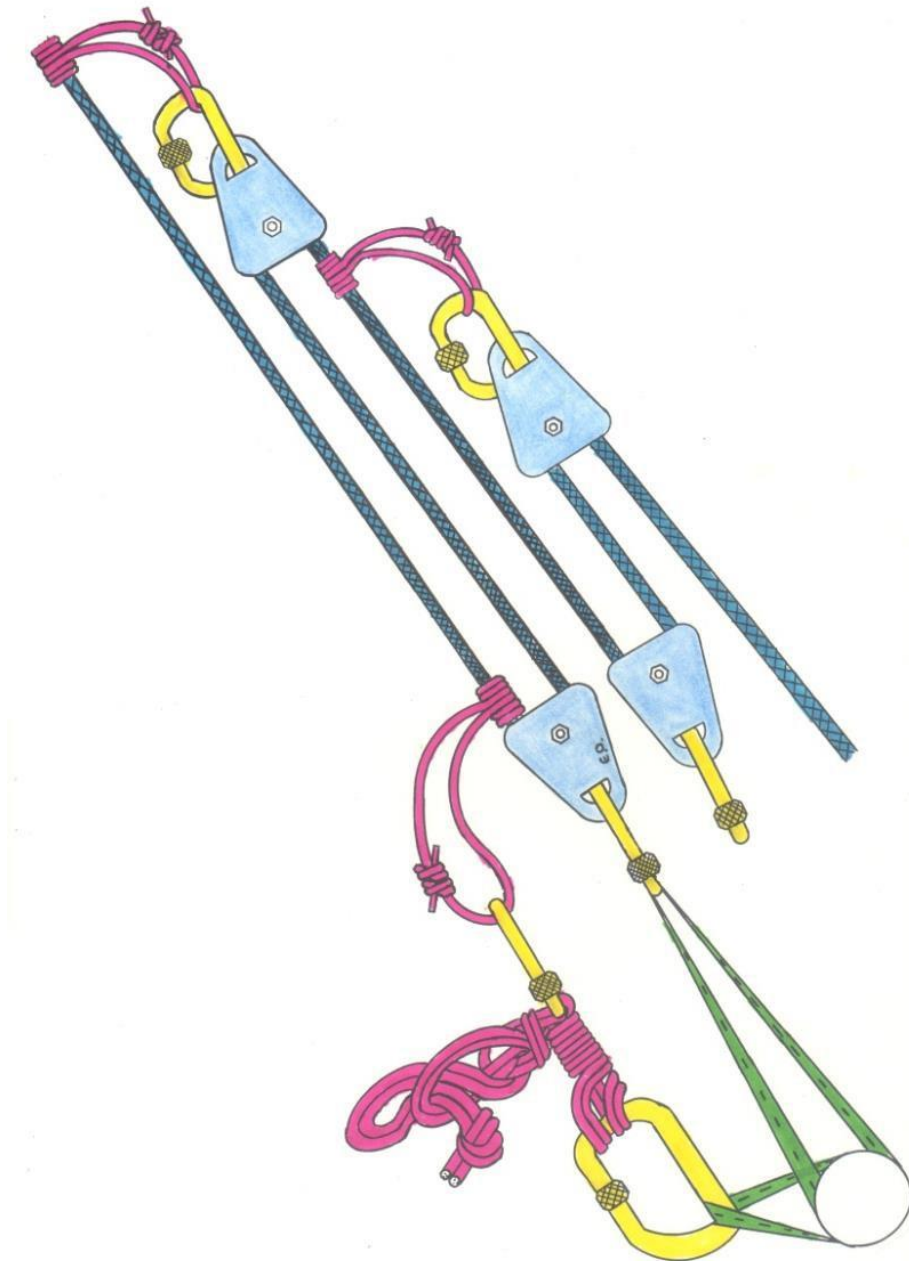


Figure 8-4. 9:1 Compound Mechanical advantage ($3:1 \times 3:1 = 9:1$)

CHAPTER 9: LOAD RELEASING METHODS

TERMINAL LEARNING OBJECTIVE

The student will construct and operate a load releasing device.

ENABLING LEARNING OBJECTIVE

1. Demonstrate proper technique when transferring a load (e.g. an inadvertently loaded belay or converting from a raising system to a lowering system).

The two methods for releasing a line that has been loaded include pre-sewn load releasing devices (LRD) and tied load releasing hitches (LRH).

PRE-SEWN LOAD RELEASE

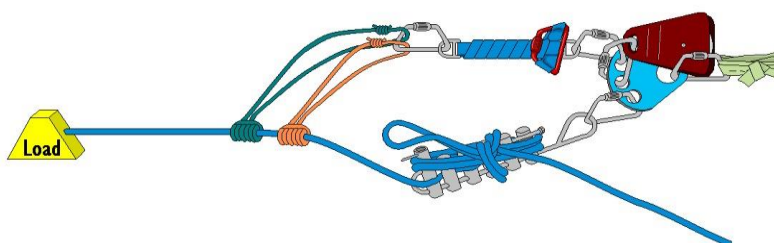


Figure 9-1. Step 1 Locked off.

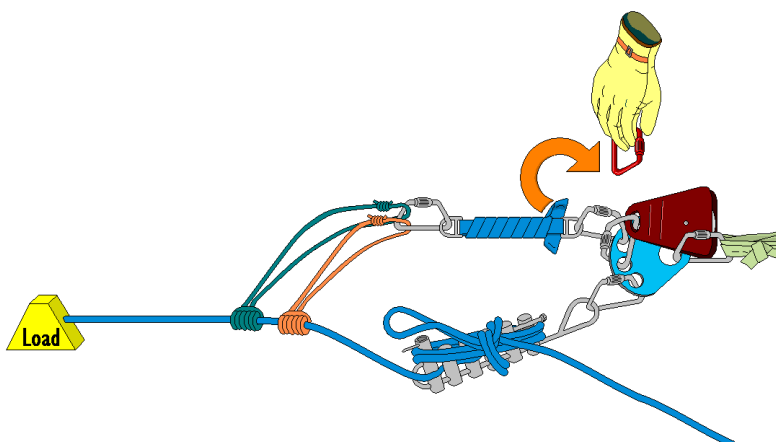


Figure 9-2. Step 2 Remove carabiner

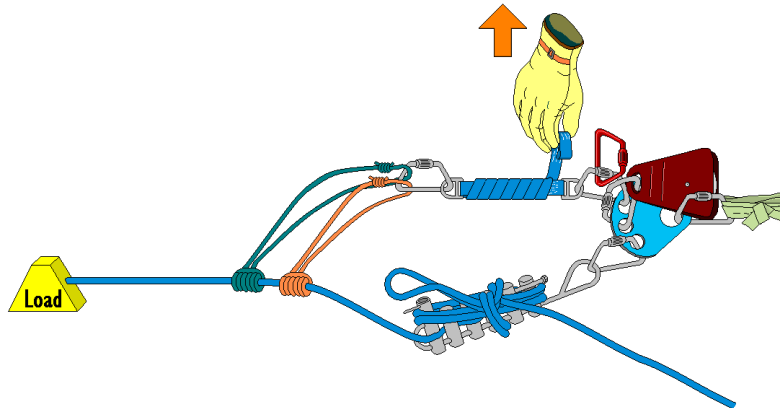


Figure 9-3. Step 3 Unlace strap.

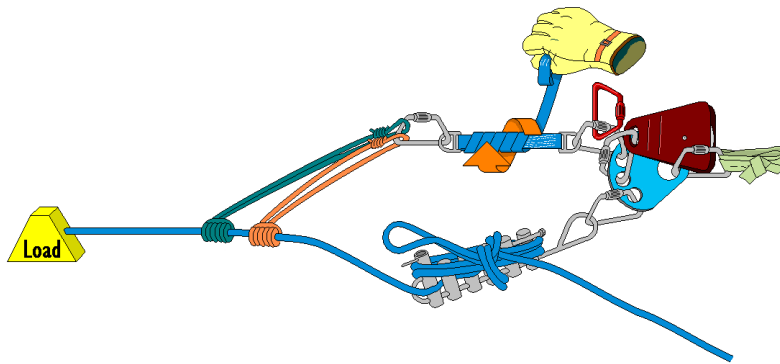


Figure 9-4. Step 4 Slowly unwind strap.

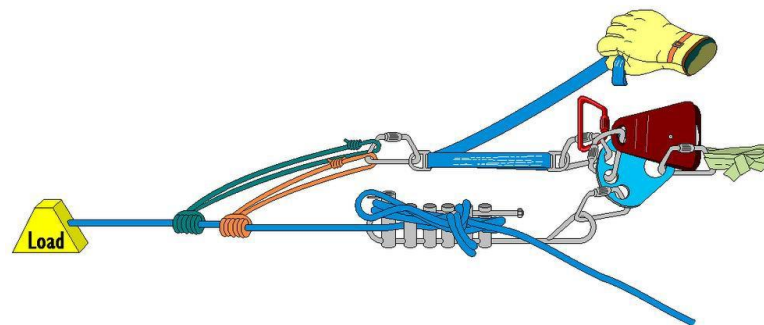


Figure 9-5. Step 5 Slowly allow LRH to extend.

TIED LOAD RELEASE

The second method is using a tied load releasing hitch. The first three diagrams illustrate the hitch being untied and extended. The final two diagrams illustrate the hitch as it would be placed in a system.

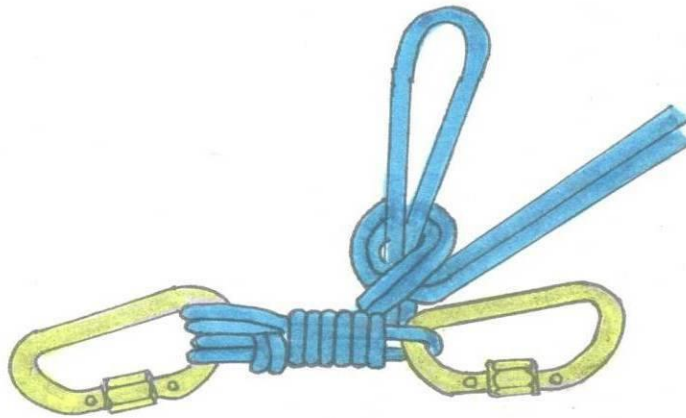


FIGURE 9-6. Step 1 Tied off.

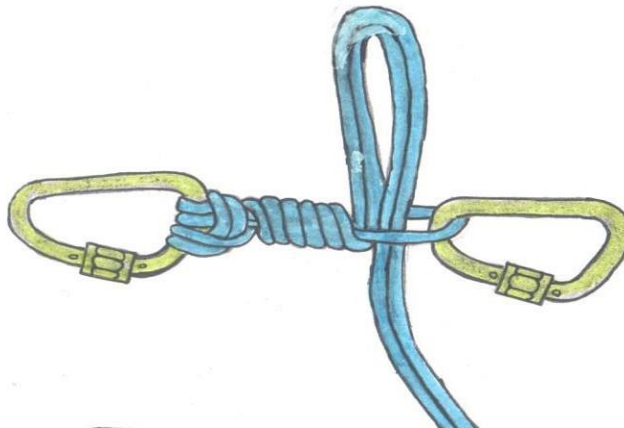


FIGURE 9-7. Step 2 Untying.

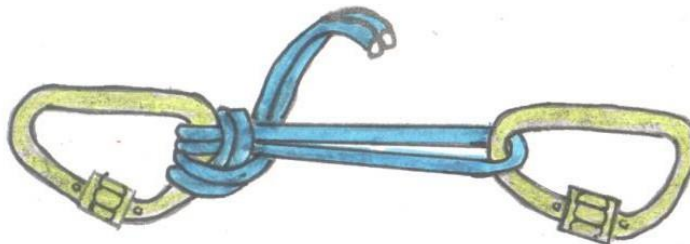


FIGURE 9-8. Step 3 Extending.

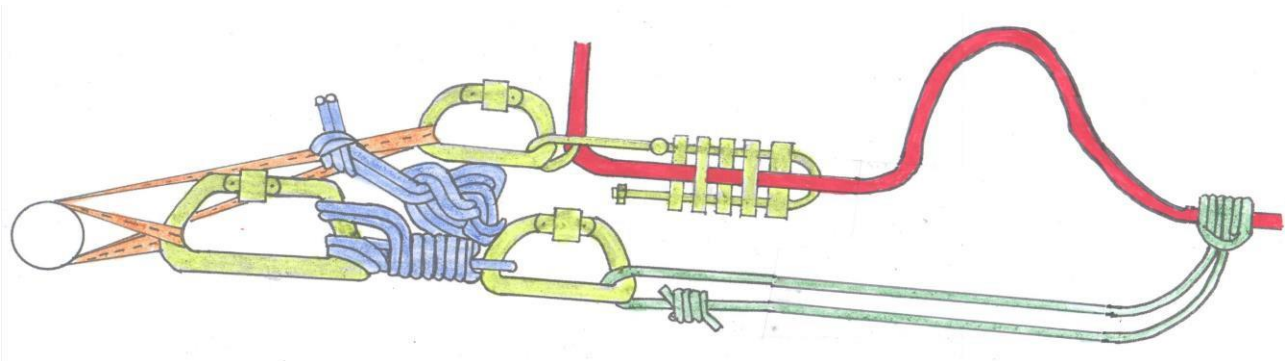


Figure 9-9. Tied LRH in system (load being held by green prusik, LRH tied).

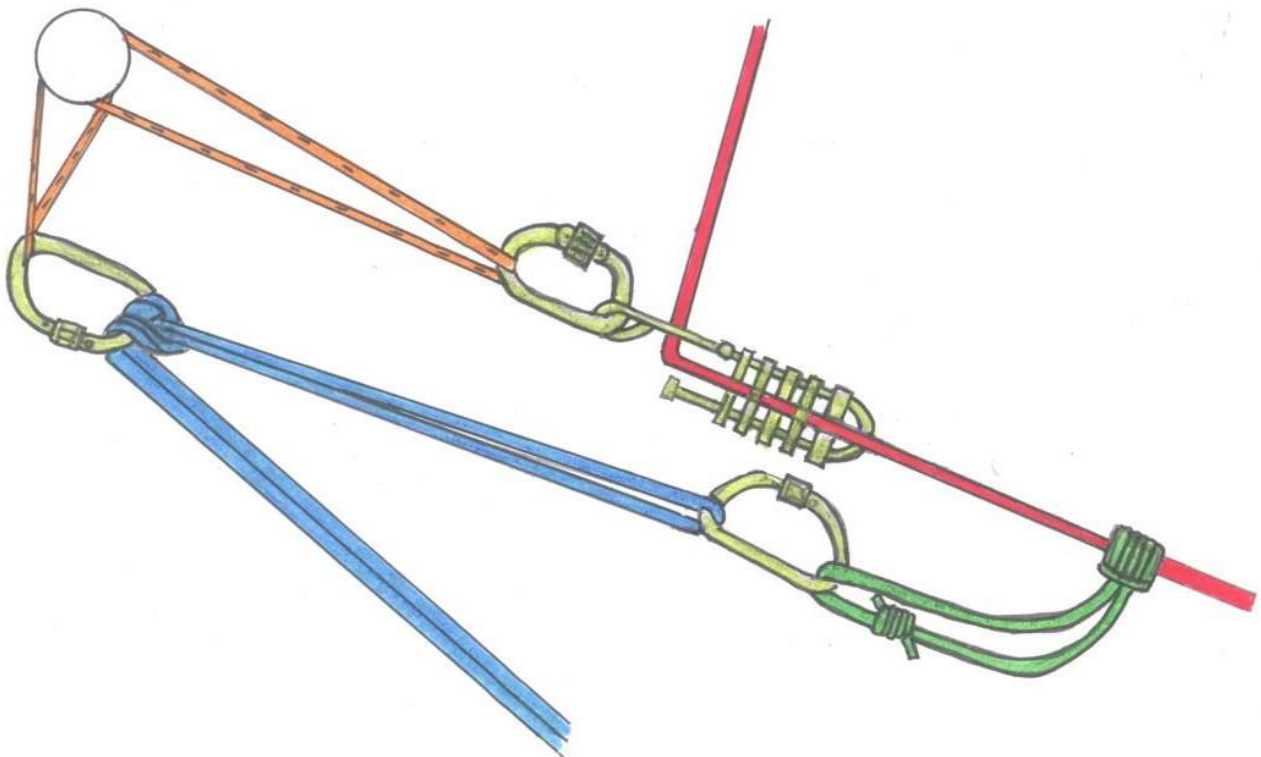


Figure 9-10. Tied LRH in system. Load being released onto rack (LRH untied).



ROPE RESCUE TECHNICIAN



CHAPTER 10: RESCUE SCENE ORGANIZATION AND MANAGEMENT

TERMINAL LEARNING OBJECTIVE

The student will implement the Incident Command System (ICS).

ENABLING LEARNING OBJECTIVES

1. Size up a rescue incident.
2. Create objectives, strategy and tactics.
3. Give operational and safety briefings.
4. Implement rescue scene organization, management, assign positions.
5. Use command and control in rope rescue operations.
6. Terminate the incident.

Rescue Scene Organization And Management

FIRST ON SCENE

The first rescuer or company on scene should assume command. The Incident Commander (IC) should utilize the Incident Command System (ICS) and develop the appropriate framework to meet the needs of the incident. Management and control objectives should guide the ICS framework. Ensure the Standard Operating Guidelines (SOG's) developed for the agency having jurisdiction are implemented.

Managing and requesting the appropriate resources are the responsibility of the IC. The ICS is expandable based on the needs of the incident. On small scale incidents only those parts of the ICS that are needed to safely and effectively handle the incident should be implemented. This gathering of information will assist the IC and rescuers to perform a safe rescue.

Scene Evaluation

Determine a safe distance and location to make your evaluations

Determine the mechanism that caused the situation

Was there a cliff or edge collapse? If so increase your safety distance.

Was it a suicide attempt? The person may endanger the rescuer.

Victim Information

Number of victims

Victim Injuries

Age/Ages

Activity engaged in

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The ICS structure below can be adjusted depending on the needs and complexity of the incident and the number of personnel available. The Edge Person is usually designated as the communication link between the rescuer over the side and the belay and mainline teams. If there is more than one Edge Person, one is selected as the communications link and will give orders during the rescue evolution. When there are fewer rescue personnel it will become necessary for individuals to fill more than one position.

