OBJECTIVE PAGE

Confined Space Lesson One Anchors

DOMAIN: PSYCHOMOTOR

LEVEL OF LEARNING: COMPREHENSION

MATERIALS

IFSTA 7th edition Fire Service Search and Rescue manual; IFSTA 1st edition Technical Rescue For Structural Collapse; High Angle Rescue Techniques, 3rd edition, by Tom Vines and Steve Hudson available through Firehouse.com; Delmar Engineering Practical Rope Rescue Systems NFPA 1932, Standard for Testing and Maintaining Fire Service Ladders; International Manual of Basic Rescue Methods, 2004 edition, by Dawson Nethercutt. Laptop computer, multimedia projector, viewing screen, whiteboard or flipchart, and marking pens. A suitable number of various lengths of tied and pre-sewn 1" and 2" flat or tubular untied web slings, (suggest 3', 8' 15' and 20'); a suitable number of various lengths of 7/16" or 1/2" untied rope slings (suggest 7', 14', and 20' lengths); several bags of 100' of lifeline rope or utility rope with a safe working load of 300 pounds for use as guy lines for portable anchors; several 50' sections of rope for lashing portable anchors; 2 fire service grade straight ladders; 1 - 24' fire service grade extension ladder; five 4" x 4" x 12' timbers for creating portable anchors, several steel rods 5' x 1" diameter for use as pickets; several steel rods, several 2 1/2' long x 1/2" diameter for use as spinners, several 12 inch long x 1 1/4" - 1 1/2" inch diameter PVC pipe to be used as a protective barrier between the spinners and the lashing rope, several pieces of 20' x 7/16" or 1/2" diameter rope for lashing pickets, sledge hammer, and several fixed anchor points or manmade anchor points (pickets), suitable number of single sheaves pulleys, suitable number of locking carabiners. Several weighted objects for lifting props, 6 - 4" x 4" x 12' timbers, one dozen 2" x 4" x 6" blocks.

NFPA 1006, 2008 edition JPRs

7.1.2 Prepare for entry into a confined space
7.1.3 Enter a confined space
7.1.4 Package the victim for removal from a confined space
7.1.5 Remove all entrants from a confined space

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 shall correctly identify, describe, and demonstrate the setup, operation, and function of various multiple-point anchor and portable anchor / lifting platform systems used during rope rescue incidents.

ENABLING OBJECTIVES

1. The Technical Rescuer shall correctly identify and demonstrate the construction of the various types of anchors that may be suitable for rope rescue operations.

2. The Technical Rescuer, given the appropriate equipment, shall correctly construct a two point and a three-point load sharing anchor system.

3. The Technical Rescuer, given the appropriate equipment, shall correctly construct a two point and a three-point load distributing anchor system.

4. The Technical Rescuer shall correctly identify in writing and demonstrate the construction of various types of

lifting systems using timbers for the purpose of moving victims during rope rescue incidents.

5. The Technical Rescuer shall correctly identify in writing and demonstrate the construction of various types of lifting systems using ladders for the purpose of moving victims during rope rescue incidents.

Confined Space
Lesson One
Anchors

MOTIVATION

Low and high angle rescue operations occur in all types of environments including multi-story urban structures, elevated farm structures, cell towers transmission lines, highway embankments, wilderness environments, and below ground environment. The ability to select a suitable and safe anchor or anchors and construct a safe anchor system is the first critical step in constructing a fixed rope system. Understanding the load capabilities of an anchor and anchor systems is especially critical when supporting heavy rescue loads. Almost all of our high and low angle rescue operations will require one or more anchors and since our operation will essentially hang on those anchors, they must be safe and strong enough to do the job.

PRESENTATION

ENABLING OBJECTIVE #1

The Technical Rescuer shall correctly identify and demonstrate the construction of the various types of anchors that may be suitable for rope rescue operations.

1. Define and discuss how anchors and a high angle system interact with each other.
    a) Anchors are the means of securing ropes, hardware and or software to a solid object.
    b) Anchor points are the object to which anchors are secured.
    c) Anchor points can take many forms such as natural, portable, or commercial artificial anchors.
    d) An anchor in the high angle system is like a foundation in a structure.
    e) Most common natural anchors include trees and rocks. Both have potential for failure.

Reference: Delmar Engineering Practical Rope Rescue Systems page 108

2. Discuss assessment criteria for selecting natural anchors.
    a) Examine trees for weakness such as rot, exposed or shallow root system, or soft or saturated soil.
    b) Check boulders for stability and solidity.

3. Discuss assessment criteria for selecting structural anchors.
    a) Select anchors that are inherently part of the structure or specifically designed to support rescue loads.
    b) Inherent anchor points may include structural columns, structural beams or projections off structural beams, supports for large industrial machinery, stairwell supported beams, and anchors for window cleaning equipment. Examples of inherently weak structures may include corroded metal, weathered stonework, and deteriorated mortar. Examples of weak structural features may include sheet metal vents, flashing, gutters and downspouts, small chimneys, and fire hydrants.

