

General Ropes

Lesson Three

Lowers and Raises

DOMAIN: PSYCHOMOTOR

LEVEL OF LEARNING: KNOWLEDGE / APPLICATION

MATERIALS

IFSTA Fire Service Search and Rescue, 7th edition; IFSTA 5th edition Essentials of Firefighting. Laptop computer, multimedia projector and whiteboard or flipchart, and marking pens. A suitable number of 1" flat or tubular web slings or 1/2" life line for anchor slings at lengths sufficient to go around available anchors and for internal and external lashing of the litter; locking carabiners; swivels; various sizes of single and double sheave pulleys; a sufficient amount of prussik slings at recommended pre-tied lengths of 53" and 65"; commercial devices rated by manufacturer for use in a belay system; weighted objects; load release device suitable and safe for tripping the load for belay station practice station; suitable number of life lines to conduct a safe vertical lower and raise with a belay system using a litter, and sufficient ropes and rescue equipment to perform a lower using the Rescue Knot.

NFPA 1006, 2008 edition JPRs

- 5.5.3 Edge Protection
- 5.5.4 Construct a simple rope mechanical advantage system
- 5.5.5 Direct the operation of a simple mechanical advantage system in a low angle raising operation
- 5.5.6 Direct the operation of a simple rope mechanical advantage system in a high-angle raising operation
- 5.5.7 Function as a litter tender in a low angle lowering or hauling operation
- 5.5.8 Construct a lowering system

- 5.5.9 Direct a lowering operation during a low-angle environment
- 5.5.10 Direct a lowering operation in a high angle environment
- 5.5.11 Construct a belay system
- 5.5.12 Operate a belay system during a lowering or raising operation in a high angle environment
- 5.5.13 Belay a falling load in a high angle environment
- 5.5.14 Conduct a system safety check

Junior Member Statement:

Junior Member training activities should be supervised by qualified instructors to assure that the cognitive and psychomotor skills are completed in a safe and non-evasive manner. While it is critical that instructors be constantly aware of the capabilities of all students both mentally and physically to complete certain tasks safely and successfully, the instructor should take every opportunity to discuss with departmental leaders and students the maturity and job awareness each participant has for the hazards associated with fire and rescue training.

TERMINAL OBJECTIVE

The Technical Rescuer candidate, when given the appropriate equipment, shall correctly demonstrate the construction of a high angle vertical lowering system, and a low angle raising system both to include an appropriate belay system, and use these systems to perform a high angle lower from a minimum of 1 floor, and a low angle embankment raise.

ENABLING OBJECTIVES

1. The Technical Rescuer candidate, when given the appropriate equipment, shall correctly demonstrate blanketing a victim in a litter used by the Authority Having Jurisdiction, and secure the victim into the litter by means of internal and external lashing.
2. The Technical Rescuer candidate, when given the appropriate equipment, shall correctly demonstrate conducting a low angle descent to reach a victim.
3. The Technical Rescuer candidate, when given the appropriate equipment, shall correctly demonstrate

conducting a low angle raise using a simple hauling system incorporating a 2:1 and 3:1 hauling operation to include a visual safety check, a pre-hauling load test of all systems with verbal confirmation acknowledged by all rescue personnel, and the use of appropriate commands.

4. The Technical Rescuer candidate, when given the appropriate equipment, shall correctly demonstrate constructing a vertical lowering system using a stokes basket, rescue knot, appropriate lifelines, edge protection devices, and necessary auxiliary rope rescue equipment.
5. The Technical Rescuer candidate, when given the appropriate equipment, shall correctly construct a belay system designed to arrest the fall of a load in the event of a failure of a primary lowering operation and demonstrate the safe activation of the belay system.
6. The Technical Rescuer candidate, when given the appropriate equipment, shall correctly demonstrate conducting a vertical lowering operation to include a visual safety check, a pre-lowering load test of all systems with verbal confirmation acknowledged by all rescue personnel, and the use of appropriate commands, and utilization of a belay system during the operation.

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Lowers and Raises

MOTIVATION

Given the fact that high and low angle rescue operations can occur in varied environments, the Technical Rescuer should be familiar with the many components and methods of moving patients from different types of urban and wilderness environments. This knowledge includes rigging for various types of lowers, and being proficient with different types of friction systems. This lesson will give the Technical Rescuer a firm basic understanding of the components needed to successfully move a patient from a high angle environment

Emphasize that when performing all high and low angle application skills at actual sites, all personnel should wear appropriate PPE and use a training mannequin to simulate a patient. If a student is used as a patient, make sure all safety precautions are adhered to, including the use of appropriate PPE. To insure adequate safety, a minimum of two instructors should be involved in this training exercise.