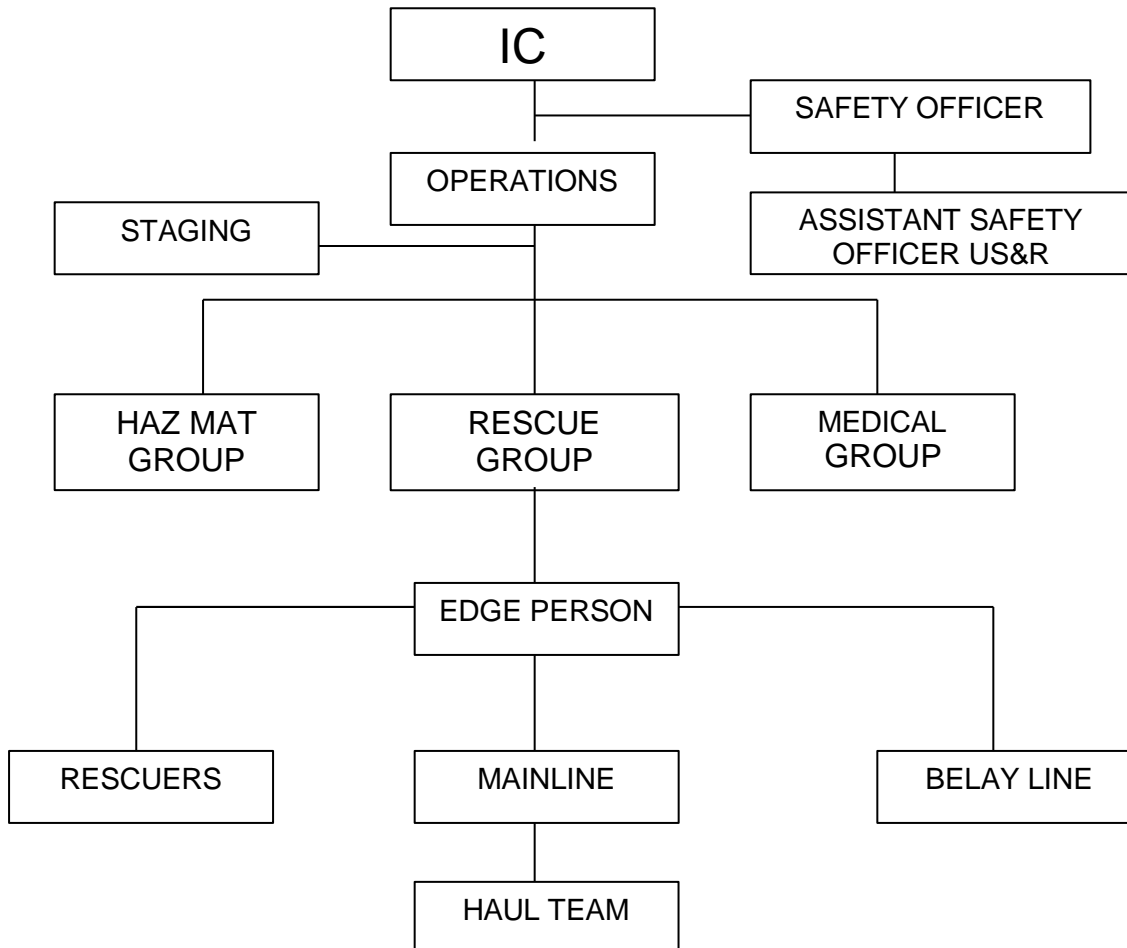


Figure 10-1. Full Response Organization

The chart below is an example of an operation with fewer personnel. The amount of personnel available will dictate how many hats a person might have to wear.

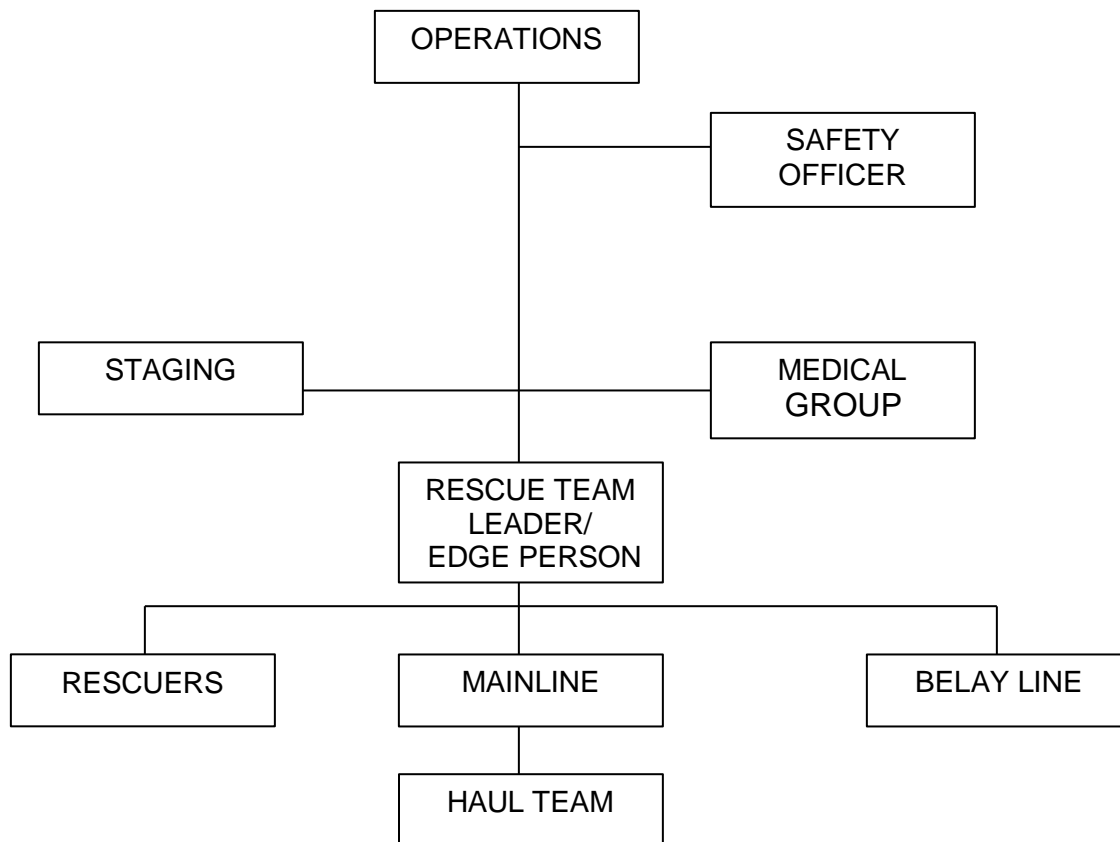


Figure 10-2. Minimal Response Organization



ROPE RESCUE TECHNICIAN



SAFETY OFFICER / ASSISTANT SAFETY OFFICER US&R

A Safety Officer shall inspect and approve all system components prior to starting operations.

A Safety Officer shall ensure that personnel closer than six feet from the edge of a cliff or similar hazard are secured with travel restriction.

A Safety Officer shall ensure that all systems are pre-tensioned. Pre-tensioning a system will show how the lines will lay during the evolution. After pre-tensioning the systems make any needed adjustments to resolve any system problems encountered.

RESCUE TEAM

Rescue team members must work with their personal safety as the highest priority. (Do not become another victim) Agency SOG's are the foundation and principles upon which rescue systems are based. There is no ONE WAY to perform a rescue. However, there are principles and safe system components which must be employed. The method of combining these components may vary. The most important question is: **"IS IT SAFE AND DOES IT WORK?"**

The priorities in rope rescue are;

- 1) Lower if possible
- 2) Raise when necessary
- 3) Use helicopters when practical
- 4) Use motorized devices, winches, or vehicles as a last resort. (preferably only winches made specifically for rope rescue use)

NOTE: Motorized devices winches, or vehicles do not give an indication to the topside crew that a rescuer has a foot, leg, or equipment caught. When performing a raising operation with a manual system, it will become apparent when there is a sudden increase in the load, indicating a problem.

Using a pulley system instead of a 10,000 pound winch will keep from injuring a rescuer as severely as a motorized system would. Some capstans are designed for rope rescue work and have a stall force of about 1,000 pounds. These devices are preferred over winches with a high stall force.



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The rescue must be made at a speed consistent with safety. Check the system and **MAKE THE RESCUE!** Success in a rescue is a combination of:

1. Training
2. Practice
3. Experience
4. Judgment

Certification and classes provide training only and possibly limited experience. This is the foundation of rescue training. The rescuer must gain the other components through training at different venues and scenarios that enhance experience and judgment. Train at higher degree of difficulty than rescuers are likely to encounter. It is important to record all training. Should an accident occur, investigators will demand to review the training records of those involved.

In some operations, the rescue team may find systems placed in service prior to their arrival. If the team will be using these systems to perform the rescue, inspect the rigging to determine if it is safe for use. If the Rescue Group Supervisor does not assign a Safety Officer, the Rescue Group Supervisor assumes the role of Safety Officer.

SELECTING A RESCUE METHOD

LOWERING SYSTEMS

Advantages: Works with gravity.
Simple friction system employed.
Requires fewer people.

Disadvantages: Must have an accessible location at the bottom of the lowering evolution from which the victim can be extracted.
Edge protection is needed.

RAISING SYSTEMS

Advantages: Places victim at the top where an ambulance or helicopter can be waiting to transport.

Disadvantages: Takes more equipment, personnel, and space (haul field).
Takes more expertise to run complex systems.



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HELICOPTERS

- Advantages:
- Allows the team to access the victim where they lie.
 - Can get the team in and out quickly.
 - Can ferry equipment caches quickly.
- Disadvantages:
- Cannot fly in all conditions.
 - Difficult to extract victim in areas of high tree density.
 - Creates rotor wash, which can roll rocks down the hill in scree evacuations.
 - Cannot fly near high tension lines.
 - Time delay in reaching the area.

SUMMARY

A successful rescue may be a combination of several of these methods. A particular method may not always work at the same location.

Example:

The team lowers a rescuer to a victim who fell down a cliff at the beach and continues to lower both victim and rescuer to the bottom of a large sandy area. Both the rescuer and victim are extracted using a helicopter. Later that day there is another rescue in the same place and now it is high tide and the waves are crashing at the bottom of the cliff and the team is unable to lower the victim and rescuer. The team must now use a haul system to raise them to safety. Never wait for a helicopter to complete an operation, the helicopter may not be able to perform the rescue. Always have an alternate plan. The most important reasons for picking a method are: IT WORKS AND IT IS SAFE.

The location of the victim and determining their condition will most likely dictate the incident objectives and the rescue method chosen. Accessing the victim is the next step in the operation. The condition of the victim may dictate whether medical personnel rappel or are lowered into place, prior to a litter basket going over the edge. The medical personnel would stabilize and either package or assist with packaging the victim. This depends on whether medical personnel rappelled ahead of the litter basket or came down with the litter basket.



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CHAPTER 11: KNOT PASSING

TERMINAL LEARNING OBJECTIVE

The student will pass a knot through a lowering and raising system

ENABLING LEARNING OBJECTIVES

1. Pass a knot through a friction device.
2. Pass a knot while through a belay during lowering and raising operations.
3. Pass a knot through a change of direction pulley during a raising operation on the main line.

PASSING A KNOT WHILE LOWERING

When a rope rescue evolution is beyond the reach of the team's longest rope they will end up tying two (or more) ropes together to reach the target. Once the ropes are tied together it is inevitable that the knot will have to be "passed" through the systems. While there are many ways to perform a knot pass, this chapter will highlight one way.

Passing a knot on the main line requires the knot to travel through the descent control device for lowering evolutions and through the mechanical advantage system for raising evolutions. The main line and belay line operate as normal up to the point when the knot pass must occur.

It is important to remember that the knot pass won't come as a surprise, after all someone tied the ropes together! This means that the proper systems can be constructed and in place prior to the knot approaching the point(s) it needs to pass.

This example will start by passing a knot through a brake bar rack during a lowering evolution with what is called a "piggyback". While the main line is being lowered a second rescuer constructs the piggyback system.

A separate rope (preferably a different color) is procured and a figure eight on a bight tied into its end. A carabiner is then clipped into the figure eight on a bight. The rope is then reeved through a separate brake bar rack with the figure eight on a bight approx. 6 inches from the top of the rack. Tie off the rack (Figure 11-1).



Figure 11-1.

Stop lowering and tie off the main line brake bar rack when the knot is approx. 12-18 inches away from the rack (Figure 11-2).

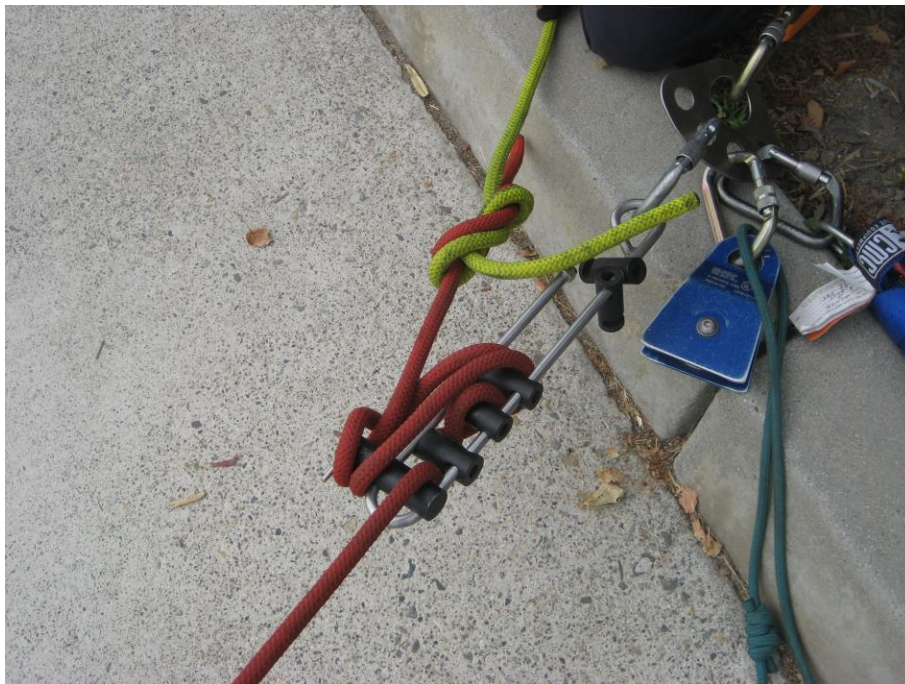


Figure 11-2.

Attach a prusik to the main line approx. 6 inches in front of the brake bar rack. Attach the piggyback system to the prusik attached to the main line. Secure the “piggyback” rack to a suitable anchor (Figure 11-3).



Figure 11-3.

Slide this prusik forward until the piggyback system is tensioned. Untie the main line brake bar rack and slowly lower the load until piggyback system has the entire load (Figure 11-4).



Figure 11-4.

Once the piggyback system has the load there will be slack in the main line brake bar rack. Take the rope out of the main line rack and place the knot in front of the rack. Reeve the rope back through the rack and secure it (Figure 11-5).



Figure 11-5.

Lower on the piggyback system until the main line system is once again carrying the load (Figure 11-6). Once the main line system has the load, remove the piggyback system from the main line and continue the lowering operation (Figure 11-7).



Figure 11-6.

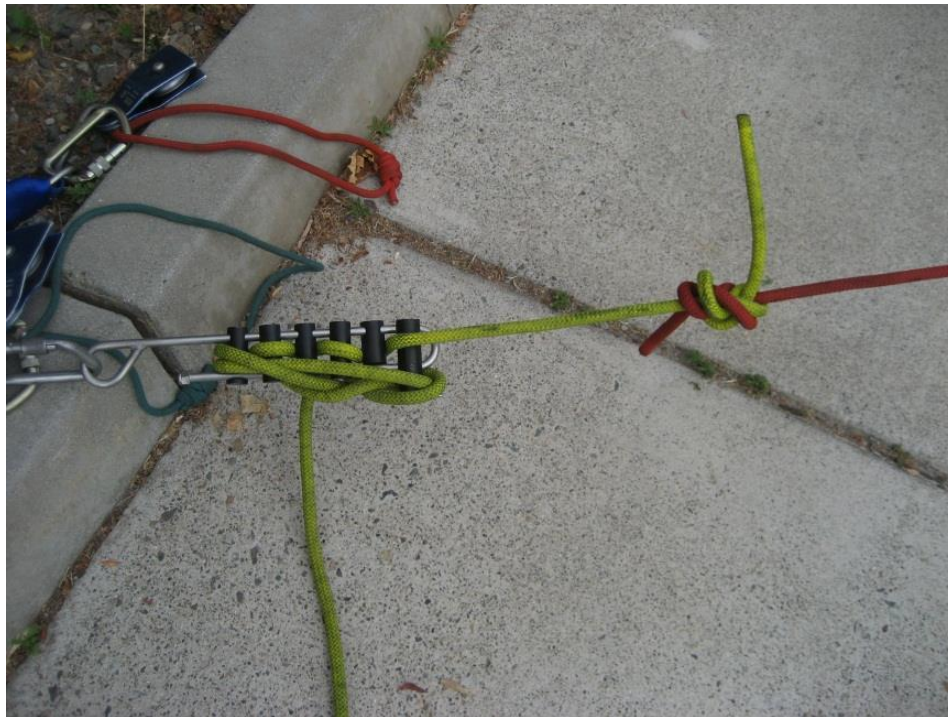


Figure 11-7.

A word of caution: The knot tied in the rope is large and bulky. The knot is very susceptible to abrasion as well as getting stuck in cracks, etc during the operation. Take the time to protect the knot by securing some sort of protection around it.

PASSING A KNOT DURING A RAISING OPERATION

In some operations the rescue team will be passing a knot through a raising system. The “piggyback” system works equally well in a raising evolution. Again, it will be no surprise that a knot needs to be passed since someone had to tie the ropes together. So once again the proper systems can be constructed and in place prior to the knot approaching the point(s) it needs to pass (Figure 11-8).



Figure 11-8. Pre-constructed 3:1 Piggy back.

Once the knot is within sight the rescuer should attempt to reset the haul prusik by putting it close to the knot as possible (Figure 11-9).



Figure 11-9.

Once the haul system has “two blocked”, attach the piggyback system to the haul line using a prusik (again it is easier to see what you are doing if you use separate color ropes for the main and piggyback system). Attach the piggyback prusik as far in front of the knot as possible. Secure the other end of the piggyback system to a suitable anchor. The rescue team can now haul on the piggyback system.



Figure 11-10.

As the load is raised the knot will approach the main line ratchet and change of direction pulley. Once the knot reaches this area disconnect it from the main line anchor system. Continue hauling on the piggyback system until the knot has reached a point where it will be well past the change of direction and mechanical advantage pulleys. At this point reassemble the main line mechanical advantage system and transfer the load from the piggyback system back to the main line.

KNOT PASSING THROUGH A TANDEM PRUSIK BELAY

Transferring a knot through the tandem prusik belay system when it arrives at the tandem prusiks (Figure 11-11) during a lowering operation is done as follows: While belaying a load on the lowering system, have another rescuer attach a set of tandem prusiks on the anchor side of the knot to be passed and attach them to a carabiner (Figure 11-12). As the prusiks approach the load release device have the lowering team stop. Attach the extra carabiner that was placed on the second set of tandem prusiks to distal end of the LRD (Figure 11-13). Once the new prusiks are attached to the system remove the ones in front of the knot (Figure 11-14).



Figure 11-11.



Figure 11-12.



Figure 11-13.



Figure 11-14



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Passing a knot on a raising belay is done exactly as described above, except that the new prusiks are placed in front of the knot to be passed.

No matter how your team passes a knot the key is to make sure you maintain a true two rope system. It is **not** advisable to pass a knot through the main line system by placing the load on the belay system while taking apart the main line to physically move the knot past a given point. Conversely you should never take the belay line apart (even for a moment) to pass a knot.

CHAPTER 12: ASCENDING

TERMINAL LEARNING OBJECTIVE

The student will ascend, descend, and negotiate an obstacle on a vertical, free hanging rope.

ENABLING LEARNING OBJECTIVES

- Ascend a fixed line
- Bypass an obstacle or knot on a fixed line during an ascent

There are many ways to ascend lines. One can use prusiks or a variety of mechanical ascenders. Additionally, there are a variety of methods that utilize the legs as the power source for ascending. The method shown is commonly called the “Frog Style” of ascending. This method is very forgiving, easy to learn and allows one to work longer than other methods.