4. Identify and discuss selecting less obvious anchor points.
    a) Elevator and machine housings are large and bulky, but usually suitable and safe anchors.
    b) Roof drain holes (scuppers) running through low concrete parapet walls. Slings can be run the through the drain holes and around the parapet wall, making sure all contact points are protected. Tiebacks, using timbers or pipes, can be secured through the scupper hole on parapet walls to create anchor points.
    c) Wall sections between windows and doors can have slings attached and padding provided much like parapet walls with drain holes.
    d) Use stairwell beams and make sure to use the open steel beams that the stair risers are attached to.

Reference: Delmar Engineering Practical Rope Rescue Systems pages 108 through 110

5. Point out that artificial anchors are special types of anchors specifically designed for creating anchor points in places where natural anchors are unavailable, used primarily in a wilderness setting.
    a) They are most commonly used for rock rescue operations. Nuts, chocks, hexcentrics, and cams are some of the various types of artificial anchors that may be used.
    b) Bolts are another type of artificial anchor; however they are time consuming to set therefore not the first choice of anchor for rescue operations.
    c) Setting all artificial anchors should be done by someone with a great deal of skill and practice in their use.

6. Discuss the criteria for placing anchors.
    a) Placing secure anchors is dependent on good judgment developed through extensive training experience.
    b) Anchors must be able to withstand the greatest anticipated force on the high angle system.
    c) An anchor's ability to withstand the forces put upon it depends on the condition of the anchor, the structural integrity of the anchor, and the location of the force on the anchor point.

7. Discuss how the direction pulled on an anchor can affect the force applied.
    a) Try to set anchors that align with the direction of pull.
    b) Be aware of the effects if the direction of pull changes.
    c) Some anchors are rigged so they are strong in one direction only. Change the direction and the anchor system may be compromised or may fail.

8. Discuss the criteria for creating a back-up anchor system and demonstrate creating a back-up anchor.
    a) This method is suggested for all questionable single anchor points.
    b) This method is called a back-tie.
    c) The concept is simple; select a strong anchor located behind the primary anchor.

9. Identify hazards that need to be assessed when selecting a suitable anchor point.
    a) Anchor points should be close to and directly above the victim.
    b) There may be the possibility of rocks or other objects falling on the rescuers or victim.
    c) There may be conditions that exist between the anchor point and the victim that may be hazardous to the victim and rescuers.
    d) Be mindful of any direct flame impingement on the rope during fire rescues.
    e) There may not be suitable anchor points directly above the load.

10. Identify and discuss the concept of directional anchors.
    a) Directional anchors are used to bring a rope into a more favorable position and or angle.
    b) The concept involves establishing a second anchor that is below and to one side of the original anchor point and in close proximity to the main line.
    c) A section of lifeline, which can be adjusted in length, is secured between the secondary anchor point and the mainline.
    d) Adjusting the length on the secondary lifeline, pulls the mainline into a better position in relationship to the victim.
    e) Make sure the same amount of attention used to select a primary anchor point is used to select the anchor point for the directional line.

11. Identify situations when back-up anchors may have to be employed.
    a) Backing up a primary anchor creates redundant anchors for the purpose of safety.
    b) They are used when there is an uncertainty of the strength of the primary anchor.
    c) The specific type of back-up anchor is based on the condition of the anchor points, the nature of the high angle experience, and the loads.

Reference: IFSTA Fire Service Search and Rescue 7th edition, pages 132 and 133.
Reference: High Angle Rescue Techniques, 3rd edition, pages 80 through 84.

12. Demonstrate various ways rope can be used for creating anchors and discuss the pros and cons of each.
    a) Tensionless hitch.
    b) Figure-eight-follow-through.
    c) Bowline.

13. Discuss the pros and cons of using webbing for anchors and demonstrate various ways webbing can be used for creating anchors.
    a) They are less expensive than rope and allows for fewer knots to be learned.
    b) As a disadvantage, they cannot be tied using as many knots as rope.
    c) They do not absorb shock loading as well as most lifelines.

14. Point out that the knot of choice for constructing a web sling is a ring bend, or water knot.

15. Discuss the proper application of using webbing for slings.
    a) Dispel the myth that larger is better. Unfortunately, the old adage that bigger better was adopted and many rescuers started using the larger webbing for anchor sling. In reality the larger webbing inserted through a standard size locking carabiner and then loaded can reduce the load strength of the carabiner up to 50% of its rated capacity.
    b) 1 3/4" and 2" diameter webbing came into the picture as a result of NFPA 1983 requiring it whenever webbing comes into contact with a human being.
    c) Based on testing documentation it would seem that 1" webbing is better suited as anchor slings for standard size locking carabiners. On inch tubular webbing tensile strength is between 4000 - 4500 pounds.
    d) One inch of flat webbing, although a little frustrating when dressing down knots, is rated at 6000 pounds which is the same rating for most 2" webbing.