PRESENTATION

ENABLING OBJECTIVE #1

The Technical Rescuer candidate, when given the appropriate equipment, shall correctly demonstrate blanketing a victim in a litter used by the Authority Having Jurisdiction, and secure the victim into the litter by means of internal and external lashing.

1. Demonstrate blanketing the patient into an approved litter.
 - a) The two-blanket method. One blanket at the upper body, the other blanket at the lower body.
2. Point out that blanketing helps to immobilize and protect the patient from the weather elements.

3. Point out that blanketing may also help to protect the body from potential abrasions caused by contact with the lashing material.
4. Demonstrate internal lashing procedures.
 - a) When using a stokes litter, the internal lashing cord is tied using overhand or inverted split locking clove hitches with an overhand safety knot at the head of the litter.
5. Demonstrate external lashing procedures.
 - a) When using a stokes litter longer than six feet, a minimum of 25' of 1" - 2" inch webbing, 8 or 9mm accessory cord, or available lifeline not to exceed 1/2" diameter will be needed.
 - b) When doing external lashing on a stokes basket, or other comparable metal litter, the lashing cord will criss-cross through the "D" spaces, and the ends of the lashing cord are secured at the "D" space nearest the shoulders using an overhand or inverted split-locking clove hitch with safety knot.
 - c) Show using a round turn; 2 - half hitch tie-off on pin.

NOTE: When referencing IFSTA 7th edition Fire Service Search and Rescue manual page 150, an alternative method for step #2 is to bring the midpoint of the lashing cord around the instep of the feet then continue to follow steps #3 through #5 found on pages 150 and 151. The reason for this is to reduce undue pressure on the ankles created by hitching the feet. Additionally, this internal lashing resolves the possibility of the victim sliding out at the bottom end of the litter.

Reference: IFSTA 7th edition Fire Service Search and Rescue manual, pages 150 and 151

APPLICATION

Divide the class into small groups, and assign each group the appropriate equipment to blanket and lash a patient into a litter using an internal and external lashing.

PRESENTATION

ENABLING OBJECTIVE #2

The Technical Rescuer candidate, when given the appropriate equipment, shall correctly demonstrate conducting a low angle descent to reach a victim.

1. Demonstrate constructing a modified class II seat harness also known as a Swiss seat.
 - a) Using a 2" piece of webbing, attach the two ends with a water knot secured with an overhand safety knot on each side to form a loop.
 - b) Pass the loop behind the legs and buttocks.
 - c) Reach between the legs and bring the webbing under the section that is around the waist and dress it down snugly.
 - d) The instructor may choose to demonstrate another type of seat harness used by the AHJ, providing it meets the criteria specified in NFPA 1983.

2. Demonstrate how to tie a chest harness.
 - a) Take a 2" piece of webbing; attach the two ends with a water knot secured with an overhand safety knot on each side to form a loop.
 - b) Form a twist in the webbing, creating a figure 8 in the loop.
 - c) Slip the rescuer's arms through the ends of the figure of eight plate so that the crossover point rests in the middle of the rescuer's upper back.
 - d) Connect the ends of the chest hitch with a locking carabiner.
 - e) Connect the chest harness to the seat harness using two carabiners between a short webbing tether, creating a modified class III harness.

NOTE: There are many techniques for creating a modified class II and class III harness that may be used by the AHJ. It is acceptable to demonstrate these as long as they are proven to be safe and comply with NFPA 1983 regarding the definition and the use of acceptable material.

Reference: IFSTA Fire Service Search and Rescue 7th Edition, Pages 117 through 120

5. Discuss the advantages and disadvantages of using conventional figure 8 plate.
 - a) The figure 8 plate is molded to form a large ring stacked on top of a small ring constructed from aluminum or steel.
 - b) The larger ring creates friction on the rope and the smaller ring is attached to a seat harness carabiner.
 - c) Drawbacks include large rope won't thread through the smaller designs. Ropes can slip over the large ring causing a girth hitch.
 - d) The Rescue 8 descender is the descender of choice for most rescue operations including rappelling.
 - e) The rabbit ear design allows for extra friction to be applied and the ears prevent the formation of a girth hitch across the larger ring.

6. Most manufacturers of figure 8 plate do not recommend using these devices for rappels exceeding 75' – 100' due to excessive heat buildup and potential damage to lifelines.