ASCENDING A FIXED LINE

The basic attachments are as follows:

- Attach the lead ascender via a carabiner to the ascending line (Figure 12-1)
- Attach both leg (stirrup) straps to the lead ascender (Figures 12-2 and 12-3)
- Attach the ascender via a multi-loop connection to the chest attachment on the harness. Necessary for passing a knot or obstacle (Figure 12-1)
- Attach the second ascender to the waist attachment point via a carabiner (Figure 12-5)

- Lead ascender attachment to line
- Both leg strap attachments to ascender
- Gibbs ascender 2nd attachment point
- Ascender attached to waist
- Multi-loop attachment to chest & ascender



Figure 12-1. Ascending Attachment Points

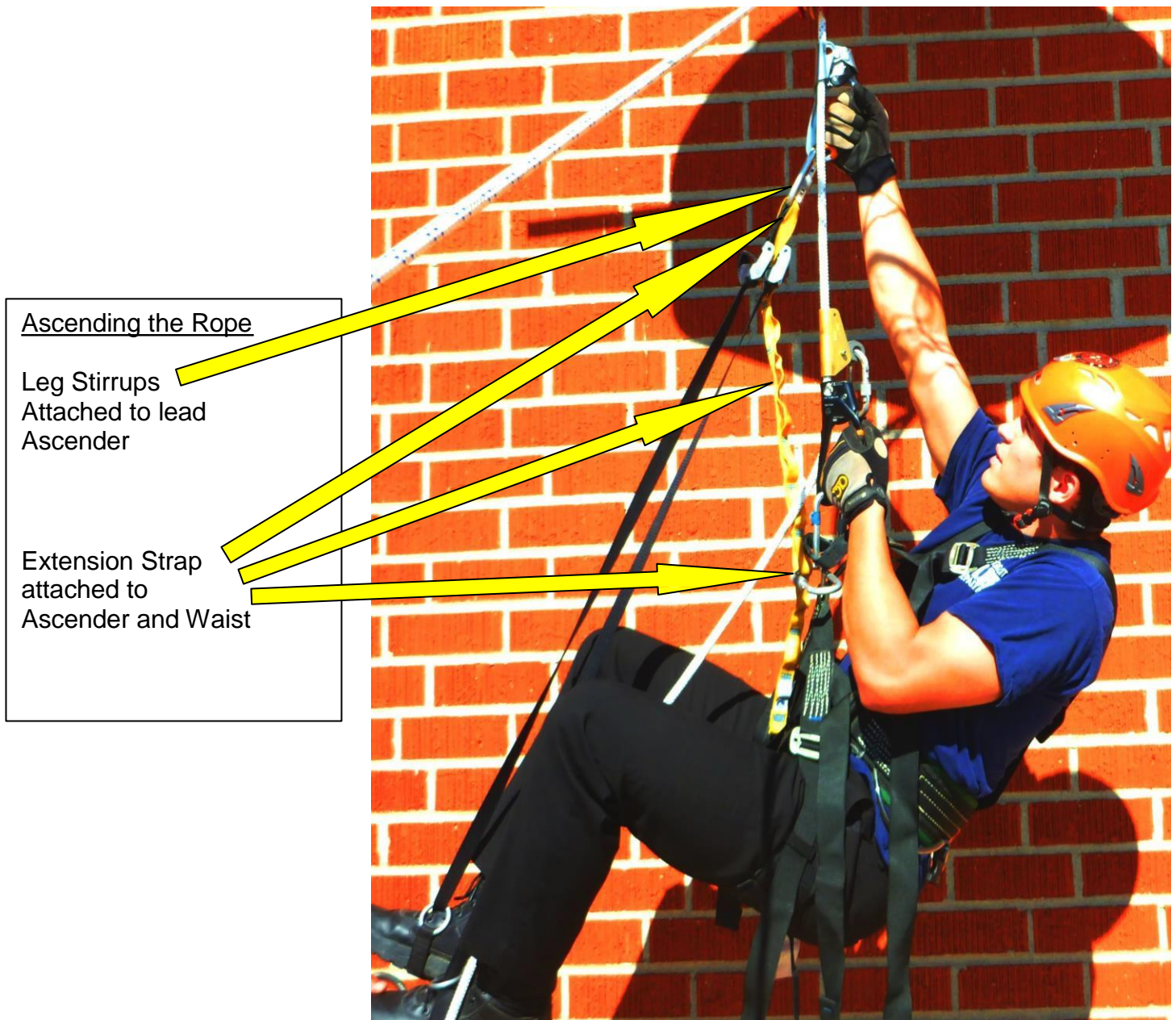


Figure 12-2. Ascending Attachment Points



Figure 12-3. Attaching foot stirrups

Placing Foot
stirrup

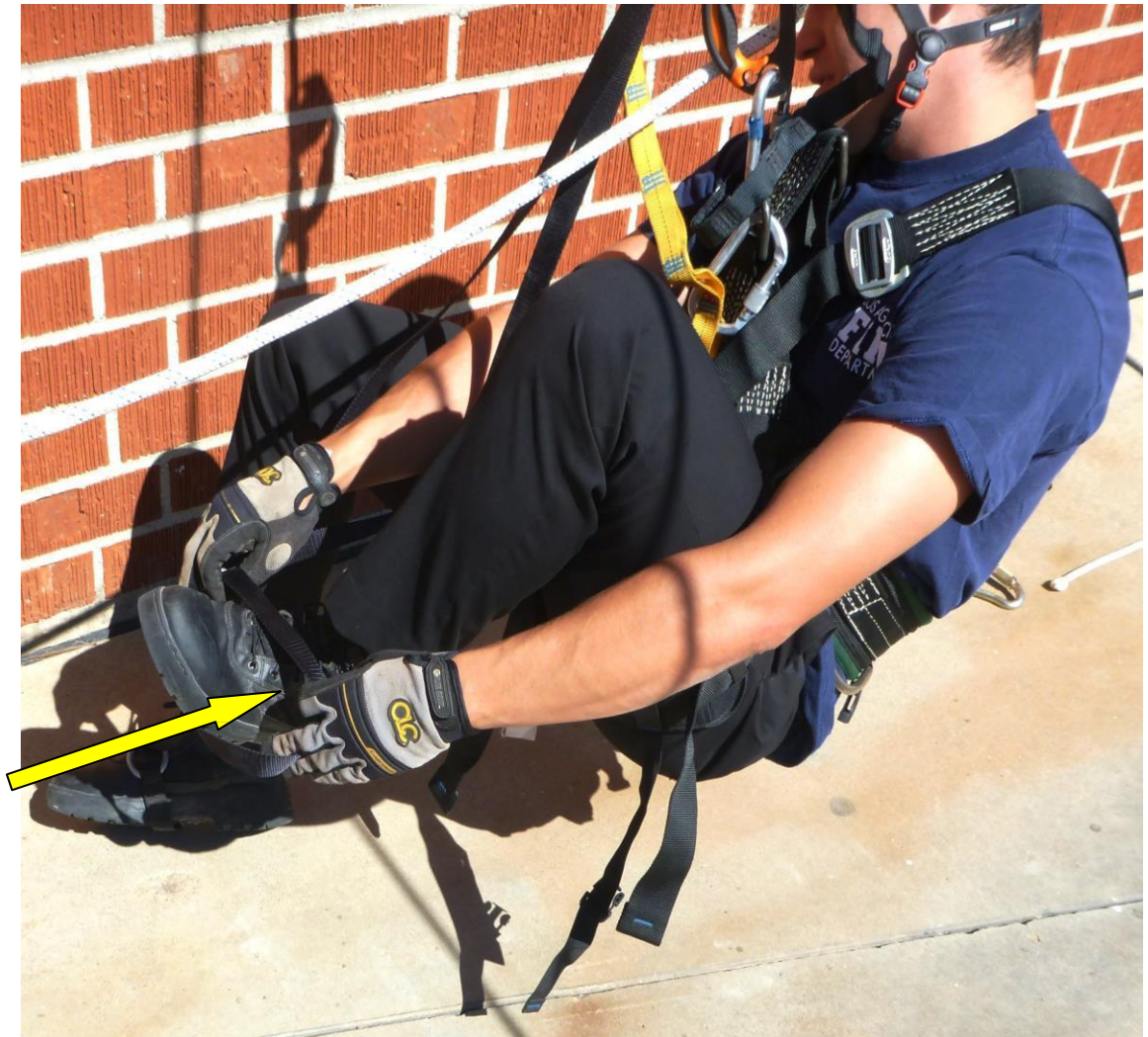


Figure 12-4. Adjusting foot stirrup

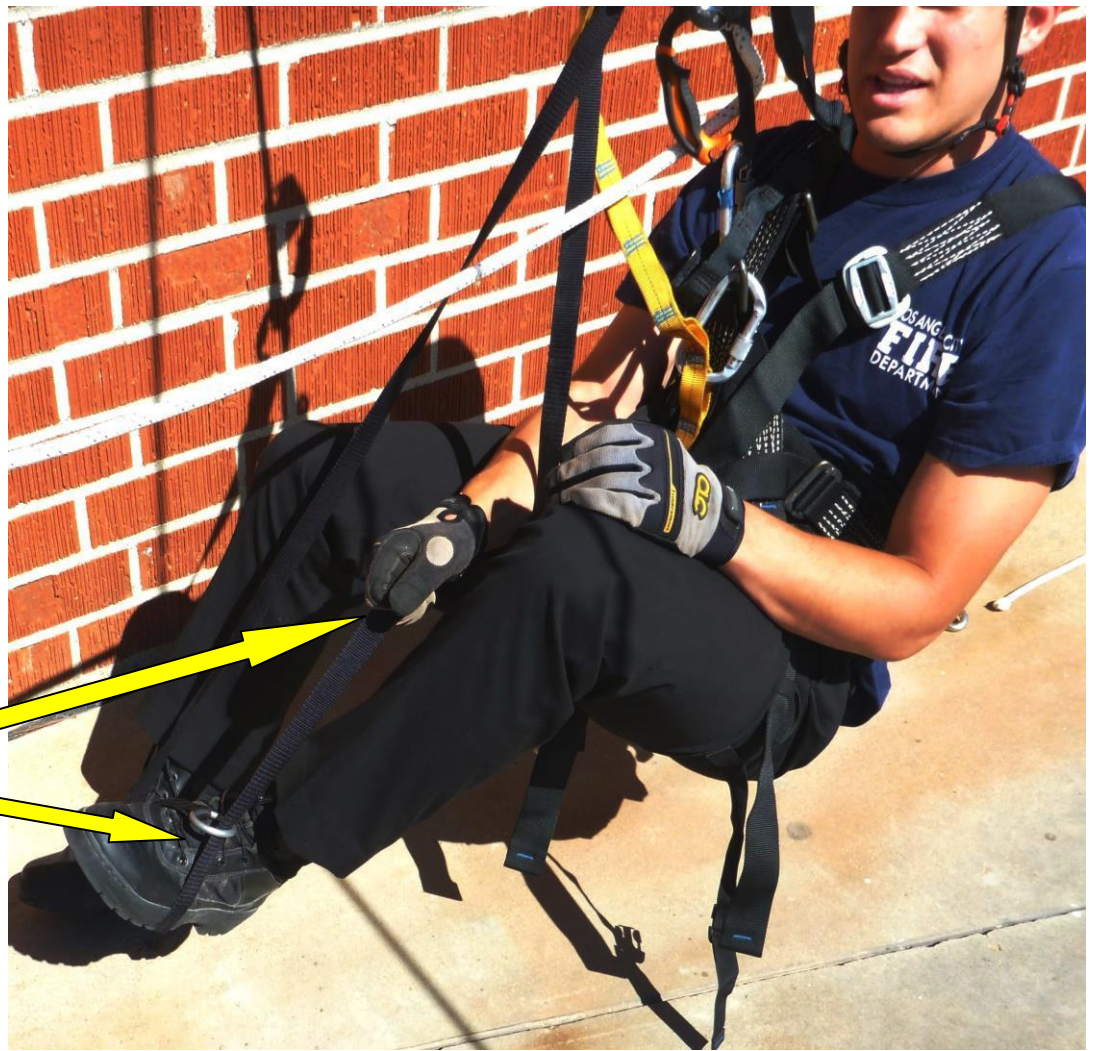


Figure 12-5. Tensioning foot stirrups



Lead ascender
adjustment

Figure 12-6. Adjusting Lead ascender



Ascending the Rope

Lead Ascender
Extended

2nd Attachment
Gibbs Ascender

Trailing Ascender
pushes up the Gibbs
Ascender

Figure 12-7. Ascending

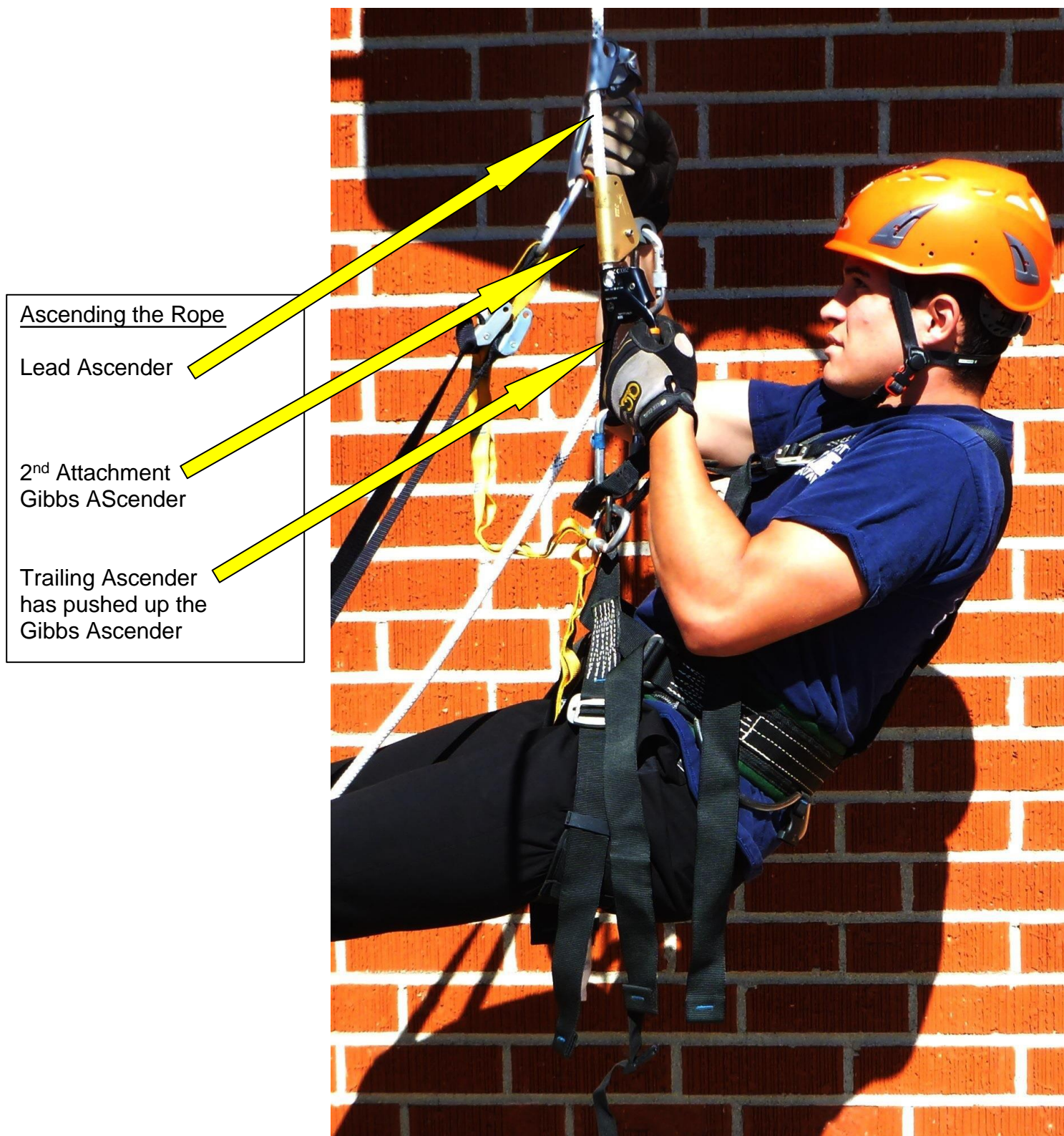


Figure 12-8. Pushing waist ascender and 2nd attachment point up to lead ascender

Passing a Knot

Lead Ascender
Pushed up to the
Knot

2nd Attachment
Gibbs AScender

Trailing Ascender
has pushed up the
Gibbs Ascender

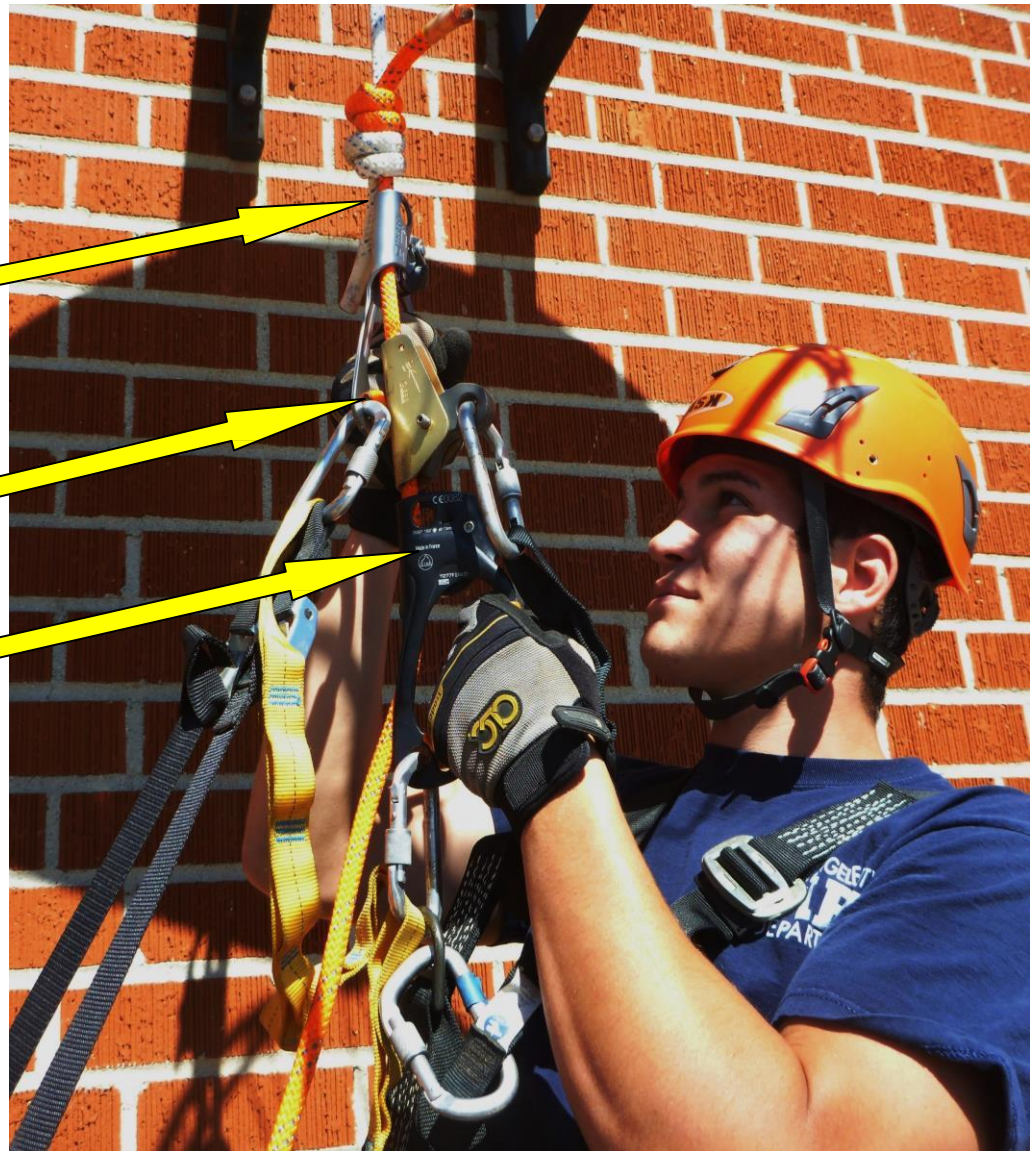


Figure 12-9. Ascending up to knot



Ascending the Rope

Removing Lead
Ascender

2nd Attachment
Gibbs Ascender

Trailing Ascender
has pushed up the
Gibbs Ascender

Figure 12-10. Removing lead ascender

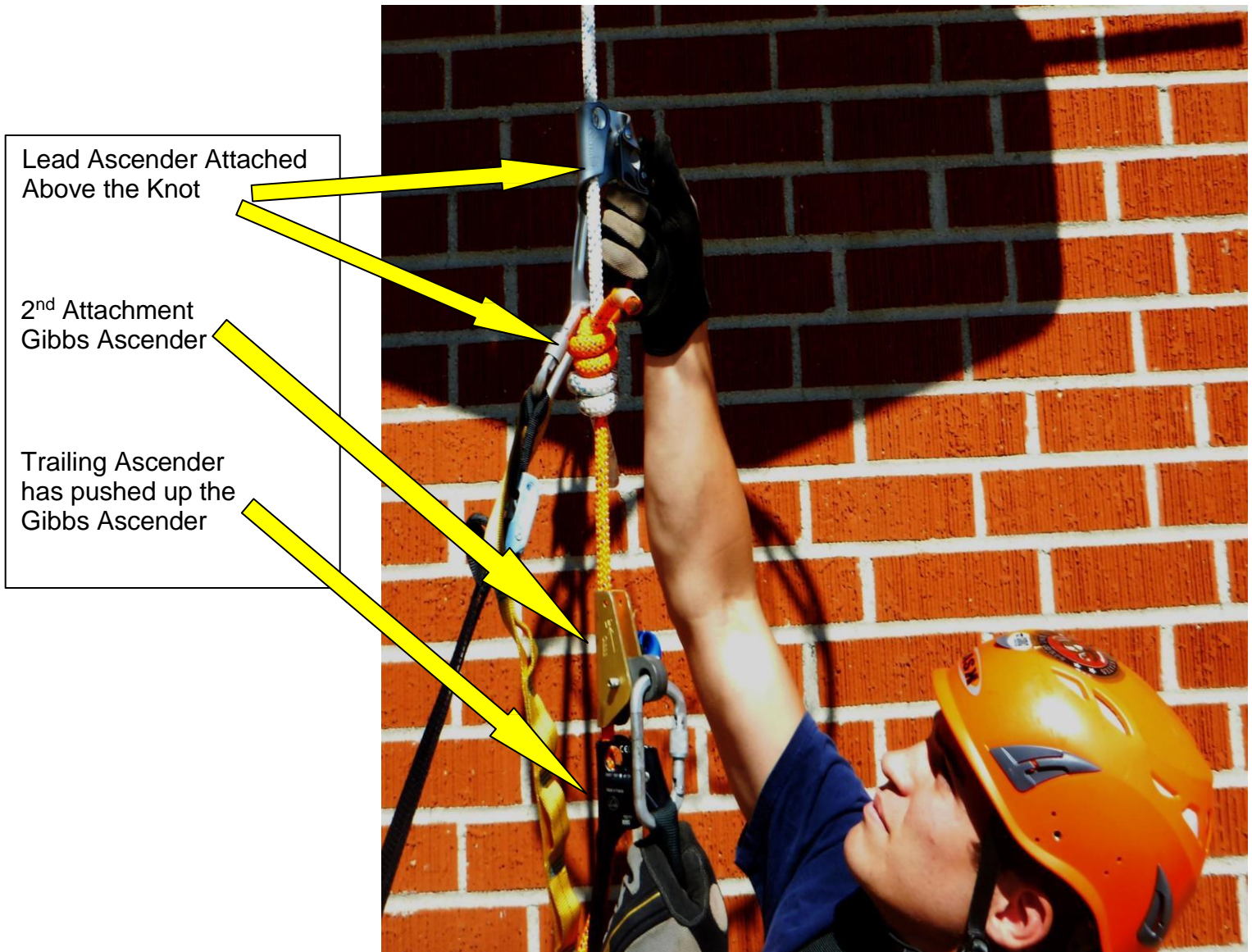


Figure 12-11. Reattaching lead ascender above the knot

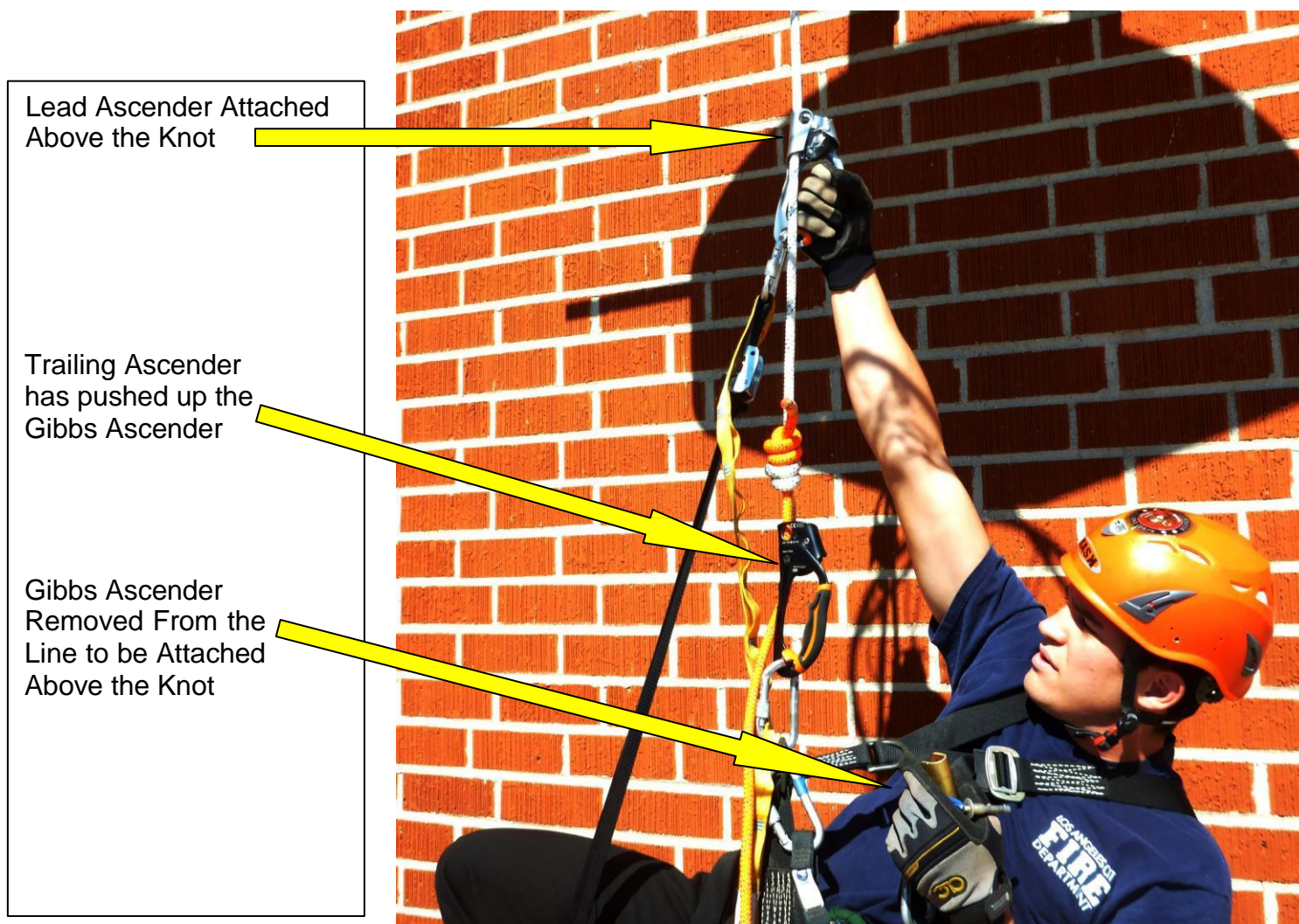


Figure 12-12. Removing second attachment to place above the knot

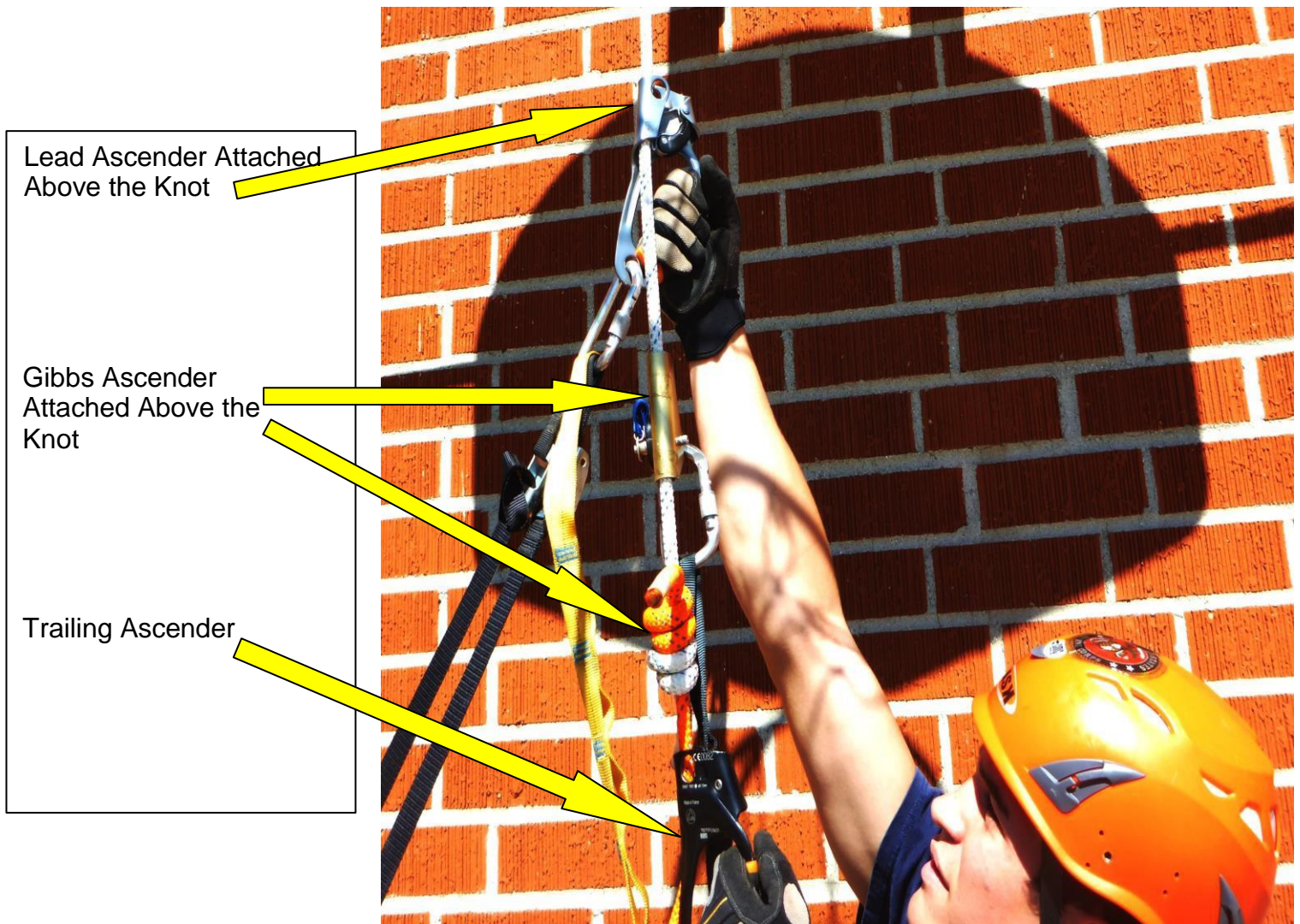


Figure 12-13. 2nd attachment point placed above the knot

Lead Ascender Attached
Above the Knot

Gibbs Ascender
Attached Above the
Knot

Trailing Ascender
Attached Above the
Knot

Bypassed Knot



Figure 12-14. Trailing ascender placed above the knot

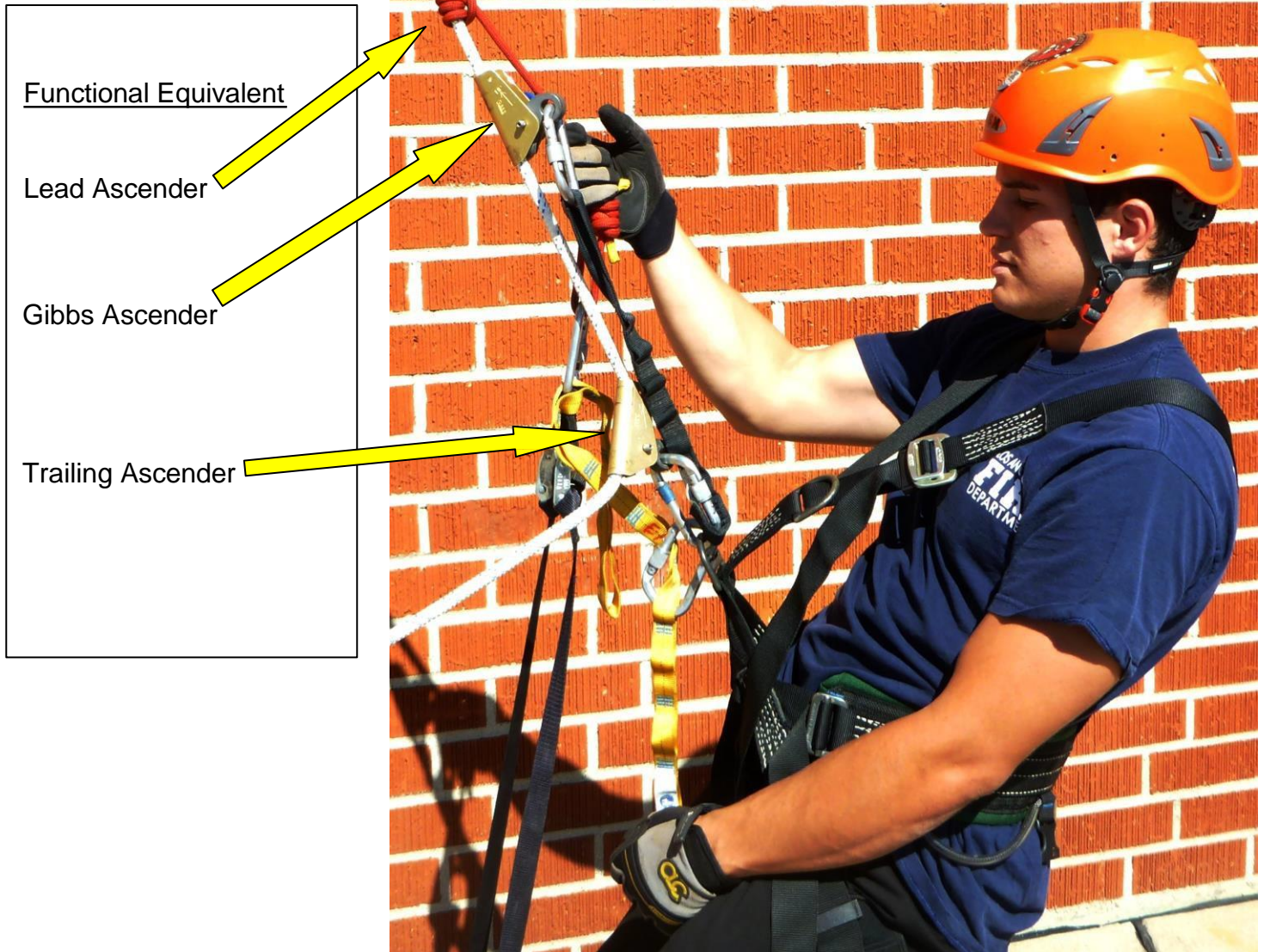


Figure 12-15. Utilizing other equipment to ascend



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CHAPTER 13: PICK OFFS

TERMINAL LEARNING OBJECTIVE

The student will perform a victim pick off.

ENABLING LEARNING OBJECTIVES

1. Construct a two line system for a victim pick off.
2. Attach a victim to a two line system.
3. Perform a pick-off of a supported/suspended victim.
4. Perform a pick-off of an unsupported victim.

PICK OFF RESCUES

Rescuers may be faced with situations in which a victim is supported/suspended mid-slope or mid structure from a cable or rope. Victims may also be found in unsupported positions with no attachment for support. In either case the rescuer must be prepared to capture the victim quickly to prevent the victim from falling or to minimize injury. After the victim is captured the victim should be placed on the rescue system as soon as practical.