15. Discuss the advantages for using pre-sewn web slings.
    a) They are quicker to use.

b) There is less chance of tying a wrong knot.
c) Many pre-sewn slings are sewn with loops for quick attachment to hardware.

16. Discuss verifying the tensile strength of the slings, and that they are rated to support life loads and can meet the safety factor that the rescue team has adopted for rope rescue system.

17. Point out that as a general rule, do not leave knots tied in webbing after using them, unless each sling is carefully inspected before returning it to the equipment box and inspected prior to its next use.

18. Discuss the characteristics of anchor straps.
    a) Anchor straps are webbing lengths with metal “D” rings sewn into each end to accommodate an appropriate size carabiner.
    b) The heavy-duty strap with the NFPA “G” for general use designation has an end to end breaking strength of 8,000 pounds.
    c) The light duty strap with the NFPA “L” for light use designation has an end-to-end breaking strength of 4,900 pounds.
    d) Some anchor straps have adjusting buckles.
    e) Under heavy loads these buckles can slip when subjected to forces less than the straps overall breaking strength.

19. Demonstrate various ways webbing, pre-sewn loops, and anchor straps can be attached to anchor points.
    a) Open web sling: wrap webbing around anchor and secure with a water knot (ring bend).
    b) Wrapped web sling: construct a web sling and wrap it around the anchor and places a carabiner in the two ends.
    c) Wrap 3 pull 2 web sling: make three loose wraps around the anchor and secure with a water knot (ring bend), then pull two of the wraps causing the third wrap to lie snug against the anchor. Connect a carabiner across the two loose wraps. Leave enough slack so that the angle formed by the single sling is no greater than 90 degrees.

20. Discuss techniques for keeping anchors in position.

a) On vertical anchors, slings should be secured as low as possible.
b) With a strong anchor available, there may be situations when it is necessary to elevate the anchor, creating a better angle for a rappeller to clear the edge. Rope abrasion can be reduced, and may improve conditions for lowering a litter over the edge. It may reduce friction in a hauling system.
c) The potential hazard for securing the sling high on a vertical anchor is if the strength of the vertical anchor is questionable causing failure when loaded.

PRESENTATION

ENABLING OBJECTIVE #2

The Technical Rescuer, given the appropriate equipment, shall correctly construct a two point and a three-point load sharing anchor system.

1. Discuss the advantages and disadvantages of a two-point and three point load sharing anchor system.
   a) They are useful when the integrity of a single anchor is questionable, or the location of the single anchor point in relationship to the load is in an inconvenient place for attaching to the load.
   b) If the load shifts laterally, the disadvantage is that both anchors no longer support the weight of the load equally.

2. Demonstrate rigging a two-point and three-point load sharing anchor systems.
   a) Select two or three separate stable points.
   b) Secure a sling to each anchor point.
   c) Each sling should be long enough to come equally together at a certain distance away from the anchors.
   d) Secure the slings together with a large carabiner.
   e) Make sure the carabiner is in line with the load.

Reference: IFSTA 7th edition Fire Service Search and Rescue, pages 134 and 135.
Reference: High Angle Rescue Techniques, 3rd edition, pages 90 through 91.

PRESENTATION

ENABLING OBJECTIVE # 3

The Technical Rescuer, given the appropriate equipment, shall correctly describe and demonstrate constructing a two-point and three point load-distributing anchor.

1. Discuss the advantages and disadvantages of a load distributing anchor system.
   a) It is used when a single point anchor is not strong enough to support the load and a potential exists for the direction of the pull or load to change.
   b) A disadvantage of this system is if the selected anchors are not individually strong enough to sustain a shock load, then an anchor could fail imposing dynamic energy on the other anchor thus causing the remaining anchor to fail.

2. Discuss how angles created by multi-point anchor systems can have a negative impact on the anchors as a result of the implied force created on the anchors when the system is loaded.
   a) Any angle created in a load sharing or load distributing system increases the load on the anchors and other elements of the system.
   b) Only when the angle between each leg is at 0, each leg of the system will support one half of the load.
   c) At 45 degrees each is leg will be supporting 54 pounds of force base on a 100 pound load.
   d) At 90 degrees each is leg will be supporting 71 pounds of force base on a 100 pound load.
   e) At 120 degrees each is leg will be supporting 100 pounds of force base on a 100 pound load.
   f) At 145 degrees each is leg will be supporting 166 pounds of force base on a 100 pound load.

Reference: IFSTA Fire Service Search and Rescue, 7th edition, page 136.
Reference: High Angle Rescue Techniques, 3rd edition, pages 91 through 92.

3. Demonstrate rigging a simple two-point load distributing anchor system.

a) Configure a loop of webbing or rope into the shape of an 8.
b) Clip a carabiner across the inside loop.
c) Clip each end of the outside loop to an anchor point.
d) Clip the inside loop carabiner to the mainline.
e) Keep the angle small.
f) Test all components of the system by manual means before loading.
g) To construct three-point load sharing system, add one more anchor and sling to the system.