Reference: IFSTA Fire Service Search and Rescue, 7th edition, Pages 124 and 125

7. Demonstrate rigging a Rescue 8 descender rappel system.
 - a) Secure one end of the lifeline to a secure anchor.
 - b) Form a bight in the lifeline with running end on rescuer's brake hand side.
 - c) Slip the bight through the large ring from the top. For extra friction that may be needed for large rescuers, bring the bight through the large ring twice.
 - d) Slip the bight over the small ring.
 - e) Connect the Rescue 8 descender to the rescuer's seat with a carabiner with the gate in the up position.

Reference: High Angle Rescue Techniques, 3rd edition, pages 122 through 128.

NOTE: There are other acceptable locking methods for securing the rescue 8 descender. The one described is one of the easiest to understand.

8. Demonstrate rigging a brake bar rack rappel system.
 - a) Lay lifeline across the top of the training groove on the rack.
 - b) Weave the lifeline under and over each bar until desired friction is obtained. This will vary depending on the weight of the rescuer.
 - c) The running end coming out the bottom of the rack is held in the rescuer's brake hand and positioned between the center of the rescuers back and hip.
 - d) Connect the rack to the rescuer's harness with a carabiner, with the gate in the up position.
 - e) Manipulating the slack in the rope and by adding or subtracting bars from the system controls the speed of the descent. Pulling the running end of the rope up towards the top of the rack slows the descent.
 - f) Slacking the running end of the rope and loosening one's grip can increase the descent speed.

Reference: IFSTA Fire Service Search and Rescue, 7th edition, Page 125

Reference: High Angle Rescue Techniques, 3rd edition, pages 130 through 137.

9. Discuss and demonstrate the use of carabiner wrap for emergency (low angle) descents.
 - a) Wrap a carabiner connected to the seat harness with several turns of the rappel rope. The more turns, the greater the friction produced.
10. Discuss and demonstrate the use of a munter hitch for emergency (low angle) descents.
 - a) The munter hitch and the carabiner wrap afford the best protection to the rescuer during an emergency descent when Rescue 8 descenders or brake bar racks are unavailable.
11. Discuss and demonstrate using a prussik safety as a self belay technique for emergency (low angle) decent.

Reference: High Angle Rescue Techniques, 3rd edition, pages 138 through 139.

PRESENTATION

ENABLING OBJECTIVE #3

The Technical Rescuer candidate, when given the appropriate equipment, shall correctly demonstrate conducting a low angle raise using a simple hauling system incorporating a 2:1 and 3:1 hauling operation to include a visual safety check, a pre-haul load test of all systems with verbal confirmation acknowledged by all rescue personnel, and the use of appropriate commands.

1. Define slope evacuation, also known as a low angle environment.
 - a) Moving rescuers and a patient over rough terrain or angled terrain requiring the litter and rescuers to be secured to a rope. The descent is controlled by a braking system, and the ascent is controlled by a hauling system.
2. Give examples of a low angle rescue environment.
 - a) Road cuts and fills.
 - b) Loose rocky slopes.
 - c) Road embankments.
 - d) Broken, uneven terrain.
 - e) Low hills.
 - f) Stairways.
 - g) Industrial environments.
3. Discuss litter tender positions for a low angle raise.
 - a) Option 1 - Use six rescuers, three on each side of the litter.
 - b) Option 2 - Use five rescuers, two on each side of the litter and one rescuer at the foot end of the litter. A minimum of four tenders can be used.
 - c) The victim should be transported up the embankment head first.
4. Point out that one of the tenders will be for victim medical care and should be located near the head of the victim.
 - a) Another option would be to use an independent Medical Technician attached to the litter, but not responsible for carrying the litter.
5. Demonstrate securing the litter tender tie-ins.

Reference: IFSTA Fire Service Search and Rescue, 7th edition, Pages 117 through 120

Note: There are several acceptable methods for tying Swiss seats and chest harnesses that may be demonstrated by the instructor.

6. Demonstrate setting up a low angle raise using a main line, a litter hauling system with mechanical advantage, a belay system, and a load release hitch.

NOTE: An independent anchor sling will need to be attached to the litter when using the 2:1 hauling system

Reference: IFSTA Fire Service Search and Rescue, 7th edition, Page 138

NOTE: The rigging techniques for attaching a main line and belay line to the Stokes basket are the same rigging techniques used when rigging a stokes basket for a vertical lowering system.

APPLICATION

Have the candidates construct and operate a low angle raising system, perform a safety check and a whistle test. Rotate candidates to act as a Rigging Supervisor.