After the rescue system has been rigged, the sequence of a pick off rescue generally is in the following order:

1. Quick capture of the victim.
2. Position the victim for efficient load transfer.
3. Place the victim on the rescue system.
4. Unweight the victim system if appropriate.
5. Lower or raise the victim and rescuer to safety as appropriate.



Figure 13-1. Quick capture of the victim and placement of a connection to the victim.



Figure 13-2. Rescuer positions the victim for load transfer to the rescue system.



Figure 13-3. Transfer the victim to the rescue system.



Figure 13-4. Unweight the victim from existing system.



Figure 13-6. Adjustable two point attachment for victim to main and belay.

CHAPTER 14: PROTECTED CLIMBING

TERMINAL LEARNING OBJECTIVE

The student will perform a protected climb on a natural or manmade structure.

ENABLING LEARNING OBJECTIVES

1. Climb a manmade structure utilizing a bottom belay or Double Bypass Lanyard; or
2. Climb a landscape feature (e.g. arborist tree rescue) utilizing a bottom belay.

PROTECTED CLIMBING

Rescuers may come across a situation where they cannot reach a victim stranded on a manmade structure with their ladders or they are unable to be lowered from above. In these situations, the rescuer must climb the structure in order to gain access to the victim and set up an anchor or directional change for their rope rescue system. The rescuer must maintain two points of contact with the structure at all times for safety reasons.

At a minimum, the rescuer must carry a drop line long enough to reach the ground from working height. This drop line can be used to hoist a main line, belay line, and any other equipment needed to package and lower the victim to the ground. If the victim is not secured to the structure, the rescuer must also carry a victim harness and any equipment needed to secure the victim to the structure.



Figure 14-1. Rescuer ready for a protected climb with bottom belay.



Figure 14-2. Rescuer ready for a protected climb with Double Bypass Lanyards.

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If the victim is not secured to the structure, the rescuer climbs to the victim and secures them to the structure. Then the rescuer can climb above the victim to set up rigging for a rope rescue system. If the victim is secured to the structure, the rescuer can climb past them to set up rigging for a rope rescue system. Typically a spot ten feet above the victim is selected as the working height.



Figure 14-3a. Securing victim to structure.



Figure 14-3b. Victim secured to structure.

Once a working spot has been selected, the rescuer lowers the drop line to hoist ropes, rigging, and any other equipment to working height. To lower a drop line, one end is secured to the structure and the other end is dropped from height. The rigging for the main line and belay line should be attached to different points on the structure if possible.