4. Demonstrate rigging a three-point load distributing anchor system using a two-loop figure eight.

Reference: IFSTA Fire Service Search and Rescue, 7th edition, pages 136 through 137.
Reference: High Angle Rescue Techniques, 3rd edition, pages 93 through 94.

5. Discuss and demonstrate techniques for anchoring to a vehicle.
   a) Potential anchors on a vehicle may include axles, and cross members, and secure towing points on a vehicle.
   b) Remove keys from the ignition, set the emergency brake, and choke the wheels.
   c) Make sure the anchor sling is protected from abrasion and any fluids such as battery acid, and anti-freeze that may be harmful to the integrity of the sling material.

6. Demonstrate rigging a three-point load distributing anchor system using a large loop webbing sling.
   a) Using a 15' - 20' piece of 1" webbing, form a loop using a water knot or figure-eight-bend.
   b) Select three suitable anchor points that are in line with each other and attach a short web sling with a locking carabiner to each.
   c) Clip the back side of the large sling into each anchor point.
   d) Clip a carabiner in between each anchor point and bring them to the front side of the large sling.
   e) Before clipping the carabiners into the front of the loop make a twist in the webbing using the

carabiners then clip them to the front side of the large loop.

7. Discuss attachment procedures for carabiners.
   a) When attaching locking carabiners to any system, make sure the locking nut is facing towards the load. This reduces the chance of the gate accidentally opening as a result of vibration.

8. Discuss and demonstrate extending anchors.
   a) Extending an anchor is used to decrease the angle between the anchors and the load point to an acceptable degree.
   b) Use static lifeline rope or webbing rated for the load.
   c) Protect all contact points.

9. Discuss and demonstrate the application of anchor plates or rigging plates.
   a) They are designed to help organize anchor rigging and reduce the possibility of the system being jammed.
   b) They make the rigging system easier to see thus reducing the risk of errors in construction.
   c) They are used most often when multiple lines come to a common point.
   d) Use anchor plates that have an NFPA rating of "G" general use.
   e) Rigging plates can also be used as an attachment point for litter bridles.

PRESENTATION

ENABLING OBJECTIVE #4

The Technical Rescuer shall correctly identify in writing and demonstrate the construction of various types of lifting systems using timbers for the purpose of moving victims during rope rescue incidents.

1. Define portable anchors.
   a) They are prefabricated anchor systems that can be moved from place to place. They usually serve as directional anchors in places where no anchors are available. They provide hauling direction in such places as confined spaces and

over manholes, or lifting a line above the edge of a mountainside.

Reference: High Angle Rescue techniques, 3rd edition, page 89.

2. Identify and discuss the use of portable anchors.
   a) Portable anchors are designed so they can be set up in different locations and environments.
   b) Commercial Tripods are available.
   c) Beam clamps.
   d) Man-made portable anchors may include picket systems, timber a-frames, timber and metal tripods ladder a-frames, and derricks, timber and ladder jibs, and gin poles.

3. Discuss the use of various types of picket systems.
   a) A picket system is an alternative anchor used in a natural setting such a soil when no other anchors are available.
   b) Soft soils do not accommodate a picket system well.

4. Demonstrate the steps required in setting up a picket-holdfast system.
   a) Point out that pickets should be driven into the ground approximately two-thirds their length at an angle of 15 degrees away from the object to be moved.
   b) When using a combination of pickets, they should be driven into the ground at a distance apart approximately equal to their length. Pickets should never be less than three feet apart.
   c) When using a combination of pickets, they should be lashed together with a 1/2" x 25' - 50’ rope.
   d) Start the lashing with a clove hitch in the center of the rope near the top of the first picket. Make as many turns as possible around the first and second picket, going from the top of the front picket (primary anchor) to the bottom of the back-up picket (secondary anchor).
   e) Secure the lashing with two half hitches on the lashing between the two pickets.
   f) Take a short steel rod for use as a spinner rod (minimum 2' by 3/8" diameter), and put it through the turns of the lashing rope, twisting until the

lashing is tight, and then drive the short picket into the ground.

g) Use a short piece of PVC pipe (minimum 1 1/4" diameter) as a buffer between the spinner and the rope.

5. Identify sample picket configurations and their load capacities when constructed in average soil.
   a) Single Picket System- 700 pounds.
   b) 1:1 Combination- 1400 pounds.
   c) 1:1:1 Combination- 2000 pounds.

Reference: IFSTA 1st edition Technical Rescue For Structural Collapse, pages 177 through 179.
Reference: High Angle Rescue techniques, 3rd edition, pages 88 through 89.

6. Describe the application, operation, basic safety components, and limiting factors of a A-frame, utilizing timbers

7. Discuss how A-frames are used as a portable anchor.
   a) Are used to lift relatively heavy loads where the use of gin poles is impractical.
   b) Can only be used to move a weight in a straight line between the timbers.
   c) Consist of two timbers with their butts on the ground and the tops lashed together with round lashing.
   d) Minimum dimension lumber required for the A-frame is a 4" x 4” x 12’ timber.

