

# **LESSON THREE**

## **RT: Confined Space – Anchor Systems**

**DOMAIN:** PSYCHOMOTOR

**LEVEL OF LEARNING:** COMPREHENSION /  
APPLICATION

### **MATERIALS**

IFSTA 6th edition Fire Service Rescue manual; IFSTA 1st edition Technical Rescue For Structural Collapse; ON ROPE Level 1 Rope Technician; High Angle Rescue Techniques, 3rd edition, by Tom Vines and Steve Hudson available through Firehouse.com; 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 inch flat or tubular untied web slings, (suggest 3', 8' 15' and 20'); a suitable number of various lengths of 7/16 inch or 1/2 inch 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 foot sections of rope for lashing portable anchors; 2 12-14' fire service grade straight ladders; 1 - 24 foot 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 feet long x 1/2 inch diameter for use as spinners, several 12 inch long x 1 1/4 inch - 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 foot x 7/16 inch or 1/2 inch 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, 2003 edition JPR**

- 9.1.5 Prepare for entry into a confined space
- 9.1.6 Enter a confined space
- 9.1.7 Package the victim for removal from a confined space
- 9.1.8 Remove all entrants from a confined space

**TERMINAL OBJECTIVE**

The Rescue Technician shall correctly identify, describe, and demonstrate the setup, operation, and function of various multiple-point anchors and portable anchor / lifting platform systems used during confined space rescue incidents.

**ENABLING OBJECTIVES**

1. The Rescue Technician shall correctly identify and demonstrate the construction of the various types of anchors that may be suitable for confined space rescue incidents.
2. The Rescue Technician when given the appropriate equipment shall correctly construct a two point and a three-point load sharing anchor system.
3. The Rescue Technician when given the appropriate equipment shall correctly construct a two point and a three-point load distributing anchor system.
4. The Rescue Technician shall correctly identify in writing, and demonstrate the construction of various types of anchoring systems using timbers for the purpose of gaining access into a confined space.
5. The Rescue Technician shall correctly identify in writing, and demonstrate the construction of various types of portable anchors, using ladders, for the purpose of gaining access into a confined space.

# LESSON THREE

## RT: Confined Space – Anchor Systems

### 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 confined space rescue operations. 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 confined space rescue lifting operations require one or more anchors and since the successful operation will essentially hang on those anchors, they must be safe and strong enough to do the job.

### PRESENTATION

#### ENABLING OBJECTIVE #1

The Rescue Technician shall correctly identify and demonstrate the construction of the various types of anchors that may be suitable for confined space rescue incidents.

1. Define and discuss how anchors, anchor systems, and lifting systems interact with each other in a confined space rescue operation.
  - 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 anchor system or lifting system is like a foundation in a structure.

2. Discuss assessment criteria for selecting natural anchors.
  - a) Most common natural anchors include trees and rocks. Both have potential for failure.
  - b) Examine trees for weakness such as rot, exposed or shallow root system, or soft or saturated soil.
  - c) Check boulders for stability and solidness.
  
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 structure features include corroded metal, weathered stonework, deteriorated mortar, sheet metal vents, flashing, gutters and downspouts, small chimneys.
  
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 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.
  
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.
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 6th edition Fire Service Rescue, pages 108 through 109.

Reference: 3rd edition High Angle Rescue Techniques, 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-8-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.
  - b) 1 3/4" and 2" diameter webbing came into the picture as a result of NFPA 1983 requiring it when ever webbing comes into contact with a human being for the purpose of being constructed to form a harness around the person.
  - c) Unfortunately, the old adage that bigger is better was adopted, and many rescuers started using the larger webbing for anchor sling.
  - d) 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.
  - e) Based on testing documentation it would seem that 1" webbing is better suited as anchor slings for standard size locking carabiners. One inch tubular webbing tensile strength goes between 4000 - 4500 pounds.
  - f) One inch flat webbing, although a little frustrating when dressing down knots, is rated at 6000 pounds, the same rating as 2" webbing.

Reference: Level 1 Rope Technician, page 35.

**NOTE: The above information was also proven during extensive testing and documentation done by Arnor Larson and Kirk Mauthner of Rigging for Rescue, Inc. based in British Columbia. Both gentlemen are well respected by the rope rescue community for their research analysis and rope rescue skills.**

16. 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.
  