PRESENTATION

ENABLING OBJECTIVE #4

The Technical Rescuer candidate, when given the appropriate equipment, shall correctly demonstrate constructing a vertical lowering system using a stokes basket, rescue knot, appropriate lifelines, edge protection devices, and necessary auxiliary rope rescue equipment.

1. Define a high angle evacuation.
 - a) The victim, attendant or attendants, and the litter's weight are suspended and supported by a rope in a vertical or near vertical environment.
2. List examples of high angle rescue environments.
 - a) Rock climbing.
 - b) Urban buildings.

- c) Caving.
 - d) Silos and grain bins.
 - e) Confined spaces.
3. Demonstrate constructing a vertical lowering system.
- a) Using the main line, measure the length of the litter and add one arms length.
 - b) Starting on one side of the litter at the “D” space nearest the patient’s shoulder, tie an inverted split-locking clove hitch. A safety knot isn’t required. The running end should be pointing towards the ground when it is passed under the litter to the opposite side.
 - c) Pass the running end of the rope under the litter to the opposite side and secure it at the “D” space using an overhand split-locking clove hitch. No safety knot is required.
 - d) Be sure to pass the rope between the lining of the litter and the skid rails, if applicable to prevent abrasion to the rope.
 - e) Secure the standing part and running end of the lowering line using a bowline knot with safety knot.
 - f) The bowline knot should be centered and dressed down a forearm’s length approximately 18” away from the head of the litter and use a safety with an overhand knot. Using a figure-of-eight follow through knot is an acceptable alternative.
 - g) Attach the belay line around the pins at the head of litter using the method recommended for the main line. The length of this line should be approximately 3/4’s the length of the basket.
 - h) Measure the belay line so that the bowline knot is positioned inside the bowline knot of the main line approximately 1/4 to 1/2 the length of the litter.
 - i) Attach a tag line to the foot end of the litter using a self-adjusting bowline knot or figure-of-eight follow through knot.
4. Demonstrate rigging a rescue knot for a vertical lower.
- a) Tie the rescue knot onto the Rescue Randy.
 - b) Attach the belay line system.
 - c) Attach the tag line.
5. Demonstrate rigging a Rescue Randy with a class III harness for a vertical lower.

APPLICATION

Divide the class into small groups and assign each group the appropriate equipment to rig a vertical lowering system to a litter for a vertical lower.

PRESENTATION

ENABLING OBJECTIVE #5

The Technical Rescuer candidate, when given the appropriate equipment, shall correctly construct a belay system designed to arrest the fall of a load in the event of a failure of a primary lowering operation and demonstrate the safe activation of the belay system.

1. Define the term belay.
 - a) Belay is a derivative of the “belay pin” located on the rails of old sailing ships.
 - b) Sailors would attach a rope to a load then take several turns around the belay pin to prevent losing control of the load.
 - c) “Belaying” is a critical skill for low and high angle rescue environment and should not be taken lightly.

2. Define the role of the belayer.
 - a) They protect the person on the rope in case of a fall.
 - b) The belayer sets up the belay system using a separate lifeline attached to a load and separate anchor system.
 - c) They must not allow slack to gather in the rope.
 - d) They monitor the progress of the operation, and are always ready to engage the belay device instantly if any part of the main line system fails.

3. Identify the preparatory and operational commands for lowering a litter.
 - a) On Belay - Is lowering team ready?
 - b) Belay's On - Lowering team is ready.
 - c) Prepare to Lower - Bring litter to edge of elevated point.
 - d) Lower - Begin descent.
 - e) Down Slow - Slow descent.

- f) Down Fast - Increase speed of descent.
 - g) Stop - Something wrong with system, hold tension.
 - h) Off Belay - Have reached the ground.
 - i) All Clear - Litter has been disconnected from the lowering system.
4. Discuss the design, use, and safety considerations of a one-person belay system.
- a) It is designed for one-person loads.
 - b) It is used to back-up climbers and rappellers and to back-up lowering and raising systems.
 - c) This belay system is not designed to stop extreme dynamic loads.
 - d) It is used in any rescue situation where the potential for a fall exists such as when a person's physical or mental status is diminished and there is a potential for a fall, or during a rescue lower or raise in which the lifeline cannot be adequately protected.
5. Discuss the efficiency of the various one-person belay systems.
- a) Tandem double-wrap, tandem triple-wrap prussik system, brake bar racks, brake tubes, rescue 8s, belay plates for personal use, and a munter hitch work well as primary friction control and belay devices for descending operations that do not have the potential for shock a shock load.
 - b) Belay plates are used for descending and ascending belay operations for personnel on a rope only.
6. Demonstrate rigging a tandem double-wrap and tandem triple-wrap prussik belay system.
- a) Place one long and one short prussik sling on the rope.
 - b) The long 65" pre-tied prussik is attached going toward the load and is secured to the anchor carabiner first.
 - c) The shorter 53" pre-tied prussik is attached between the long prussik and the anchor then secured to the anchor carabiner.
 - d) The selection of diameter and number of wraps should be based on the load to be moved and ultimately is the choice of the AHJ.