8. Demonstrate the steps required in round lashing an A-frame.
   a) Select two 4" x 4” x 12’ timbers, even the butts, and put 2" x 2” x 24” spacers between the timbers near the top and bottom, tie the timbers together near the base with a draw-hitch.
   b) Start with a clove hitch approximately 24” to 36” down from the tip of the shortest timber and marry the ends. Be sure to chamfer, or notch the area where the lashing is to be secured.
   c) Continue with six close round turns around both timbers traveling upward.
   d) Make two frapping turns between the two timbers, draw tight, and finish with a clove hitch

on the opposite timber from where you started at the bottom of the lashing.

e) The round turns should be counted on the outside timber, then return to the nearest timber where the first clove hitch was tied before starting the frapping turns on an A-frame.

f) To reduce the risk of the lashing from slipping when loaded, 2 wedges can be driven under the lashing from the bottom of each side, or 2" x 4" blocks can be nailed at the bottom of the lashing on each side.

g) Cross the timbers and spread them 1/3 the distance between the bottom of the lashing and the butt ends.

9. Point out that a 2” x 6’ tubular nylon sling is passed over the crotch at the top so that it will rest across the timbers and not on the lashing. This is the anchor sling for the tackle system.

10. Discuss an alternate method of opening a 2” x 6’ tubular nylon sling and passing it over both timbers at the top. Take a loop of the sling down through the timbers above the lashing, and pull a loop up through the timbers above the lashing. Take these two loops down and around the timbers below the lashing so that they pull the timbers together.

    a) A mechanical advantage system is then secured at this sling to create a mechanical advantage.

11. Demonstrate the steps required in constructing an “A” frame utilizing 4” x 4” x 12’ timbers.

    a) After lashing the two timbers together with round lashing, spread the butts of the timbers until their distance apart is approximately one-third of the distance from the butt to the lashing.

    b) To prevent the timbers from spreading further, a board ledger can be used to lash the legs using square lashing.

    c) An alternate method to prevent the timbers from spreading further, is to use a 1/2" x 20’ kernmantle rope ledger. Start with a clove hitch and safety knot on the first timber. Go to the second timber and tie a round turn and two half hitches.

d) A 2” x 6’ tubular nylon sling is passed over the crotch so that it will rest across the timbers and not on the lashing.
e) Discuss an alternate method of opening a 2” x 6’ tubular nylon sling and pass it over both timbers at the top. Take a loop of the sling down through the timbers above the lashing, and pull a loop up through the timbers above the lashing. Take these two loops down and around the timbers below the lashing so that they pull the timbers together.
f) A mechanical advantage system is then secured at this sling to create a mechanical advantage.
g) A change of direction sling is lashed near the ground of one pole. Attach the change of direction pulley with the fall line being hauled in the direction of the opposite timber.

12. Discuss how “A” frames are held upright by a fore and aft guy line, forming an inverted “V.”

13. Demonstrate the steps required in setting up a fore and aft guy line.
    a) A-frames are held upright by a two guy lines, fore and aft, forming an inverted “V.”
    b) Tie a clove hitch in the center of the rope and place it over the top of one timber, as close to the lashing as possible. The rope should be long enough to provide a length of 1 1/2 to 2 times the height of the timbers for the guy lines and made of 1/2" kernmantle rope. The clove hitch should pull from the inside of the timber.
    c) Form another clove hitch and place it on the other timber in the same manner. The guy lines must be put on so that they draw the timbers together when the load is applied. Example: The forward guy line is fastened to the rear timber while the aft guy line is fastened to the front timber.
    d) The fore and aft guy lines are secured to a solid anchor or picket anchoring system with a round turn and two half hitches or other form of brake control after the desired luff has been obtained.
    e) The anchor points for the guy lines should be one and one-half to two times the length of the A-frame, never less than the length. The anchor

points or is placed in line with the object to be lifted.

14. Point out that the initial luff should not be over one-fifth the distance between the butt ends and the top lashing on the A-frame, while the maximum luff should not be over one-third the distance between the butt ends and the top lashing of the A-frame.

15. Demonstrate the steps required for setting up a change of direction pulley at the base of the A-frame.
    a) Point out that the fall line should be pulled in the same direction as the initial luff. This will cause the base of the timbers to “dig in” rather than slip.

Reference: International Manual Of Basic Rescue Methods, 2004 edition, page 74.

16. Describe the application, operation, basic safety components, and limiting factors of a tripod, utilizing timbers.

17. Discuss the use of a tripod system.
    a) A tripod is used to lift loads heavier than those that can be handled by a gin pole or A-frame.
    b) Tripods have three legs and do not require the use of guy lines.
    c) Tripods are designed to lift loads vertically.
    d) The minimum dimensions for the timber are 4" x 4” x 12’ long.