17. Discuss verifying the tensile strength of the slings, and point out that they are rated to support life loads and can meet the safety factor that the rescue team has adopted for rope rescue system.
  
18. 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.
  
19. 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.
  
20. 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.
  - d) Connect a carabineer across the two loose wraps. Leave enough slack so that the angle formed by the single sling is no greater than 90 degrees. This is the preferred angle.

21. Discuss techniques for keeping anchors in position.
  - a) On vertical anchor points, slings should be secured as low as possible. 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.
  - b) 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.

Reference: IFSTA Fire Service Rescue 6th edition pages 106-107.

Reference: High Angle Rescue Techniques 3rd edition page 74

## **PRESENTATION**

### **ENABLING OBJECTIVE #2**

The Rescue Technician when 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 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 6th edition Fire Service Rescue, page 111.

Reference: 3rd edition High Angle Rescue Techniques, pages 90 through 91.

## **PRESENTATION**

### **ENABLING OBJECTIVE # 3**

The Rescue Technician when 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 (LDA) 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) 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 leg will be supporting 54 pounds of force base on a 100 pound load.
  - d) At 90 degrees each leg will be supporting 71 pounds of force base on a 100 pound load.
  - e) At 120 degrees each leg will be supporting 100 pounds of force base on a 100 pound load.
  - f) At 145 degrees each leg will be supporting 166 pounds of force base on a 100 pound load.

Reference: IFSTA 6th edition Fire Service Rescue manual, page 112

Reference: 3rd edition High Angle Rescue Techniques, 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.

Reference: IFSTA 6th edition Fire Service Rescue manual, pages 111 through 113.

Reference: 3rd edition High Angle Rescue Techniques, pages 93 through 94.

4. Demonstrate rigging a three-point load distributing anchor system using a two-loop figure 8.

Reference: IFSTA 6th edition Fire Service Rescue manual, pages 111 through 113.

Reference: 3rd edition High Angle Rescue Techniques, pages 93 through 94.

5. 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.

6. 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.
  
7. 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.
  
8. 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.
  
9. 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) 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.

## **PRESENTATION**

### **ENABLING OBJECTIVE #4**

The Rescue Technician shall correctly identify in writing, and demonstrate the construction of various types of portable anchor systems using timbers for the purpose of gaining access into a confined space.

1. Discuss the application of a timber A-frame and a derrick, and demonstrate the construction of each.
  - a) A-frames are typically constructed of 4 x 4" x 12' wood, and derricks typically utilize fire service rated ladders. They are used as portable anchors to which lifting devices can be attached to for lifting loads and moving them in a forward and aft direction.
  - b) For confined space rescue operations both systems can be used to lift and move light to moderate loads or assist with the extrication of a victim.
  
2. 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 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.
  
3. Demonstrate constructing an A-frame using 4" x 4" x 12' timbers.
  - a) 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.
  - b) 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.

4. 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) Secure a tackle system to the sling. Secure a line to the lower block so the tackle can be extended once the A-frame is raised.
  
5. Demonstrate the steps required in setting up a fore and aft guy line.
  - a) A-frames are held upright by a fore and aft guy line, forming an inverted "V."
  - b) Using a 1/2" x 100' kernmantle rope, 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 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 holdfast or picket anchoring system with a round turn and two half-hitches after the desired luff has been obtained.
  - e) The fore and aft guy lines should be one and one-half to two times the length of the A-frame, never less than the length. The holdfast or picket anchoring system is placed in line with the object to be lifted.
  - f) The base of the A-frame may be set in shallow holes. It may also be necessary to set the base of the A-frame on bearing plates.
  
6. 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.

7. 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.

8. 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.
  - 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 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 pickets, going from the top of the first to the bottom of the second.
  - e) Finish the lashing with two half hitches on the lashing between the two pickets.
  - f) Take a short picket or spinner rod, and put it through the turns of the lashing rope, using a short piece of PVC pipe as a protective device between the rope and picket rod, twisting until the lashing is tight, and then drive the short picket into the ground.

Reference: IFSTA 1st edition Technical Rescue for Structural Collapse, pages 177 through 179.