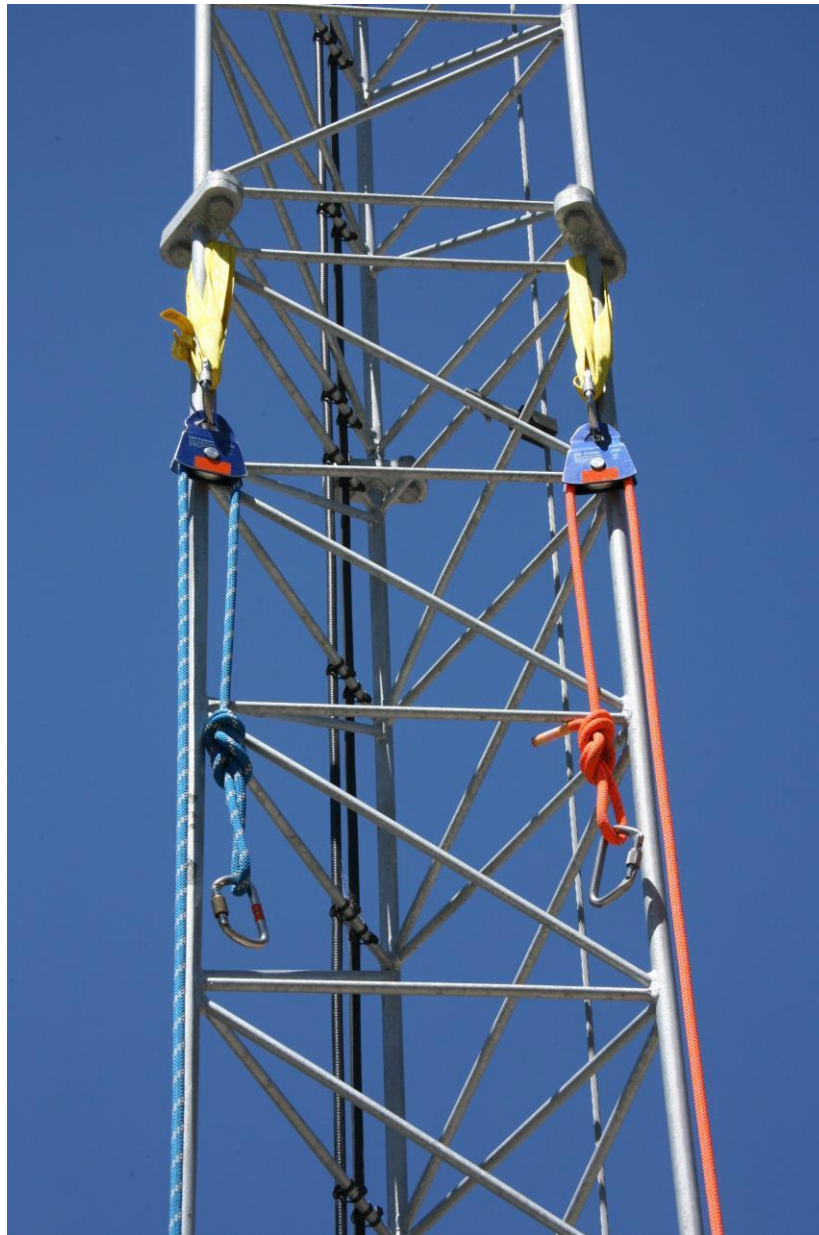


Figure 14-4. Rigging set-up at working height (change of direction).

Alternatively, in large towers, multiple rescuers may opt to ascend the tower and operate the main and belay from a working area above the victim. Rigging set-up at working height (anchors for main and safety/belay).

The rescuer can now descend to the victim and package them for lowering. The belay line is attached to the victim first, then the main line. Tag lines may also be needed in order to keep the victim off the structure. The victim is now lowered to the ground.



Figure 14-5. Victim lowering attachment points.



Figure 14-6a. Rescuer and victim being lowered to the ground (aerial view).



Figure 14-6b. Rescuer and victim being lowered by rescuers on the ground (ground view).

When the victim is on the ground, any rope, rigging, and other equipment can be lowered to the ground with the drop line. Once this is complete, the rescuer(s) can descend the structure.

There are two methods rescuer(s) can use to climb a manmade structure; with a bottom belay or with a bypass lanyard. In both cases, the ground team rigs the rope rescue system as much as possible so that the rescuer has to do as little rigging as possible while working at height. One rescuer is preferred when working at height, however, if packaging, patient care, or rigging is an issue another rescuer may be required.

BOTTOM BELAY

When protected climbing with a bottom belay, the rescuer's hands and feet serve as one point of contact. The second point of contact is with a belay line. The rescuer starts the ascent with a belay line attached to the harness. As the rescuer ascends, carabiners are attached to the structure with webbing. The rescuer puts the belay line through each carabiner as he ascends the structure to serve as fall arrest (Figures 14-7a-d).



Figure 14-7a. Protected climb rigging with a bottom belay and main (for lowering).



Figure 14-7b. Protected climb rigging change of direction at bottom.



Figure 14-7c. Rescuer beginning protected climbing with a bottom belay.



Figure 14-7d. Rescuer mid-way up protected climbing with a bottom belay (trailing main).

When rigging the victim for lowering, the rescuer can remove the Safety/Belay Line from himself and attach it to the victim. The rescuer must be secured to the structure before removing the Safety/Belay Line.

When the victim is on the ground, the Safety/Belay Line must be retrieved so that the rescuer can reattach it to his harness before descending the structure. The rescuer can gather any equipment attached to the structure on the way down.

DOUBLE BYPASS LANYARD

When protected climbing using a bypass lanyard, the rescuer's hands and feet serve as one point of contact. The bypass lanyard is attached to the rescuer's harness and serves as the second point of contact. As the rescuer ascends the structure, at least one lanyard is attached to the structure at all times.



Figure 14-9. Rescuer protected climbing with bypass lanyard

When negotiating obstacles, one lanyard is attached to the structure. The other lanyard is attached to the structure on the other side of the obstacle. Once the rescuer passes the obstacle, the lanyard still attached to the structure on the first side can be disconnected. The rescuer can now continue their ascent.



Figure 14-10. Rescuer negotiating obstacle with bypass lanyard



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CHAPTER 15: HIGH ANGLE LITTER RIGGING AND TENDING

TERMINAL LEARNING OBJECTIVE

The student will rig and tend an occupied rescue litter in a high angle environment.

ENABLING LEARNING OBJECTIVES

1. Package a patient into a rescue litter.
2. Attach the occupied rescue litter to a rope rescue system with a litter tender.
3. Tend the litter basket operation both above and below the basket
4. Negotiate obstacles and manipulate the occupied litter while being raised and lowered.
5. Move the occupied litter up and over an edge.

There may be times that require a non-ambulatory patient to be raised or lowered, in a rescue litter, while being tended by a litter attendant. This may be due to patient care needs, edge management issues, patient packaging issues, and/or the need to negotiate obstacles.

RESCUER ATTACHMENT

The rescuer must be attached to the system with two points of attachment. This can be accomplished by using two separate ten to twenty foot lines attached to the top of the litter rigging or by tying long tails in the main line and belay line. The main line attachment and belay line attachments need to be adjustable. This will allow the rescuer to tend to the patient and adjust the rigging, if needed, while being able to maneuver above, below, and around the rescue litter. Each line must either be attached to the rescuer or have a stopper knot tied in the end to prevent the device used for adjustment from sliding off the line.



Prusik for belay
line connects
these two points

Figure 15-1. The main line and belay line are connected to an anchor plate. Two separate 20' lines are also connected to the anchor plate. The rescuer is attached to the two 20' lines. The prusik on the belay line is omitted for picture clarity.

LITTER ATTACHMENT

The situation will dictate how the rescue litter is attached to the system. The rescue litter can be attached to the system in a horizontal or vertical position. In the vertical position, the head of the rescue litter is attached to the system. In the horizontal position, the litter pre-rig is typically used. There may be times when the rescuer will need to adjust the orientation of the rescue litter while it is occupied. In this case, a mechanical advantage device can be used in place of the litter pre-rig attached to the foot of the rescue litter.



Figure 15-2. Litter rigged for a vertical lower/raise. Second line omitted for picture clarity.

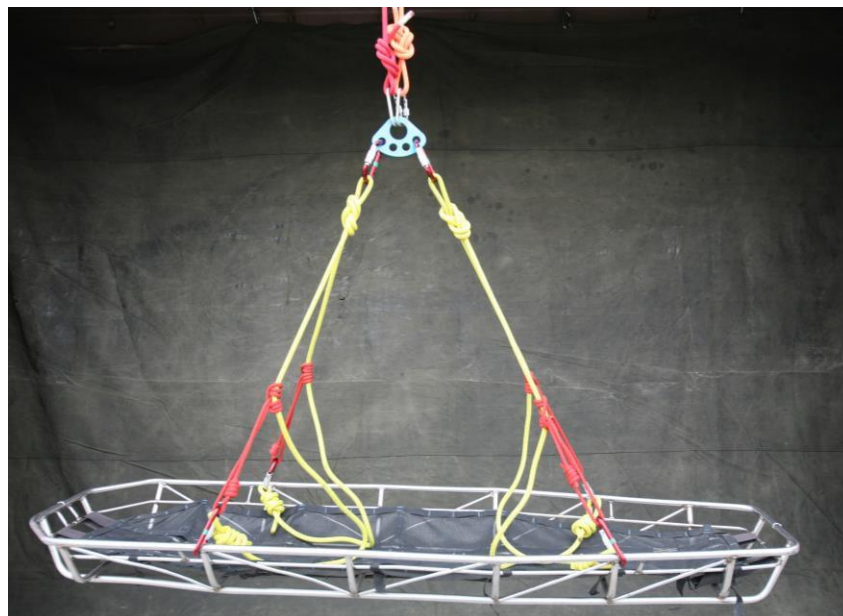


Figure 15-3. Litter rigged for a horizontal lower/raise.

PATIENT CARE

The rescue litter can be positioned head high, which is preferred for conscious patients or head dependant for patients in shock. For patients who are vomiting, the litter tender may need to position the patient laterally.

EDGE MANAGEMENT

There may be times when negotiating an edge causes a problem, such as when there is no high change of direction at the departure point. If the rescue litter is unoccupied, this should not be much of an issue. If the rescue litter is occupied, this can create a significant issue that requires additional personnel to overcome.

Edge attendants will be needed to assist an occupied rescue litter over an edge. Two to four edge attendants may be needed depending on the situation. The litter attendant may be used as an edge attendant to assist moving a rescue litter over an edge. Anytime an edge attendant is within six feet of an edge, and there is a fall hazard, travel restriction is required. Anytime an edge attendant is over the edge, a class 3 harness connected to a main line and belay line is required.

In the horizontal orientation, the more edge attendants there are the better. If there are enough personnel and the situation dictates, two attendants should be placed over the edge to assist with an occupied litter. If staffing is short, personnel must work closely together to get the occupied litter over the edge. Teamwork and communication are extremely important.



Figure 15-4a. Attendants assisting the litter over the edge (raising operation shown).



Figure 15-4b. Attendants assisting the litter over the edge

In the vertical orientation, a "V" strap may be used to assist the rescue litter over the edge. A "V" strap can either be a long piece of webbing with an overhand on a bight tied in the middle or one half of a litter pre-rig. One end is attached to the rigging at the head of the litter basket and the legs are tied to the litter below the patient's waist. Each leg **must** be tied below the patient's center of gravity. When the rigging at the head of the litter reaches the edge, the "V" strap is disconnected from the rigging and attached to a separate raising system. The haul team can haul on this separate raising system to raise the head of the litter up and over the edge.



Figure 15-5. One half of the litter pre-rig used as a "V" Strap.



Figure 15-6. An alternate method for the "V" Strap is to use a 20' piece of webbing.



Figure 15-7. The raise is stopped before the hardware reaches the edge.



Figure 15-8. The "V" Strap is disconnected from the anchor plate and connected to a separate mechanical advantage system.



Figure 15-9. The litter and hardware can now easily clear the edge.

PATIENT PACKAGING

Packaging a patient in a rescue litter in an unstable location requires patience and skill. The litter tender needs to position the rescue litter so that the patient can be positioned inside and secured to the rescue litter as safely as possible. If the patient is connected to a separate rope system, the patient must be positioned inside and secured to the rescue litter before being disconnected from their system.

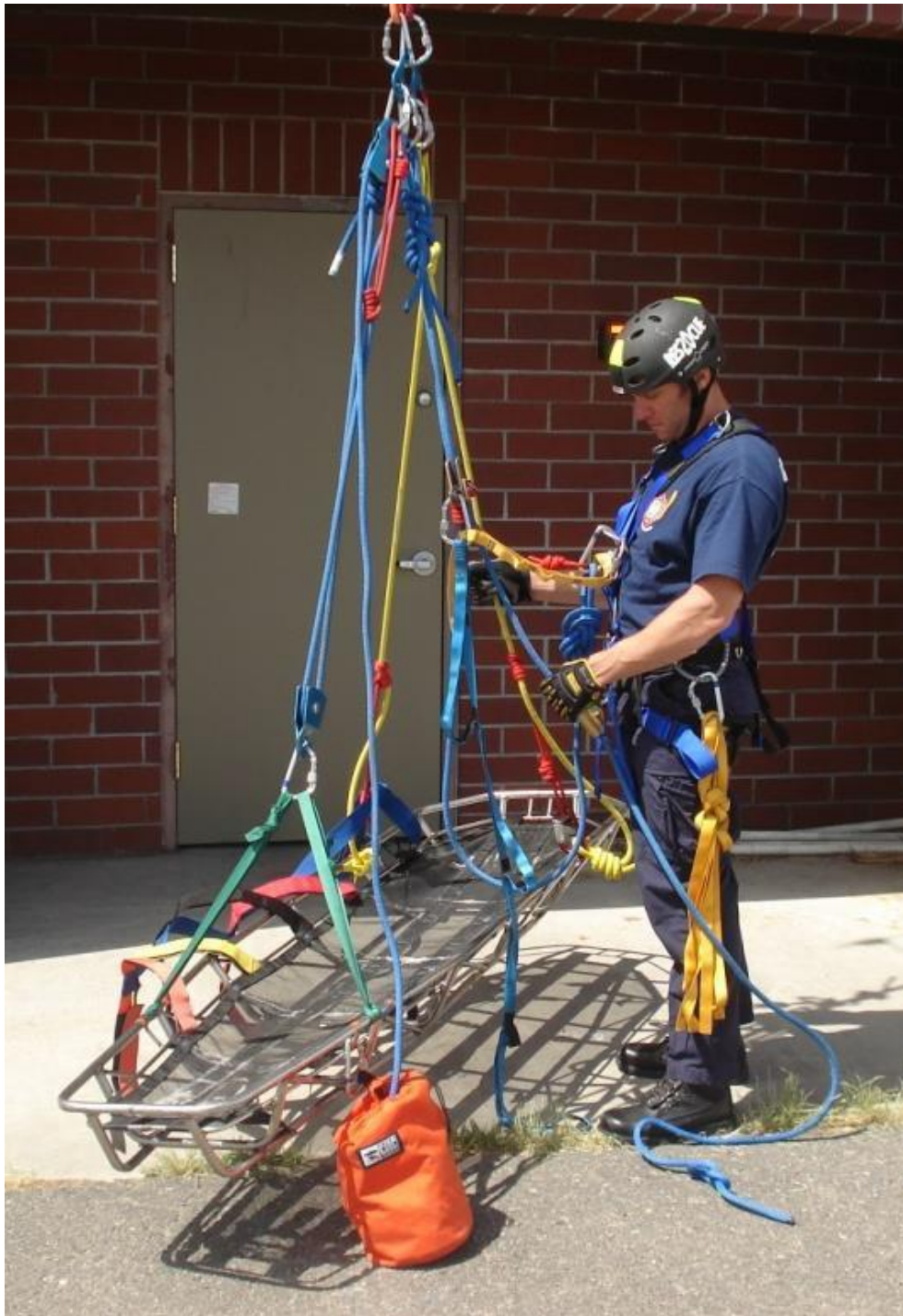


Figure 15-10. The rescuer is prepared for a litter scoop. He is attached to the system as seen before but carries webbing to use as interior lashing to secure the patient into the litter. The top half of the litter is rigged as before but the bottom half litter pre-rig is replaced with a ladder rig and prusik at the top pulley. Velcro straps have been pre-positioned on the litter ready to be used as exterior lashing to secure the patient into the litter.

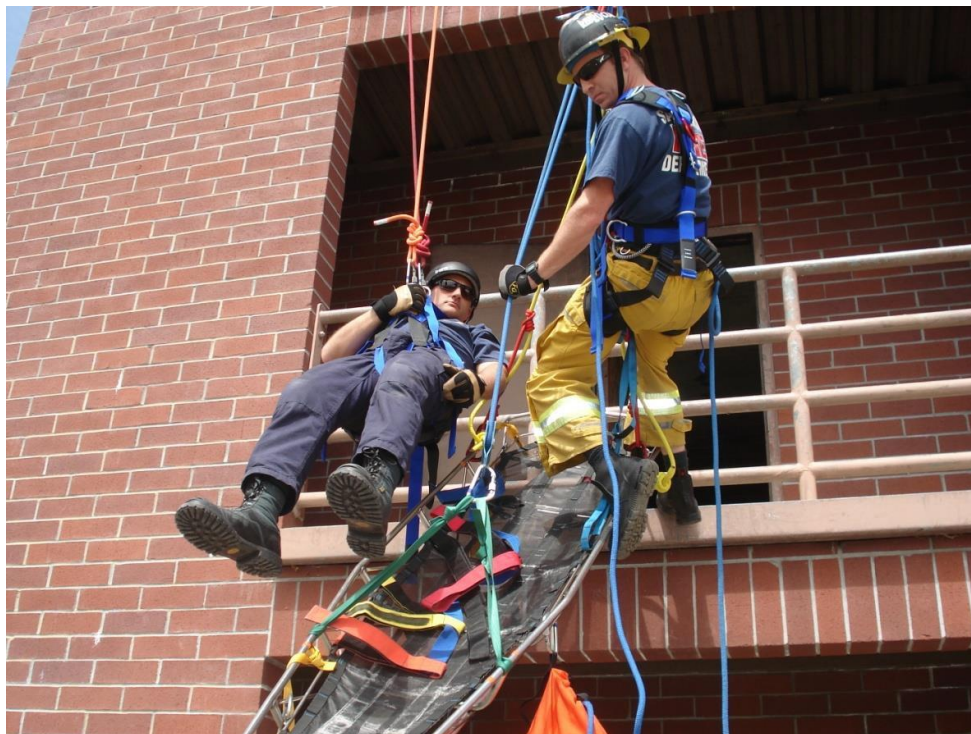


Figure 15-11. The rescuer is lowered to the patient and orients the litter for a scoop.



Figure 15-12. The rescuer positions the patient into the litter.



Figure 15-13. The rescuer raises the foot of the litter to weight the patient onto the system.

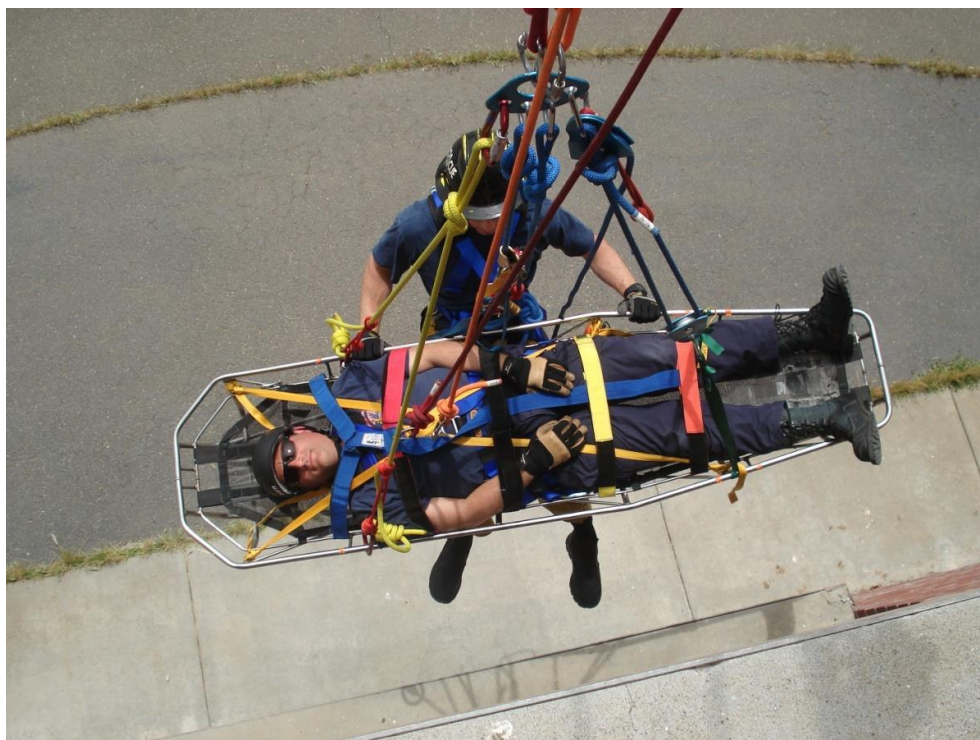


Figure 15-14. The patient is secured into the litter but still connected to their own system.