18. Demonstrate constructing a timber Tripod.
    a) Select three 4" x 4” x 12’ timbers and align the butt ends. Place 2" x 4" x 24” spacers between the timbers near the top and bottom of the timbers.
    b) Tie the timbers together near the base with a draw-hitch.
    c) Start with a clove hitch approximately 24” to 36” down from the tip of the shortest timber and marry the ends, be sure to chamfer, (notch the area) where the lashing is to be secured.
    d) Next take the rope over and under the three timbers in a figure-of-eight fashion. Make at least six turns, working upward.

e) Then make two frapping turns between the first and second timber, and two frapping turns between the second and third timber.
f) Finish off with a clove hitch on the outside timber below the lashing. The remainder of the rope can be coiled around the outside timber.
g) After the figure-of-eight lashing is complete, raise the center timber and cross the outer timbers until their butts are at a distance apart equal to approximately one-half the distance between the butt end and the top lashing on the timbers (from lashing to the base of the timbers).
h) The timbers are set to form an equilateral triangle.

19. Demonstrate the method for attaching the primary sling to the crotch of the tripod and the secondary change of direction pulley at the base of one leg of the tripod.
a) Using a 6' long webbing sling rated for 6000 pounds (carabiner should be large enough to accommodate the width of the web sling).
b) Open the nylon sling and pass it over the outside timbers at the top.
c) Take a bight of the sling down through one side of the center timber above the lashing and pull a bight up through the other side of the center timber above the lashing.
d) Take these two bights down and around the timbers below the lashing so that they pull the timbers together.
e) Secure a selected hauling system to the sling.
f) Secure an appropriate anchor sling system to the bottom of one leg of the tripod so it does not slip up when loaded; creating a secondary change of direction point. A wedge or 2" x 4" block can be attached above the sling to prevent slippage.
g) The direction of pull through the secondary change of direction pulley shall be towards the opposite leg of the tripod.
h) A mechanical advantage system is then secured at this sling to create a mechanical advantage.

18. Demonstrate securing the base of the tripod.
a) Secure the butt ends (to prevent kick-out) using a rope ledger by tying a clove hitch with safety knot or other suitable hitch near the bottom of one

timber and round turns to the remaining two timbers then tie off back at the original timber or secure the butt ends by lashing them to pickets.

b) The base of the tripod may be set in shallow holes for added stability, it may also be necessary to set the base of the tripod on bearing plates.

Reference: International Manual of Basic Rescue Methods, 2004 edition, page 84.

19. Demonstrate setting up a commercial tripod, and the application of a beam clamp.

Reference: IFSTA Fire Service Search and Rescue, 7th edition, pages 132 and 133.
Reference: High Angle Rescue Techniques, 3rd edition, pages 88 to 89.

20. Describe the application, operation, basic safety components, and limiting factors of a gin pole, utilizing timbers.

21. Discuss the use of a gin pole system.
    a) A gin pole allows the object being lifted to be moved to the left or right, in addition to the front and rear.
    b) Gin poles consists of one timber or two timbers lashed together for strength with the top supported by the use of four guy lines.
    c) Square lashing is used to hold two timbers together that cross at right angles.

22. Demonstrate the steps required in square lashing a gin pole.
    a) Select one 4" x 4” x 12’ timber, or a 6” x 6” x 12’ timber.
    b) Lay a 2" x 4” x 24” board or ledger at a right angle to the timber approximately 18” from the top.
    c) Using a 1/2" x 50’ kernmantle rope, start with a clove hitch around the timber below the ledger and marry the running end to the standing part. Then take the married ends up and around both the timber and ledger.

d) Repeat this circuit four times inside on the timber and outside on the ledger; drawing the rope as tight as possible.
e) Take four frapping turns around the whole lashing between the timber and the ledger. Draw tight and finish with a clove hitch on the ledger.

23. Demonstrate the steps required in constructing a gin pole utilizing a 4" x 4" x 12' timber.
    a) After the square lashing is complete, a change of direction sling is lashed so the upper block will be suspended over the ledger.
    b) Place the base of the gin pole where it is to be erected.
    c) Place the guy lines on the gin pole using 1/2" kernmantle rope. The rope should be long enough to provide a length of 1 1/2 to 2 times the height of the timbers for the guy lines.
    d) The distance of the guy line between the top of the gin pole and the bottom of the ledger should be 1 1/2 to 2 times the distance between the butt end and the bottom of the ledger.
    e) For the base of the gin pole, dig a hole 6" to 12" deep, depending on the soil, and the weight to be lifted. If the ground is soft, use boards to make a bearing plate for the gin pole.
    f) A picket holdfast may be used to keep the base of the gin pole from slipping.
    g) Set up the picket holdfast approximately three feet from the base of the gin pole, and tie a rope from the base of the gin pole to the picket.
    h) This holdfast will keep the gin pole from skidding while being raised, and it will hold it in place while lifting; or loosely lash a picket to the base of the pole and create a snatch block sling for the change of direction pulley.

24. Discuss how the initial luff should not be over one-fifth the height of the gin pole while the maximum luff should not be over one-third the height of the gin pole.
    a) The side guy lines and the fore and aft guy lines are secured to a holdfast or picket anchoring system with a round turn and two half hitches after the desired luff has been obtained.