7. Discuss the design, use, and safety considerations of a rescue belay system.
 - a) For rescue belay operations where there is a more than a one person load, or a chance of shock loading, a tandem triple wrap prussik system or a commercial belay device rated for more than a one-person load such as a 540 belay device is recommended.
 - b) Testing has shown under ideal conditions a tandem triple wrap prussik has arrested up to a 400 pound free-falling load a distance of one meter without failure of the system.
 - c) Prussik belay efficiency depends on several factors including the prussik material and the diameter of the prussik cord in relation to the diameter of the rope. Muddy rope or icy rope will decrease the efficiency of the prussik belay system.
 - d) All belay system components that have sustained a significant shock load should be evaluated for damage and proper function before returning it to service.
8. Demonstrate rigging a prussik-minded pulley to an anchor system when using the tandem prussik belay in a hauling mode.
9. Describe the function of the load release hitch.
 - a) A type of hitch constructed using webbing or accessory cord.
 - b) It has two purposes. It sustains major loads, and when tension is applied, it is used to release tension in the system into which it was incorporated.
 - c) The load release hitch has some shock absorbing capability.
 - d) It can be used in the switching over from a raising system to a lowering system and vice versa.
10. Demonstrate setting up a high angle raise using a main line, a litter hauling system with mechanical advantage, a belay system, and a load release hitch

APPLICATION

Set up a practice belay station to demonstrate the principals of a safe belay system.

Set up a break away load such as a suspended load that is tied off to a secure anchor, and rigged with a release system that can be tripped from the ground, using a Rescue Randy or a load equal to the weight of a Rescue Randy. Have each candidate set up and operate a belay line rated to arrest a general use two-person load. Secure the belay system to a separate holdfast anchor.

PRESENTATION

ENABLING OBJECTIVE #6

The Technical Rescuer candidate, when given the appropriate equipment, shall correctly demonstrate conducting a vertical lowering operation to include a visual safety check, a pre-lowering load test of all systems with verbal confirmation acknowledged by all rescue personnel, and the use of appropriate commands, and utilization of a belay system during the operation.

1. Demonstrate constructing a vertical lowering system for a high angle descent to include a primary lowering system, a back-up belay system and a load release hitch.
 - a) Use a stokes basket.
 - b) Use a rescue knot.

2. Discuss the criteria for conducting a safety inspection.
 - a) Check the litter for cracks and broken welds.
 - b) Inspect all lifelines for integrity prior to constructing the system.
 - c) Inspect all webbing slings, prussik slings for cuts, abrasions and ruptured core.
 - d) Are all knots correctly tied and have a safety?
 - e) Is the main line system correctly rigged?
 - f) Is the belay system correctly rigged?
 - g) Are all lifelines protected with edge protection devices?
 - h) Are all carabiners locked?
 - i) Define the whistle test. Once all components of the system have been constructed and placed

under a test load, the Rigging Supervisor will blow a whistle. All personnel tending the system shall let go. The system passes the whistle test when all components remain stable and do not move including all anchor points.

- j) Perform the whistle test.

Reference: IFSTA Fire Service Search and Rescue, 7th edition, Pages 111 through 113

APPLICATION

Set up a high angle lowering station and have the candidates practice making lowers using a stokes basket or other type of litter used by the AHJ that is rated for high angle rescue operations. Also practice lowers using a rescue knot. A Rescue Randy or equivalent is recommended for use as the victim. Assign a rigging Supervisor to inspect all of the components of the system and test load the system. Rotate as many candidates as possible to act as a Rigging Supervisor. 5 - 7 candidates are needed for this operation.

SUMMARY

This lesson covers a broad spectrum of techniques for responding to high angle lowers and low angle raises. It exposes the Technical Rescuer candidate to a variety of realistic scenarios and simple techniques to accomplish each one. This lesson plan by no means addresses all rescue situations encountered by the Technical Rescuer, so continued education and practice of skills is a must to insure rescuer safety and an accident free operation. Use the applications in this lesson plan to review all techniques.