Figure 15-15. The patient is disconnected from their own system and is on the rescuer's system.

NEGOTIATING OBSTACLES

When there are obstacles that must be negotiated, the litter tender must be in a position that allows for the obstacle to be negotiated and for the protection of the patient. This may be above or below the rescue litter.



Figure 15-16a. The Rescuer negotiating an overhang (approach).



Figure 15-16b. The Rescuer negotiating an overhang (midway).

TOTAL SYSTEM REDUNDANCY

Those agencies that desire total system redundancy may want to attach the Rescuer and Rescue Litter to the Main Line and Belay Line differently. Here is an alternate method of system attachment.



Figure 15-17. A longtail bowline is tied in the main line and the belay line with a steel ring in the knot and an etrier connected to the steel ring. The rescuer is attached to one line and the etrier. The other line is used to attach the victim to the system.



Figure 15-18. The litter pre-rig is attached to the Steel Ring.

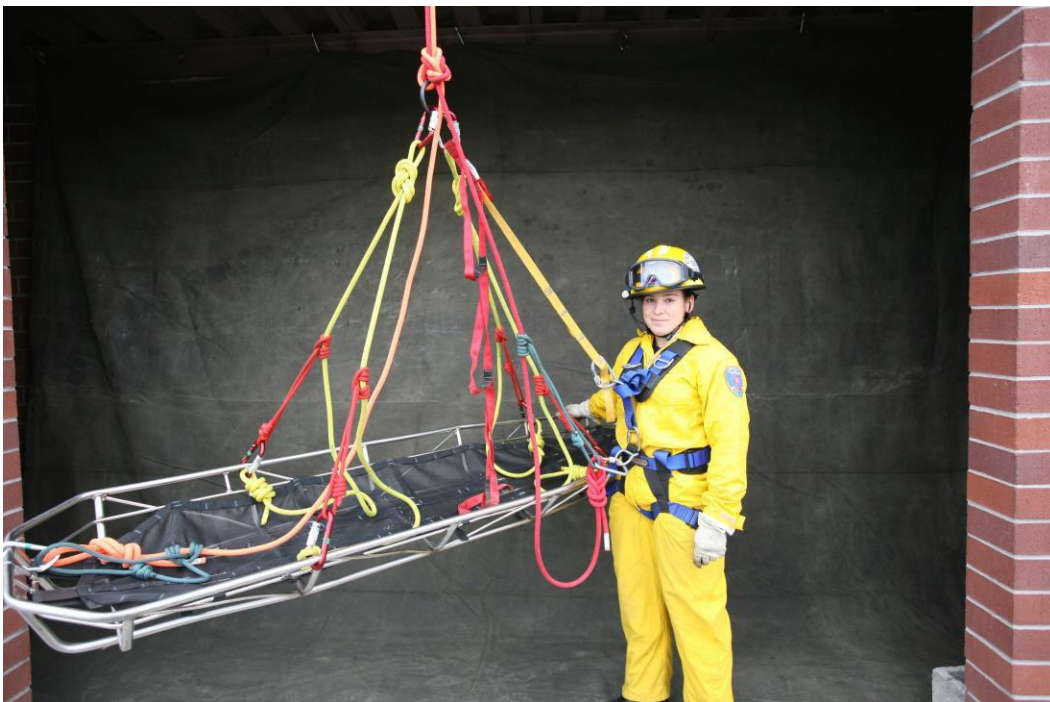


Figure 15-19. The rescuer and litter are attached as seen above. One longtail is attached to the rescuer and the other longtail is attached to the head of the stokes. System redundancy for the rescuer and patient is achieved.



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CHAPTER 16: ARTIFICIAL HIGH DIRECTIONALS

TERMINAL LEARNING OBJECTIVE

The student will construct and rig an artificial high directional.

ENABLING LEARNING OBJECTIVES

1. Construct an artificial high directional.
2. Rig a high directional.

Artificial High Directionals (AHDs) are constructed to assist the rescue team with edge transitions or any time the rescue team can benefit from having their ropes elevated above obstacles. In some situations a place to secure a high directional pulley may already exist. Examples of this include a tree limb, overhead structural components, or an improvised anchor. There a variety of high directional types and they can be categorized by the acronym H.A.N.S.

H – Human High Directional
A – Artificial High Directional
N – Natural High Directional
S – Structural High Directional

Each of these high directionals has their own advantages and disadvantages. For example a pair of rescuers holding up a rope to create a highpoint is easily added but it is limited in lift height and the amount of time they can actually impart the needed lift. Conversely an Arizona Vortex fashioned as a floating “A” frame is very useful but can take time to construct.

The decision to use a high directional really is driven by two questions;

1. Is it needed?
2. Does the subject have the time to wait while one is constructed?

If the rescuer determines that a high directional is needed and the time to construct one is worth it, the rescuer should then determine what type to build.

HUMAN HIGH DIRECTIONALS

Human high directionals are the quickest to deploy but have limited use. A pair of rescuers holding a large pry bar can provide a quick high point to allow a rescuer to make a quick edge transition. In the low angle environment a pair of rescuers can hold a large bar under the main line to allow the litter team to safely transition the edge.

ARTIFICIAL HIGH DIRECTIONALS

Artificial high directionals is a large category that includes such devices as tripods, davits, the Terradaptor™, the Arizona Vortex™, or lumber lashed into an improvised “A” frame. The focused floating anchor is also an AHD.



Figure 16-1. Artificial High Directional.

There are several commercial Artificial High Directionals on the market. The Arizona Vortex™ (AZV) is one of the more popular devices among rescue teams. NFPA 1983 classifies these as “*portable anchor devices*”. The AZV can be set up in any number of configurations from the simple tripod and easel “A” frame to the more advanced “A” frame, sideways “A” frame and gin pole or monopod.

Whatever the configuration, the rescuer must understand the physics involved to ensure the AHD is loaded properly and will not fall over. The basic principle a rescuer must understand is called a “*resultant force vector*” or “*resultant*”. This is best visualized as a rope enters and exits a pulley. The rope on each side of the pulley has a force applied to it. The resultant can be visualized by drawing an imaginary line from the carabiner, through the axle of the pulley and terminating at the surface. This resultant determines where the force is applied and ultimately the “stability” of the AZV (or any other high directional).

Each variation of the AZV has a different requirement for the location of the resultant. For example, a tripod needs the resultant to be within the center of the three legs. The easel “A” frame allows the rescuer to move the resultant closer to the front legs. The more advanced applications of the AZV, such as the bipod (“A” frame) and monopod (gin pole) require the resultant to be straight down the legs. If, for some reason, the resultant does not go straight down the legs, the guy lines (and their anchors) take additional stress.

Safety Points of the AZV (and similar AHDs):

- The AZV has a safe working load of 600 lbf (2.7kN).
- Always ensure a belay line is used independent of the AZV (or any AHD).
- The rescuer must ensure that all the feet are secured to prevent to spreading, uplifting or sideways forces.
- Never couple more than 3 lower leg sections together on any one leg.
- Attach a tether cord to the AZV when placing it.

The AZV is “G” rated (36kN) as a portable anchor device in the following 2 configurations:

1. Tripod (3 equal legs). This test was conducted using 1 upper leg with two lower legs and either flat or raptor feet. The legs were an equal distance apart and the upper legs were pinned to the head at the upper head pin hole and the last upper leg pin hole.
2. Easel – This test was conducted using 2 lower legs and one upper leg at max length for the “A” frame section and three lower legs and one upper leg for the easel leg. The test was completed with the “A” frame section at 90 degrees relative to the ground with either flat or raptor feet.

NOTE: This manual is not intended to teach the rescuer everything about the AZV (or any other AHD). It is very important that the rescuer obtain training from a recognized school of instruction when it comes to using any artificial high directional.

NATURAL HIGH DIRECTIONALS

Natural High Directionals are created by using rock outcroppings, limbs of trees, etc.



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STRUCTURAL HIGH DIRECTIONALS

Structural high directionals are those that are created by using parts of the structure to anchor your high point.



Figure 16-2. Structural High Directional.

Rescue Systems 1 gave the rescuer the skills needed to construct any number of “Ladder Rescue Systems”. Depending on the overall need any one of these ladder systems may be sufficient to complete the task at hand.

Regardless of the high directional chosen, the Rope Rescue Technician must take into account the potential resultant forces imparted on the high directional. This is determined by looking at the angle formed by the rope entering and leaving the high directional pulley. For example a rope that goes straight up, enters a change of direction pulley, and returns down to the starting point imparts a zero degree angle on the pulley. A zero degree pulley angle has a factor of 2. In other words a 200 pound load hanging on a rope that goes up, enters a pulley and returns to the ground next to the load requires 200 pounds of input force to lift the load. Once the load is off the ground gravity is exerted on the load. 200 pounds of input force plus the 200 pound load places 400 pounds on the high directional anchor.

A rope running through a pulley system at a 90 degree angle will magnify the load 1.41 times. So in the scenario noted above a 200 pound load running through a pulley at 90 degrees will place 282 pounds on the anchor supporting the pulley. Although 1.41 is the exact magnification for a 90 degree angle, it is common practice in the field to use 1.5 as the factor for ease in multiplication. It is also important to remember that these calculations are based on no friction. Friction will have an effect on the overall number but since each pulley and manufacturer have different construction techniques it is impossible to give one accurate number, hence the use of "frictionless" multipliers.

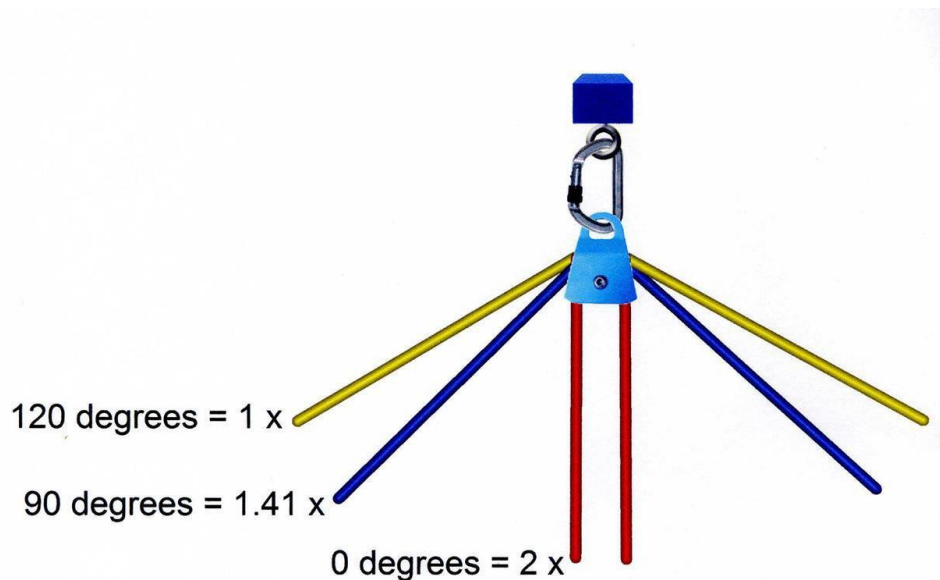


Figure 16-3. Magnification of load by the field angle.

HOW TO CONSTRUCT A WOODEN "A" FRAME AS A FLOATING HIGH DIRECTIONAL

An artificial high directional can be constructed out of 4 x 4 or 6 x 6 timbers common in many Fire Department's Technical Rescue companies. The following is one way to construct an

Artificial High Directional out of 12 foot long 4 x 4's and 30 feet of ½ static or low stretch kernmantle rope.

Lay two 4 x 4's side by side and prop one end up on top of another 4 x 4 allowing 360 degree access to each leg. Next insert a short 2 x 4 in between the legs so that the legs are separated approximately 1 ½ inches.



Figure 16-4. Starting an “A”-frame.

Using the ½ kernmantle rope make a clove hitch on one of the legs.



Figure 16-5. Clove hitch on one leg.

Lash both timbers with approximately 6-8 figure eight lashes. Upon completion of the lashes the rescuer shall frap the figure eight lashes four times. Complete the sequence by tying a clove hitch on the opposite 4 x 4. It is important to make sure the wraps and fraps are very tight.



Figure 16-6. Wrapping and frapping.



Figure 16-7. Secured with second clove hitch on opposite leg.

The next step is to construct the anchor that will support the pulley(s). Using either a 10 foot piece of kernmantle rope, cordelette, or webbing, wrap the ends in opposite directions until there are at least two loops. Secure the ends with a double overhand bend for rope or cordelette, or a water knot for webbing. Hang the pulley(s) from the anchor and stand up the “A” frame.



Figure 16-8. Anchor at head of “A” frame (purple cordelette).
Hobble the legs with a length of webbing or rope to prevent splaying.



Figure 16-9. Hobble on legs of “A” frame.

Prusiks are attached to the track lines on both sides of the “A” frame and carabineered into the loose loop or the head of the vortex. Once the system is tensioned the “A” frame will stand centered (at the appropriate angle) without further assistance.



Figure 16-10. "A" frame centering prusiks (shown on AZV).



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CHAPTER 17: HIGHLINES

TERMINAL LEARNING OBJECTIVE

The students will construct and operate a reeving highline with a midpoint drop to transport rescuers, equipment, and an occupied litter from one elevated location to another.

ENABLING LEARNING OBJECTIVES

1. Describe system safety factors, critical angles, and force multipliers.
2. Construct and operate a reeving highline system to perform a midpoint drop.
3. Move an occupied litter with an attendant from one elevated location to another above an obstacle or projection.

INTRODUCTION

Most rope rescues are accomplished by lowering a rescuer from above, packaging the victim, and either lowering the rescue package down or raising the rescue package back up to an area for transport to a medical facility. These are known as vertical rescues. There may become a time, however, in which these vertical rescues will not work and the rescue must be completed in the horizontal realm. Highline systems can provide a solution to this problem. FIRESCOPE's Urban Search and Rescue Operational System Description 120-1 defines a highline as "a system using rope suspended between two points for movement of persons or equipment over an area that is a barrier to the rescue operation, including systems capable of movement between points of equal or unequal height".

Highline systems can be very dangerous due to the extreme forces these systems can generate. They require the Rope Rescue Technician to have a thorough understanding of force vectors, component uses and limitations, and require specialized training. An extensive system analysis should be performed before prior to using highline systems.

COMPONENTS AND TERMINOLOGY OF A HIGHLINE

Trackline(s) – The tracklines are the ropes that support the load. They span the gap between the two anchor points. Tracklines are usually tensioned using mechanical advantage systems.

Tagline – A tagline is used to control horizontal movement of the carriage system. The tagline acts as the system belay and, as such, should always have tandem prusiks.

Reeve Line – The reeve line is incorporated when the rescue team wants to add a vertical component to their highline. Reeve lines allow the rescue team to lower a rescuer to a victim without de-tensioning the trackline(s). Reeve Lines are either English or Norwegian.

Tagline Hangers – Tagline hangers, sometimes called “Festoons”, are made using webbing or cordelette and carabiners. Their purpose is to keep the tagline from sagging excessively below the trackline. Tagline hangers are affixed to the tagline with a girth hitch and the trackline with a carabiner. Tagline hangers are spaced approximately 15-20 feet apart.

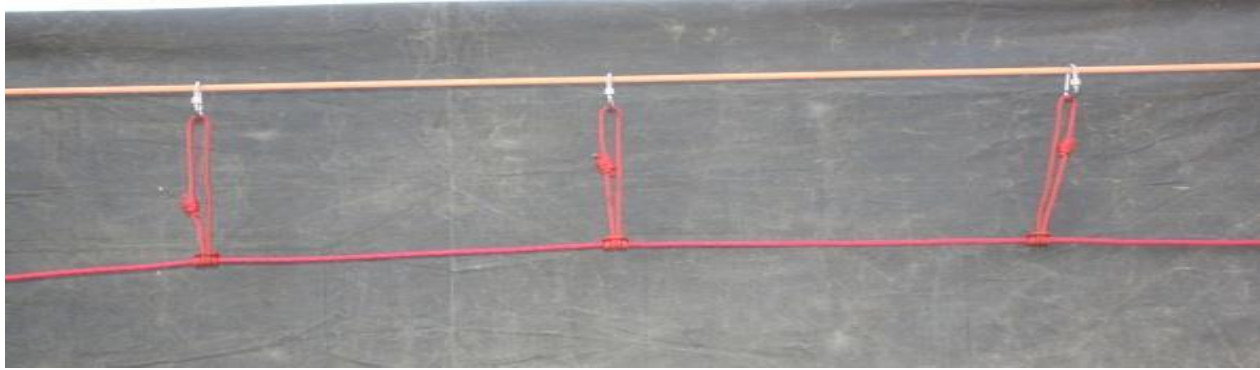


Figure 17-1. Tagline Hangers

Tensioning System – The tensioning system is the mechanical advantage system used to apply tension to the tracklines. This system should incorporate tandem prusiks and should tension the tracklines equally. The hitches grip the trackline(s) and will slip if the system is overloaded.

Vector Angle – The vector angle of the trackline is measured from above the trackline. The vector angles in highlines regularly exceed 120 degrees.

Pilot Line – The pilot line is a small diameter cord that is sent across a gap. It can be shot from a line gun or thrown. The pilot line is used to pull the messenger line.

Messenger Line – The messenger line is a line (larger than a pilot line but smaller than the main line) that is used to pull the heavier main line across a span.

Far side or “static anchor” – The anchor in a highline system that has the fixed end(s) of the track line attached to it.

Tensioning Anchor – The anchor that has the tensioning system attached to it.

CONSTRUCTING THE HIGHLINE

The first step in constructing a highline is “spanning the gap”. This can be done by shooting or throwing a pilot line across the gap, the pilot line pulls across the messenger line which in turn pulls across the trackline(s). Once a trackline has reached the far side it must be secured to a bombproof anchor with a tensionless hitch.

The next step will be to determine if a high directional is needed near the edge. A high directional is employed whenever the tracklines need to be elevated higher than the anchor systems will allow. High directionals may be needed at the far side and the control side depending on the how you are designing your system to operate. There a variety of high directional types and they can be categorized by the acronym H.A.N.S.

H – Human High Directional – rescuers holding a “jumbo bar” or other device under the ropes to provide a temporary high point while a rescuer negotiates an edge.

A – Artificial High Directional – an Arizona Vortex, Terradaptor, or 6 x 6 lumber constructed into an “A” frame. A focused floating anchor is also categorized as an AHD.

N – Natural High Directional – using trees, boulders, etc to keep the ropes at the correct height.

S – Structural High Directional – using parts of a structure as an anchor to create a high point.