25. Point out that a change of direction sling is lashed near the ground of the gin pole.
    a) Secure an appropriate anchor sling system to the bottom of the gin pole so it does not slip up when loaded, creating a secondary change of direction point, a wedge or 2" x 4" block can be attached above the sling to prevent slippage.
    b) Attach the change of direction pulley with the fall line being hauled in the same direction as the initial luff, this will cause the base of the gin pole to dig in, rather than slip.

Reference: International Manual Of Basic Rescue Methods, 2004 edition, page 78.

PRESENTATION

ENABLING OBJECTIVE #5

The Technical Rescuer shall correctly identify in writing and demonstrate the construction of various types of lifting systems using ladders for the purpose of moving victims during rope rescue incidents.

1. Discuss the load limits for fire service ladders.
    a) According to NFPA 1932, Standard for Testing and Maintaining Fire Service Ladders, the working load of a straight wall ladder positioned in an acceptable climbing angle is 750 pounds.
    b) According to NFPA 1932, Standard for Testing and Maintaining Fire Service Ladders, the working load of an extension ladder positioned in an acceptable climbing angle is 750 pounds.
    c) According to NFPA 1931, Standard for Manufacturer's Design of Fire Department Ground Ladders, all structural components of ground ladders shall be constructed of materials such that the ground ladder maintains at least 75% of the strength necessary to pass all test requirements in this standard at 300°F.

2. Describe the application, operation, basic safety components, and limiting factors of a ladder A-frame.

3. Discuss and demonstrate the use of a ladder A-frame.

a) Position the two ladders on the ground on their beams with the heels of the ladder even.
b) Align the top rungs of the ladder.
c) With the top rungs and beams together, keep the butts of the ladder apart equal to approximately one-half the distance from the heel of the ladder to the sling used to support the pulley system.
d) Lash the top rungs or beams together using round lashing. Clove hitch - round turns - clove hitch.
e) The two side guy lines are put on with a split clove hitch around the first rung and beam of the ladder with a loop being placed on the opposite beam and the side guy line being secured to a holdfast on that side of the ladder A-frame pulling the beams of the ladder together rather than apart.
f) The side guy lines should be one and one-half times the distance from the sling at the top of the ladder to the butts of the ladders.
g) The holdfast or picket anchoring system should be placed in line with the object being lifted.
h) A rope sling or tubular nylon sling is passed around the beams of one ladder and over the top rung of the connecting ladder so that it rests over the top rungs of the two ladders.
i) A mechanical advantage system is then secured at this sling to create a mechanical.
j) The ladders are now ready to be raised over the point of the operation.
k) To prevent the ladders from spreading further at the base, a rope ledger is attached at the bottom rungs of the two ladders.
l) Tie a split clove hitch around the beam and bottom rung of one ladder and secure this rope to the beam and bottom rung of the second ladder with a round turn and two half hitches.
m) Tie a second rope ledger on the opposite side of the two ladders using the same step described above.

Reference: IFSTA 1st edition Technical Rescue For Structural Collapse, pages 193 through 196.

4. Describe the application, operation, basic safety components, and limiting factors of a ladder-as-a-derrick.

5. Discuss the use of a ladder-as-a-derrick.
   a) The ladder-as-a-derrick can be used to lift weights, or used for lowering or raising patients being rescued. It is a very effective method of rescue when the patient needs to be lowered or raised in a horizontal position. Demonstrate the steps for setting up a freestanding ladder-as-a-derrick.
   b) The aft guy line and side guy lines should be one and one-half to two times the length the ladder is extended, never less than the length. The holdfast or picket anchoring system should be placed forward of the base of the ladder in line with the object being lifted.
   c) A thirty-five foot three-section ladder may be used in place of the more commonly used twenty-four foot extension ladder to create a ladder-as-a-derrick.
   d) If a three-section ladder is used for this procedure, then both fly sections should be secured to one another using round lashing around the rungs or beams, as well as the bed being secured to the first fly section at one or more points.

6. Demonstrate attaching the side guys using two ropes.
   a) Secure a split locking clove hitch on each beam at the top rung of the ladder, then cross over to the opposite beam and secure a loop over them.

7. Demonstrate attaching the side guys using one rope.
   a) Form a bight in the middle of the rope and slip it under the first rung and back over the beams.
   b) At each beam form a half hitch and slip it over the top of each beam thus forming a split clove hitch.
   c) Take each leg of the rope to the opposite beam, form a loop and slip them over each beam.

8. Demonstrate constructing the aft guy.
   a) Using approximate seven to eight foot of rope, secure a split-locking clove to one beam at the second rung of the ladder.
   b) Pass the remaining portion of the running end across to the opposite beam and repeat the process.

c) Take the standing part of the rope and the remaining running to a point equal to an arm's length above the second rung and tie a self-adjusting bowline with a safety knot.

9. Demonstrate attaching the anchor sling for the upper pulley.
   a) A rope sling or tubular nylon sling rated for the load, place the sling across the beams just below the third rung.
   b) Bring each leg of the sling around each respective beam and over the top of the third rung and center up each leg and secure the upper pulley to the sling with a locking carabiner.

10. Point out safety precautions that should be adhered to when using ground ladders for a ladder-as-a-derrick.
   a) The manufacturer's specifications and guidelines should be referred to regarding the maximum load that can safely be placed on the system.
   b) It should be remembered that all loads should remain within the beams of the ladder and that this system will not accept side loading.
   c) It should also be pointed out that the higher the load is raised, the more the load is increased on the system.
   d) Use of the change of direction pulley at the base of the ladder will allow the haul line to be pulled in such a manner that forces the base of the ladder into the ground.

Reference International Manual Of Basic Rescue Methods, 2004 edition, page 87.

11. Demonstrate setting up the ladder-as-a-derrick on the tailboard of a vehicle such as a fire truck or heavy crash truck.
   a) The main difference in setting up a ladder-as-a-derrick on the tailboard of a vehicle as opposed to setting one up which is free-standing is the distance that the guy lines are secured in relation to the length the ladder is extended.
   b) The guideline of having the length of the aft and side guy lines a minimum of the length the ladder is extended may not be adhered to based upon the length and width of the vehicle being used.

c) When using a fire truck, the side guy lines are secured to the booster line reel or other appropriate anchor. If the aft guy line will not crush the light bar located on the cab of the vehicle, then it may be secured to the front bumper or other suitable anchor on the chassis of the vehicle.
d) If the aft guy line will not crush the light bar located on the cab of the vehicle, then it may be secured to the front bumper or other suitable anchor on the chassis of the vehicle.
e) The manner in which the base of the ladder is secured is based upon what is available at the tailboard of the particular vehicle being used.

Reference International Manual Of Basic Rescue Methods, 1992 edition, pages 95 through 98.

12. Describe the application, operation, basic safety components, and limiting factors of a ladder slide.

13. Discuss the use of a ladder slide.
    a) Describe how this method of rescue can be employed when manpower might be limited, or when there are several patients. Point out that the patient cannot be lowered or raised in a horizontal position using this technique.

14. Demonstrate the steps required in executing a ladder slide with a stokes basket, and point out the difference between using a stokes basket as opposed to an army litter.
    a) The rungs should be secured using cloves hitches and round turns at the point where the butt end of the fly section meets the bed section.
    b) Position the ladder so that the tips rest slightly above the windowsill, roof edge, or parapet wall. Point out that this is a different tip position than the ladder raise mentioned above,
    c) At the upper level a minimum of three rescuers shall rig the victim into the stokes basket in the same manner as preparing for a vertical lower.
    d) Point out that for this evolution the internal lashing is not necessary.
    e) Secure main line and belay line to the stokes basket using the vertical lowering method.

f) Secure both lines to separate anchors and appropriate lowering devices.
g) While one rescuer heels the butt end of the ladder, another rescuer shall climb the ladder to a position eye level to the window sill, roof edge or top of parapet wall and lock-off on the ladder until the basket is setting on the edge of the window sill, roof edge or parapet wall.
h) Two rescuers will be needed to pass the victim out to the rescuers on the ladder while a third rescuer controls the main line lowering system.
i) Once the rescuer on the ladder has secured control of the basket, one of the upper level rescuers will control the belay line while the other rescuer will act as a spotter and safety officer and will be responsible for giving the appropriate lowering commands until the victim and rescuer safely reach the ground. These are the same commands used for a vertical lowering operation.
j) Emphasize that appropriate friction devices, or other suitable means should be used when lowering the patient to keep the weight of the patient off the person on the ladder.
k) Point out that caution should be exercised that the litter does not get hung up on the ladder as it descends.

15. Emphasize that when using fire service ladders for operations other than climbing and working off of them, NFPA 1932 recommends that the ladder be visually inspected and as a minimum a center load test should be performed before placing the ladder back in service.

Reference: International Manual Of Basic Rescue Methods, 1992 edition, pages 95 through 96.

APPLICATION

Set up stations for each of the anchor systems described by the enabling objectives 1 - 4, including all of the portable and fixed anchor systems. Divide the class into small groups and have each group construct each anchor system. Where possible have a weight of 50lbs - 100lbs. that can be raised on the anchor systems constructed. This could easily be accomplished using pulleys and prussiks, or Gibbs

ascenders as rope grab devices with an attached weight at each station.

The instructor should make sure all safety precautions are adhered to including the use of appropriate PPE.

SUMMARY

This lesson plan addresses anchors and anchoring systems commonly used in high and low angle rescue operations. The construction of each of these systems should be reviewed as well as these critical points: identification of suitable anchor points, determining the construction of anchor materials, and understanding the stress loads applied to anchor systems. The Technical Rescuer will be called upon to incorporate many or perhaps all of these anchoring systems into the various rescue operations they will encounter. They must become proficient in each one. After all, the entire rescue operation may well hang on the ability of the Technical Rescuer to select and rig a safe anchor system.