Figure 17-2. A Structural High Directional

After constructing the High Directional, the trackline tensioning system needs to be constructed. Before building this system it must be understood what makes highlines so dangerous. Due to the angles created in highline systems, the force on the anchors typically exceeds that of the load. Students are always instructed to never exceed a 90 degree internal

angle when creating anchor systems. A 90 degree internal angle will place approximately 71% of the load on each anchor. Think of the trackline as an anchor with a very wide angle. It is not uncommon for a trackline to be tensioned creating an internal angle greater than 150 degrees. From previous anchor lectures, an internal angle of 120 degrees has the weight of the load on each anchor. Once 120 degrees is exceeded, the forces on the anchors are greater than the load. For example, a vector angle of 150 degrees places almost 2 times the load on each anchor. A vector angle of 170 degrees places almost 6 times the load on each anchor.

In order to avoid over tensioning the highline system, refer to the “Rule of 18”. This rule, which applies to 12.5 mm (1/2 inch) rope, simply states that the number of haulers multiplied by the mechanical advantage of the tensioning system should not exceed 18 with the load at center span. For example; a compound 6:1 mechanical advantage can have no more than 3 haulers ($6 \times 3 = 18$). Using this rule will ensure that the tensioning team does not over tension the highline.

There are many types of highlines. The simplest is a single track line with a 3:1 tensioning system. This system is very quick to construct and incorporates many skills taught in LARRO and RS1. The major difference is that the “ratchet” uses tandem prusiks, instead of a single prusik used in most raising systems.

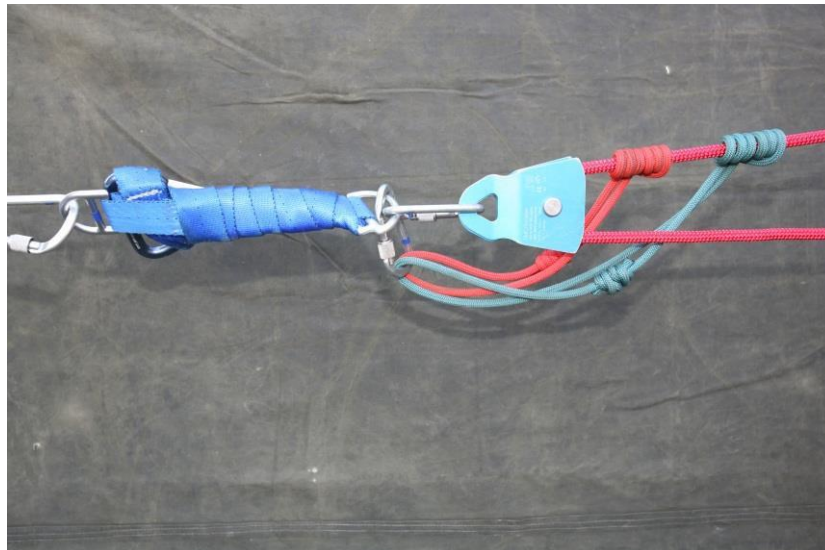


Figure 17-3. Tandem Prusiks holding on a 3:1 used as a highline

Single track highlines are easy to construct and operate. Sag is created by de-tensioning the track line thus lowering the total force on the trackline anchors. There are scenarios, however, where excessive sag is not wanted (i.e. swiftwater rescue). This problem is solved by adding a second track line.

The addition of a second trackline will help to limit sag but will not lessen the force applied to the trackline anchors. The addition of the second trackline will require a slight modification to the tensioning system. This modification comes in the form of an “equalizer pulley” that tensions each trackline with the same amount of mechanical advantage. Most highline evolutions can be completed with “progressive tensioning”. Progressive tensioning incorporates a compound 6:1 MA. Pre-tensioning of the system is completed by pulling on the 2:1 segment of the tensioning system. Many times this will provide sufficient tension to operate the highline. If additional tensioning is required the tensioning team progresses to pulling on the 3:1 segment of the progressive tensioning system. Remember that the 3:1 is pulling on the 2:1 so you have a compound 6:1 and the Rule of 18 needs to be followed.

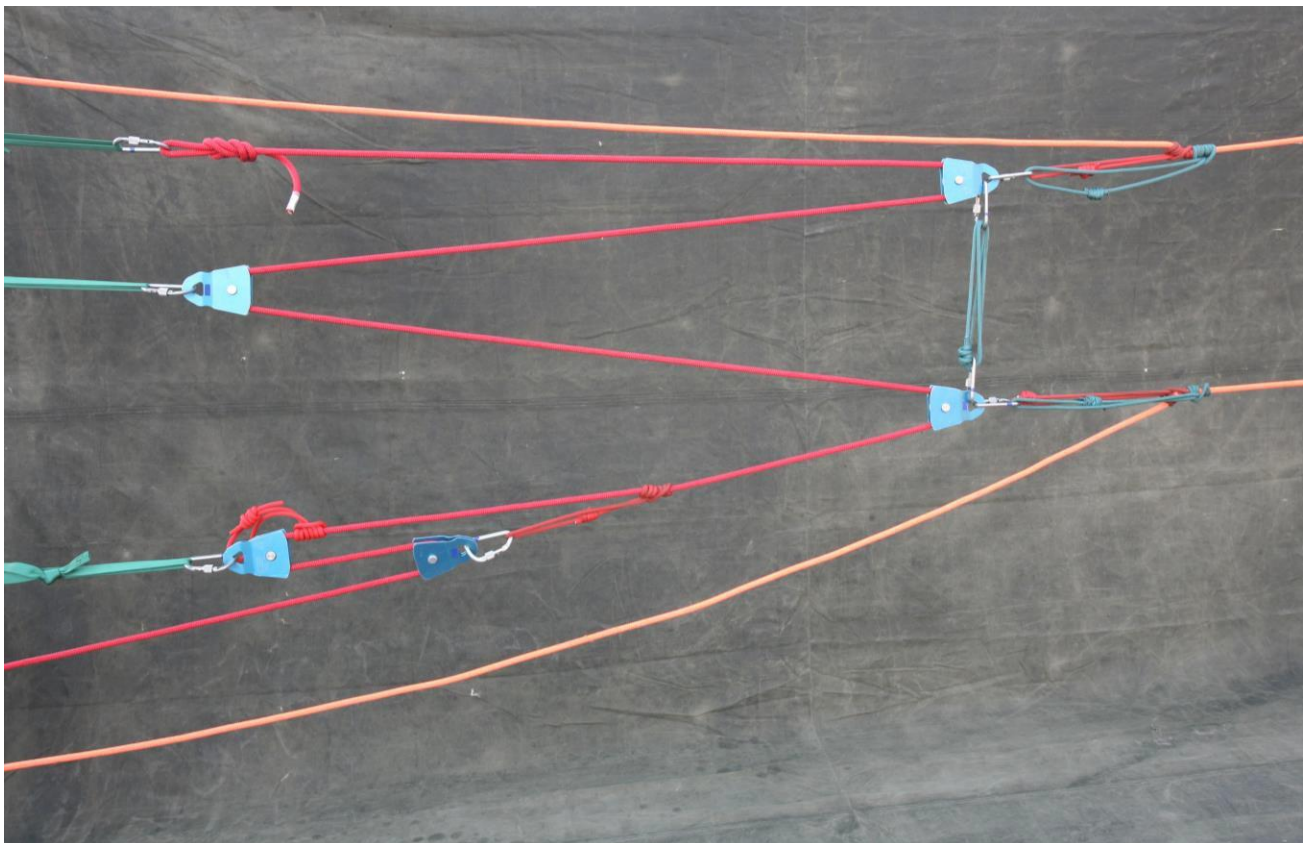


Figure 17-4. Compound 6:1 Tensioning Two (orange) tracklines

Once the trackline tensioning system is completed it is time to construct the tag line system. The tag line has 2 important functions; first and most important is its function as the system belay. Should the main line fail the tagline is constructed in such a way that it will catch and hold the load. Its second function is to control the horizontal movement of the rescue package. Horizontal movement is controlled by placing RPM systems at both sides of the tagline anchors. Travel in one direction will require a hauling system at one anchor and a descent

control device at the opposite anchor. The only difference in the construction of these systems is that there are tandem prusiks placed as a ratchet on the hauling side and tandem prusiks placed in front of the descent control device on the lowering side. The tandem prusiks are required because, as stated above, the taglines primary function is to act as the system belay. The anchors that serve as the trackline anchors can also serve as the tagline anchors.

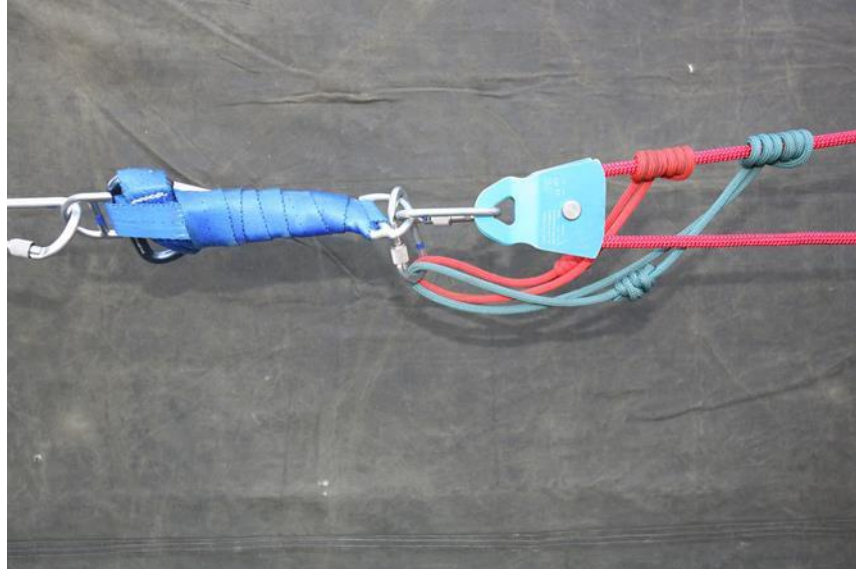


Figure 17-5. Tagline with Tandem Prusiks



Figure 17-6. Tagline with Brake Rack and Tandem Prusiks

The load is attached to the trackline(s) with a pulley. The pulley type best suited for this application is a highline carriage. What makes these pulleys so advantageous is that they are designed to be used for this purpose. Their key feature is extra rigging holes which allow for separation of taglines and hoist lines when constructing a reeving highline. The tagline(s) is/are attached to the highline carriage with a “prusik bypass”. The “slack” ends of the taglines run through the carabiners that are attached to the highline carriage.

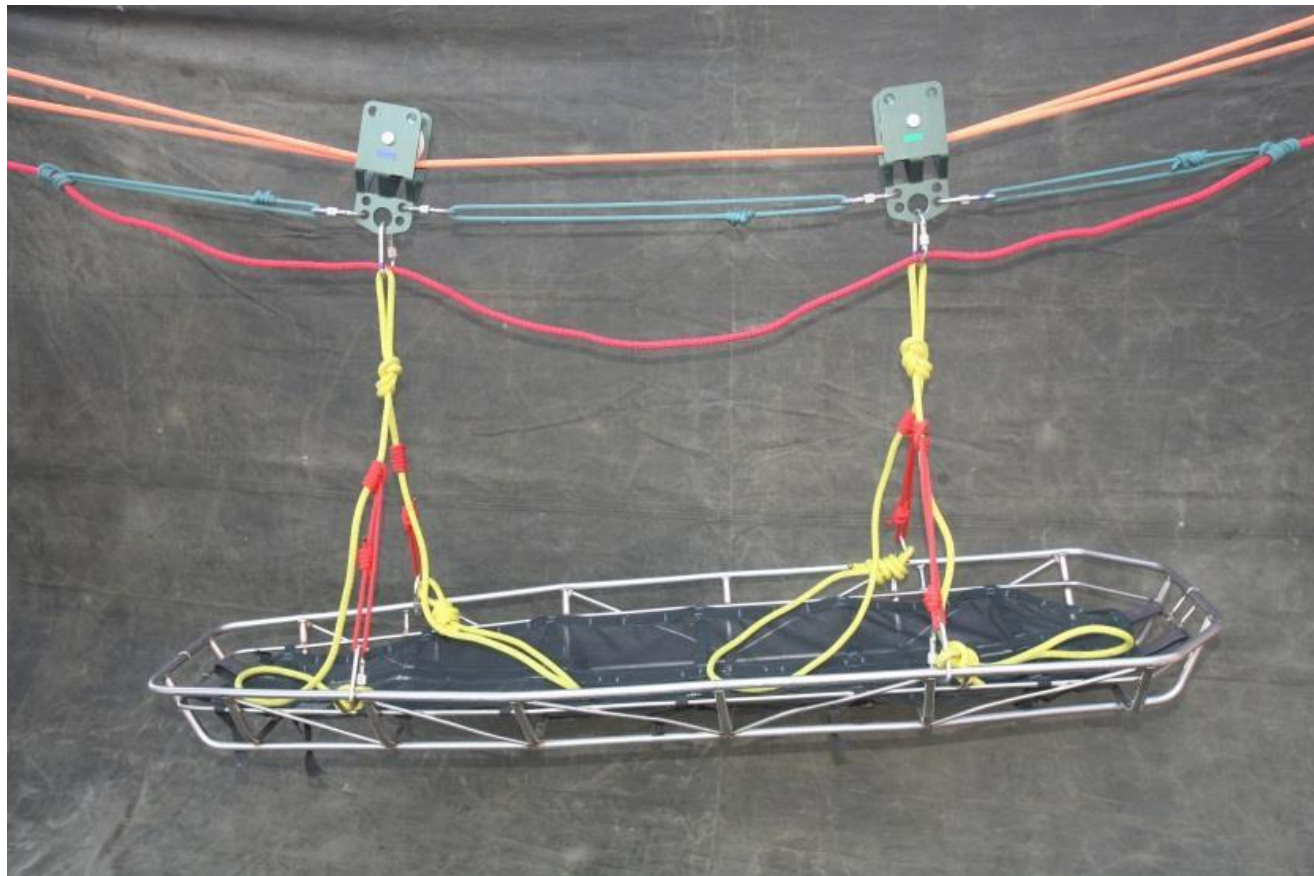


Figure 17-7. Highline Carriage with Stokes Basket

When the rescue team constructs a highline they have an option of using one or two highline carriages based on the ultimate use of the system. For example, if a litter is being used to transport persons horizontally then the rescue team may want to employ a dual carriage system to prevent any spinning of the litter during transport. Spinning can also be resolved by attaching a piece of webbing to the head and/or foot of the litter and clipping the other end over the trackline(s), much like a tagline hanger.

For horizontal movement only, the highline is complete. The “load” is hung from the tracklines by a highline carriage and pulled across the span by using the 3:1 on one side of the tagline and lowering, thru a brake bar rack, on the other side. Remember that these systems employ



ROPE RESCUE TECHNICIAN



tandem prusiks at the ratchet position, or in the case of lowering, in front of the brake bar rack. This type of highline can also be “de-tensioned”, by lowering on the mechanical advantage system. The ability to de-tension this highline is dependent on the angle of the edge and the distance the trackline must be lowered. The terrain in some scenarios will not allow the rescue team to de-tension the highline enough so that the rescuer can reach the intended target. Situations like that require the rescue team to add a third component to highline called a reeving line.

A reeving line allows the trackline to remain tensioned while lowering the rescuer. There are two types of reeves; English or Norwegian. They both incorporate a lowering component and a raising component. The Norwegian reeve uses a 6:1 compound mechanical advantage system to raise the rescue package from the floor of the span being traversed. A Norwegian reeve is worked from one side while an English reeve can be worked from either side. An English reeve is more equipment intensive than a Norwegian reeve.

A Norwegian reeve line is constructed by tying one end of the reeve line into a figure eight on a bight and clipping it into the bottom of the highline carriage which is hanging from the trackline(s). A pulley is attached in the bight forming a 2:1 mechanical advantage. A change of direction pulley is also placed on the highline carriage. The rope then continues to the control side and terminates at an RPM.

The pulley forming the 2:1 mechanical advantage should have a prusik placed on both sides of the pulley. One prusik is tended while the rescue package is being lowered and then other is tended when the rescue package is being raised. The use of 2 prusiks ensures that the load on the reeve line has two points of contact.

An English reeve is similar to a Norwegian reeve with the main difference being that the reeve line begins on one side and terminates on the other side. This system is operated similar to a highline without a reeve line. The rescue package is pulled across the span using the tag lines. Once the rescuer is above the intended target, the tag line is secured and the control side team lowers the reeve line.

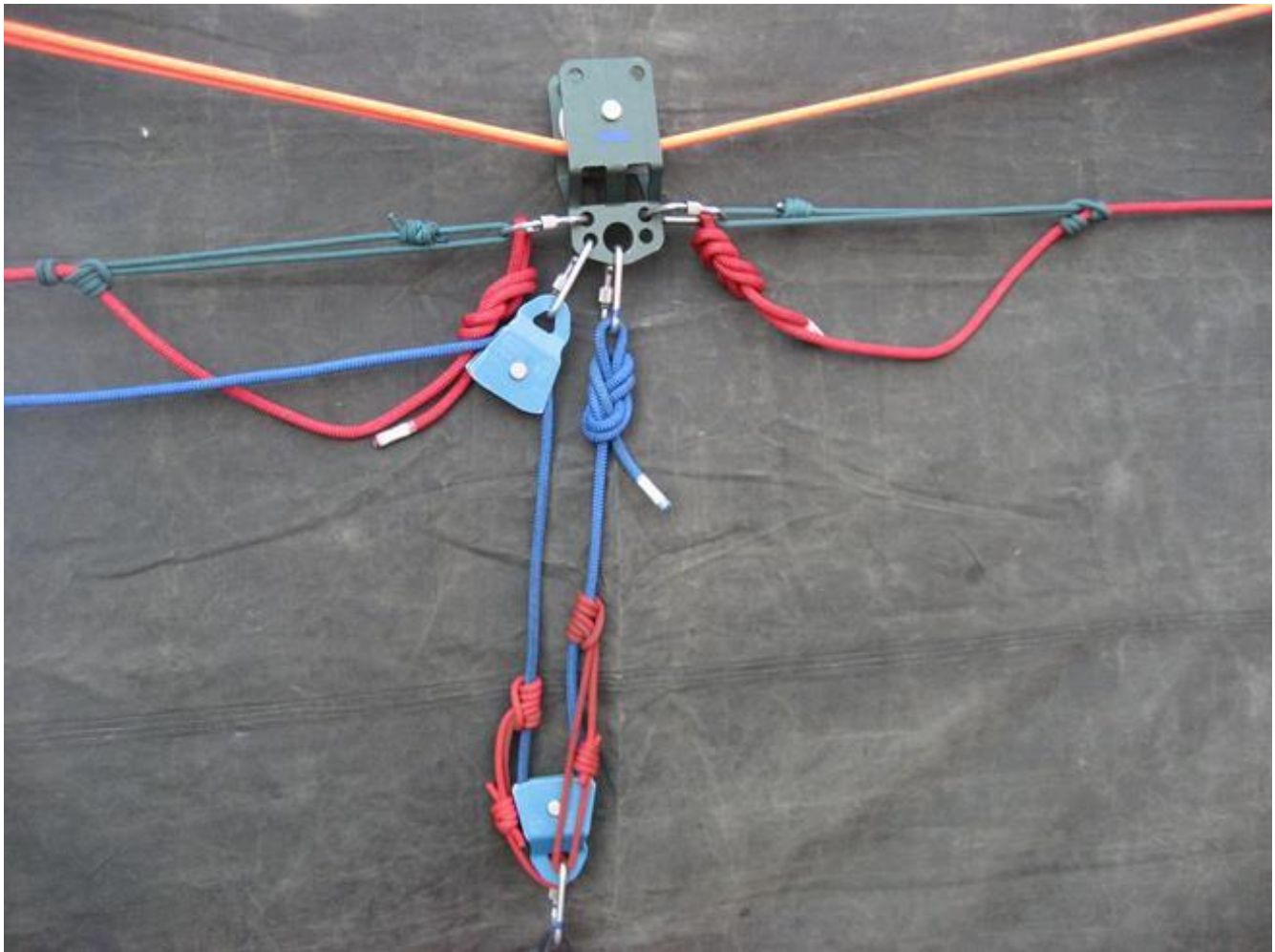


Figure 17-8. 2:1 Portion of a Norwegian Reeve

HIGHLINE RULES

1. Due to the extreme forces generated all anchors must be bombproof.
2. There should be no knots in the trackline ropes.
3. Knots in the tagline shall have a prusik bypass.
4. Load carrying prusiks on the tracklines and tag lines shall be tandem.
5. Never exceed the "Rule of 18" tensioning factor for 12.5 mm rope.
6. Ensure the device you use to hang loads from the trackline are rated for multi directional use.



ROPE RESCUE TECHNICIAN



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ROPE RESCUE TECHNICIAN



GLOSSARY

Ambulatory Victim	A victim that is capable of walking.
Anchor	An object that rope or webbing can be attached to capable of holding a load. The object may be manmade or natural.
Anchor Plate	A component of rope rescue hardware intended to help organize anchor and system component rigging.
Belay	The method by which a potential fall distance is controlled to minimize damage to equipment and/or injury to a live load. Usually constructed as part of rope system.
Bending knot	A knot used to tie rope or webbing into itself to form a continuous loop, or to join two lengths of material together to extend the length. Also referred to as a "Bend".
Bight	The open loop in a rope or piece of webbing formed when it is doubled back on itself.
Brake	Tool used to create friction to slow rope descent.
Bridle	See pre-rig.
Bollard	A round, non-trussed anchor.
Cam	An eccentric or multi curved wheel mounted on a rotating shaft, used to produce variable or reciprocating motion in another engaged or contacted part.
Carabiner	An auxiliary equipment system component; an oval or D-shaped metal, load-bearing connector with a self-closing gate used to join other components of a rope system.
Class II Victim Device	A device that secures around the waist and around the thighs or under the buttocks to be used for victim extrication in an upright position.
Class III Victim Device	A device that secures around the waist, around the thighs, or under the buttocks, and over the shoulders or that otherwise encapsulates a body to be used for victim extrication in an upright or horizontal configuration.



ROPE RESCUE TECHNICIAN



Cordelette	A narrow diameter line, usually 9mm or smaller.
Descender	A device used to create friction to control the movement or descent of the rope.
Detensioning	Releasing the load from a tensioned line.
Dressed	A knot constructed in a uniform manner free of any twists or abnormalities.
Fixed Line	A suitably anchored rope used for rappelling or ascending.
Festoons	Small loops made using webbing or prusiks and carabiners. Their purpose is to keep the Tag Line from sagging excessively below the track Line. Tagline hangers are affixed to the Tagline with a girth hitch and the Track Line with a carabiner. Tagline hangers are spaced approximately 15-20 feet apart.
Friction Device	See descender.
Hitch	A knot that attaches to, or wraps around, an object so that when the object is removed the knot will fall apart.
Kern	Continuous parallel fibers throughout the length of the rope, forming its core. The Kern accounts for 75-90% of the rope's breaking strength.
Kernmantle Rescue Rope	Rope consisting of a core (kern) and a sheath (mantle) that is the primary tool for raising and lowering rescuers, equipment, and victims.
Knot	A fastening, including bights, bends, and hitches, made by tying together lengths of rope or webbing in a prescribed way.
Lifeline	Rope dedicated solely for the purpose of supporting people during rescue, fire fighting, other emergency operations, or during training evolutions.
Litter	A transfer device designed to support and protect a victim during movement.
Load Releasing Hitch	Tied device constructed of cordelette, rope or webbing and hardware, designed to provide a controlled release under tension and to decrease shock loads. Also referred to as an LRH.



ROPE RESCUE TECHNICIAN



Load Releasing Device	Premanufactured device constructed of flat webbing and D-rings designed to provide a controlled release under tension and to decrease shock loads. Also referred to as an LRD.
Lock-off	A means to secure a descending device to prevent further movement down rope.
Loop	An element of a knot created by forming a complete circle in the rope.
Mantle	The braided jacket that forms the rope's sheath and protects its core (kern); the mantle accounts for 10-25% of the rope's breaking strength.
Messenger Line	A line that is larger than a pilot line but smaller than a track line. Commonly used to pull a tag line or track line across a gap.
Picket	Metal rods usually 1" in diameter and 4 feet long that can be driven into the ground to create a temporary anchor for a rope system.
Pilot Line	A small diameter cord that is sent across a gap and is used to pull a larger diameter line across the gap. Commonly used to pull a Messenger Line.
Pre-rig	An adjustable pre-tied combination of lifeline, prusiks, and carabiners used to connect the rescue lines, litter, and rescuers together.
Prusik (prusik loop)	Narrow kernmantle rope, usually 8 mm in diameter, tied with a double overhand bend. Adapted for rescue work as a rope grab to perform many different functions.
Prusik Hitch	The knot used for attaching the prusik loop to the host rope.
Rappel	A slow, controlled, descent down a fixed line.
Reeve	To pass a rope through a hole, ring, pulley, or block. To fasten by passing through or around.
Running End	Part of the rope that "runs" away from the knot.
Round Turn	An element of a knot created from a loop by continuing to cross one side of the loop all the way around an object to form a circle with the ends of the rope parallel as in a bight.



ROPE RESCUE TECHNICIAN



Scree	1) Loose rock debris covering a slope. 2) A slope of loose rock debris at the base of a steep incline or cliff.
Set	Setting a knot means applying tension to all strands of the standing portion of the rope and on the tail left on either side of the knot. This removes any slack from the strands forming the knot.
Set back	The distance between the edge and the anchoring apparatus.
Sheave	A wheel or disk with a grooved rim, especially one used as a pulley.
Standing Part	Part of the rope between running end and working end.
Stokes Basket	Another term for a rescue litter or litter basket.
Tag Line	1) Varying lengths of lifeline or webbing used to extend anchors in a tagged anchor system. 2) An additional line used to control motion elsewhere in a system such as on a basket in mid-air.
Training Groove	The notch or depression found in the top bar of a brake bar rack.
Two Block	A condition that occurs when two or more pulleys come together or come into contact and cause the system to become inoperable.
US&R	Urban search and rescue.
Vector Pull	Providing deflection in a rope by applying force to the rope perpendicular to the direction of the load.
Webbing	Woven material in the form of a long strip; can be of flat or tubular weave.
Windlass	The technique of connecting pickets in a windlass picket system to each other with shorter lengths of lifeline or webbing.
WMD	Weapons of mass destruction.
Working end	Part of the rope used in forming a knot. (Also known as "loose end" or "bitter end.").



ROPE RESCUE TECHNICIAN



APPENDIX A

TASK BOOKS

All Rope Rescue Task Books can be found on the SFT Website at:

<http://osfm.fire.ca.gov/training/SFTCurriculum>



ROPE RESCUE TECHNICIAN



APPENDIX B

EVENT ACTION PLAN

CALIFORNIA ROPE RESCUE TECHNICIAN COURSE



ROPE RESCUE TECHNICIAN

OPERATIONAL PERIOD
X/XX/XXXX – X/XX/XXXX
0800 – 1700 HOURS

EVENT OBJECTIVES	1. Event Name ROPE RESCUE TECHNICIAN	2. Date	3. Time
4. Operational Period			
5. General Control Objectives for the Event (include alternatives)			
6. Weather Forecast for Period			
7. General Safety Message SEE ATTACHED			
8. Attachments (mark if attached)			
<input type="checkbox"/> Organization List - ICS 203	<input type="checkbox"/> Medical Plan - ICS 206	<input type="checkbox"/> (Other) Safety Message	
<input type="checkbox"/> Div. Assignment Lists - ICS 204	<input type="checkbox"/> Incident Map	<input type="checkbox"/> Site Plan	
<input type="checkbox"/> Communications Plan - ICS 205	<input type="checkbox"/> HazMat Plan	<input type="checkbox"/> 205 - T	
9. Prepared by Training Program Manager		10. Approved by Senior Instructor	

[illegible]

1. BRANCH	2. DIVISION/GROUP DAY 1	ASSIGNMENT LIST					
3. EVENT NAME ROPE RESCUE TECHNICIAN		4. OPERATIONAL PERIOD					
5. OPERATIONS PERSONNEL							
6. RESOURCES ASSIGNED THIS PERIOD							
SUBJECT	INSTRUCTOR	NUMBER PERSONS	TRANS. NEEDED	DROP OFF PT./TIME	PICK UP PT./TIME		
7. CONTROL OPERATIONS							
8. SPECIAL INSTRUCTIONS							
9. DIVISION/GROUP COMMUNICATIONS SUMMARY							
FUNCTION	FREQ.	SYSTEM	CHAN	FUNCTION	FREQ.	SYSTEM	CHAN.
PREPARED BY TRAINING PROGRAM MANAGER:		APPROVED BY SENIOR INSTRUCTOR:			DATE:		TIME

1. BRANCH	2. DIVISION/GROUP DAY 4	ASSIGNMENT LIST					
3. EVENT NAME ROPE RESCUE TECHNICIAN		4. OPERATIONAL PERIOD					
5. OPERATIONS PERSONNEL							
6. RESOURCES ASSIGNED THIS PERIOD							
SUBJECT	INSTRUCTOR	NUMBER PERSONS	TRANS. NEEDED	DROP OFF PT./TIME	PICK UP PT./TIME		
7. CONTROL OPERATIONS							
8. SPECIAL INSTRUCTIONS							
9. DIVISION/GROUP COMMUNICATIONS SUMMARY							
FUNCTION	FREQ.	SYSTEM	CHAN	FUNCTION	FREQ.	SYSTEM	CHAN.
PREPARED BY TRAINING PROGRAM MANAGER:		APPROVED BY SENIOR INSTRUCTOR:			DATE:		TIME

SAFETY MESSAGE

SAFETY OFFICER:

EVENT RADIO COMMUNICATIONS PLAN			1. Event Name ROPE RESCUE TECHNICIAN	2. Date/Time Prepared	3. Operational Period Date/Time
4. Basic Radio Channel Utilization					
Radio Type/Cache	Channel Name	Function	Frequency/Tone	Assignment	Remarks
5. Prepared by TRAINING PROGRAM MANAGER					

TELEPHONE LIST

[illegible]

MEDICAL PLAN	1. Event Name	2. Date Prepared	3. Time Prepared	4. Operational Period			
	ROPE RESCUE TECHNICIAN						
5. Event Medical Aid Station							
Medical Aid Stations		Location			Paramedics Yes No		
6. Transportation							
A. Ambulance Services							
Name	Address		Phone		Paramedics Yes No		
B. Event Ambulances							
Name	Location			Paramedics Yes No			
7. Hospitals							
Name	Address	Travel Time Air Ground		Phone	Helipad Yes No		Burn Center Yes No
8. Medical Emergency Procedures							
Prepared by TRAINING PROGRAM MANAGER:				10. Reviewed by SAFETY OFFICER:			

XX/XX/XXXX

XX/XX/XXXX

TRAINING SITE 2



ROPE RESCUE TECHNICIAN



APPENDIX C

USE OF ROPE ACCESS EQUIPMENT (CCR 3270.1)

California Code of Regulations, Title 8, Section 3270.1. Use of Rope Access Equipment

Subchapter 7. General Industry Safety Orders Group 1. General Physical Conditions and Structures Article 4. Access, Work Space, and Work Areas §3270.1. Use of Rope Access Equipment.

§3270.1. Use of Rope Access Equipment.

(a) Scope and Application. This section establishes safety requirements for rope access and the use, care and maintenance of rope access equipment as defined in Section 3207. Rope supported work shall be permitted only when other means of access are not feasible or would increase the risk of injury to the employee and/or the public. The requirements of this section include, but are not limited to, the inspection of dams and spillways, access to interior or exterior structural and architectural components of buildings, highway/bridge inspection and maintenance, and access to powerplant penstocks.

Exception: (1) Window cleaning and exterior building maintenance as regulated by Articles 5 and 6 of these Orders; (2) **Emergency search and rescue operations**; (3) Entertainment performances and rehearsals.

(b) Approval. Rope access equipment shall be approved for its intended use as defined in Section 3206 of these Orders.

(c) Training.

(1) The employer shall establish, implement and maintain a written Code of Safe Practices for rope access work. The written Code of Safe Practices shall include, but not be limited to the following elements:

- a. Methods of rope access and anchorage used by the employer.
- b. Employee selection criteria.
- c. Equipment selection and inspection criteria.
- d. Roles and responsibilities of rope access team members.
- e. Communication systems.
- f. Employee training program.

g. Rescue and emergency protocol.

h. Identification of any unique site hazards that may affect the safety of employees using rope access methods.

(2) Employees shall be trained in accordance with the Code of Safe Practices, including rescue techniques. The employer shall evaluate the competence of the employee to perform rope access in accordance with the Code of Safe Practices including a hands-on demonstration by the employee of his/her rope access skills.

(3) Employees who perform rope access shall receive annual refresher training. The training shall include a reevaluation (e.g., hands-on demonstration) of the employee's ability to perform rope access in accordance with the Code of Safe Practices.

(4) Documentation of employee training shall be maintained as required by Section 3203 of these Orders.

(d) Equipment Inspection and Maintenance.

(1) The manufacturer's recommendations for use, care, inspection and maintenance of rope access equipment shall be followed.

(2) A qualified person shall inspect rope access equipment each day before and after use to determine that the equipment is safe for its intended use.

(3) Damaged or defective rope access equipment shall be immediately removed from service.

(e) Anchorage. Anchorages shall be sufficient to safety support at least twice the maximum anticipated dynamic load imposed upon them as determined by a qualified person.

(f) Personal Protective Equipment. Employees performing rope access work shall be provided personal protective equipment in accordance with Article 10 of these Orders.

(g) There shall be at least two trained employees present when rope access equipment and techniques are used.

(h) Trainer Qualifications. Employees who use rope access equipment and/or perform rope access shall be trained by persons with the qualifications and experience necessary to effectively instruct the employee in the proper fundamentals of rope access, equipment, and techniques as described in subsection (c) of this section.

(i) The employer shall provide for the prompt rescue of employees in case of equipment malfunction or a fall, or shall assure that employees are able to rescue themselves.

(j) A safety, secondary, belay, or backup line, or other appropriate fall arrest device shall be used when the main line is the primary means of support, unless the employer can demonstrate that the second line or other fall arrest device would create a greater hazard or would otherwise be infeasible.

(1) When a safety line is used in conjunction with the main line, each line shall be provided with a separate anchor, and shall be separately fixed to the employee's harness. This shall not prohibit both lines from being attached to a single harness attachment point.

(k) Precautions (e.g., barricades, warning lines) shall be taken to control vehicular traffic and/or prevent unauthorized persons from walking or working beneath employees performing rope access operations.

(l) The employer shall conduct a pre-rope access briefing to discuss the objective(s) of the rope access work to be performed, any unusual site-specific hazards or environmental conditions that could affect the safety of the employee, and emergency procedures to be followed (e.g., employee rescue).

NOTE

Authority cited: Section 142.3, Labor Code. Reference: Section 142.3, Labor Code.

HISTORY

1. New section filed 8-4-2000; operative 9-3-2000 (Register 2000, No. 31



ROPE RESCUE TECHNICIAN



APPENDIX D

POWERPOINT



All Rescuers operating at the technician level in CA.

3. The State Training system NFPA are built around Three levels Awareness, Operations Technician

ROPE RESCUE TECHNICIAN

**In the past California Rescuers
Did Not Have a Standardized
Curriculum for Rope Rescue
Technician That Meets Fire
Service Standards**

All Rescuers operating at the technician level in CA.

ROPE RESCUE TECHNICIAN

**First Tasked in Early 90's to Meet Needs of California Rescuers
was Disbanded by State Fire Training, Citing Lack of Need**

**Notice to all Federal and Regional TF's to Volunteer for
Committee January 2010 Only Seven Replies, Four Members
from the Original Committee Included**

Current Options – Private Contractor or In House

LARRO and RS I are Building Blocks (NFPA Operations Level)

**June 2010 First Meeting of Current Rope Rescue Technician
Committee**

3. The State Training system NFPA are built around
Three levels Awareness, Operations Technician
4. 2009 Approached Joe Gear about the need for a
technician rope class for with the Blessing of Kim
Zagaris we convened in June 2010

Rope Rescue Technician

Funding Source Secured

Joe Gear, Cal OES Assistant Chief in Charge of US&R was approached and made aware of training deficit

With approval from Kim Zagar, is Cal OES Fire and Rescue Chief a funding source was identified

ROPE RESCUE TECHNICIAN

Affects the Following Resources

- FIREScope Type 1 US&R Companies
- FIREScope Type 1 US&R Crews
- Regional US&R Task Forces
- California US&R Task Forces
- FEMA US&R Task Forces
- All California Rescuers

ROPE RESCUE TECHNICIAN

INTRODUCTIONS

- **Instructors**
- **Students**

4. 2009 Approached Joe Gear about the need for a technician rope class for with the Blessing of Kim Zagaris we convened in June 2010

ROPE RESCUE TECHNICIAN

- **Sign in Sheets**
- **Daily Schedule**
- **Breaks**
- **Cleanup**
- **Facilities**

ROPE RESCUE TECHNICIAN

- 40 Hour Curriculum
- Prepares Rescuers for High Angle
Rescue
- Safely Construct Systems
- Safely Operate Systems

ROPE RESCUE TECHNICIAN

- FIRESCOPE Compliant

- Meets US&R OSD 120-1

- NFPA 1670 Compliant

- 2009 Edition

- NFPA 1006 Compliant

- 201J Edition

- Cal/OSHA Compliant

- ccR J210.1

- Code of Safe Practices

- Opens Grants

- UAS/

- FEMA

- Other

ROPE RESCUE TECHNICIAN

Skills Verification

- **Rescue Systems 1**
- **Low Angle Rope Rescue Operations**

Following are the skills that are not currently in any State Fire Class and are necessary to reach the technician level

All Skills in the class meet the requirements in 1670 Technician & 1006 level I & II skill sets

ROPE RESCUE TECHNICIAN

CHAPTERS

1. Course Introduction
2. Rope Rescue Equipment
3. Knots, Bends, and Hitches
4. Anchor Systems
5. High Angle Victim Packaging
6. Travel Restriction
7. Belay Systems
8. Mainline Systems
9. Load Releasing Methods

ROPE RESCUE TECHNICIAN

CHAPTERS

- 10. Rescue Scene Organization and Management
- 11. Knot Passing
- 12. Ascending and Descending
- 13. Pick Offs
- 14. Protected Climbing
- 15. High Angle Litter Rigging and Tending
- 16. Artificial High Directionals
- 17. Highlines

ROPE RESCUE TECHNICIAN

Task Books

- **Student Task Book**
- **Primary Instructor Trainee**
- **Senior Instructor Trainee**

ROPE RESCUE TECHNICIAN

SAFETY

- **Personal Protective Equipment**
- **Hydration**
- **Accountability**
- **Attitude**

5. Historical recognition
6. Code of safe practices

ROPE RESCUE TECHNICIAN

Summary

- **Need Identified in 1993**
- **Curriculum Satisfies all Requirements**
- **Vetted by Cal-OSHA**
- **Delivers Technical Interoperability**

2. All regulatory Requirements NFPA 1670, 1006, Rope Access
3. Will be adopted as the code of safe practices



Roll out number of classes based on the number of eligible applicants