9. 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) Point out that a gin pole consists of one timber or two timbers lashed together for strength with the top supported by the use of four guy lines.

10. 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 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 ropes 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.
  
11. 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) Using a 1/2" x 100' kernmantle rope, place guy lines on the gin pole.
  - d) The distance of the guy line between the top of the gin pole and the anchor point should be one and one-half to twice the height of the gin pole. They should never be less than the height of the gin pole. If the ropes are of sufficient length, a clove hitch is placed in the center of the rope and placed over the gin pole.
  - 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 to place the gin pole on.
  - f) A picket holdfast may be used to keep the base of the gin pole from slipping. 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. 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.

12. 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.
13. Point out that a change of direction sling is lashed near the ground of the gin pole.
  - a) 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 Rescue Technician shall correctly identify in writing, and demonstrate the construction of various types of portable anchor systems using ladders for the purpose of gaining access into a confined space.

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: 3rd edition High Angle Rescue techniques, 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 timber a-frames, tripods, and ladder a-frames, jibs, and derricks.
3. Discuss and demonstrate the use of an A-frame using ladders.
- 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 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. 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.
  - f) The holdfast or picket anchoring system should be placed in line with the object being lifted.
  - g) 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.
  - h) A pulley system is then secured at this sling to create a mechanical advantage or change of direction system.
  - i) The ladders are now ready to be raised over the point of the operation.
  - j) To prevent the ladders from spreading further at the base, a rope ledger is attached at the bottom rungs of the two ladders. 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. 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. 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 300 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) Alco-Lite and Duo-Safety ladder companies use a 4:1 safety factor for their ladders (information retrieved directly from the ladder companies).
  - d) Using the above safety factor a straight wall ladder would have an approximate tensile strength of 1200 pounds and an extension ladder would have an approximate tensile strength of 3000 pounds.
  - e) When using an extension ladder, the fly section should be extended at least three rungs.
5. 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.
6. 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.
  - b) It is a very effective method of rescue when the patient needs to be lowered or raised in a horizontal position.
7. Demonstrate the steps for setting up a freestanding Ladder-as-a-derrick.
  - a) 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.

- b) 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.
  - c) If a three-section ladder is used for this procedure, then both fly sections should be secured to one another using the above described round lashing, as well as the bed being secured to the first fly section at one or more points.
  - d) The anchor or holdfast picket system should be in line with the object being lifted.
8. 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.
9. 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.

**NOTE: There are alternative methods for attaching the side guy lines and the AHJ should use the one most familiar.**

10. Demonstrate attaching the anchor sling for the upper pulley.
- a) Using a six-foot long pre-tied web or rope sling rated for the load, place the sling across the beams just above or resting on the third rung.
  - b) Bring each leg of the sling around each respective beam and over the top of the second rung and center up each leg and secure the upper pulley to the sling with a locking carabiner.
11. Demonstrate constructing the aft guy.
- a) Using approximate seven to eight 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 third rung and tie a self-adjusting bowline with a safety knot.
12. Point out that the following safety precautions 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 directional pulley at the base of the ladder will allow the haul line to be pulled in such a manner that it forces the base of the ladder into the ground.

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

13. 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. 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.
  - b) 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.

- c) 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.

- 14. 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 those patients cannot be lowered or raised in a horizontal position using this technique.
  
- 15. 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 lowering line is attached to the head of the Stokes basket in the same manner as a vertical lowering line.
  - b) The belay line is attached to the head of the Stokes basket in the same manner as a vertical belay line.
  - c) One person should go up the ladder to receive the Stokes basket to guide it down the ladder. Use a leg lock while waiting to receive the patient.
  - d) Additional personnel should heel the ladder as well as assist in supporting the weight of the ladder.
  - e) 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.
  - f) Caution should be exercised that the Stokes basket does not get hung up on the ladder as it descends.

Reference: International Manual of Basic Rescue Methods, 2004 edition, page 66.

## **APPLICATION**

Set up stations for each of the anchor systems described by the enabling objectives 1 through 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 50 to 100lbs. that can be raised on the anchor systems constructed. This could easily be accomplished using pulleys and prusiks, 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 various 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 Rescue Technician 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 Rescue Technician to select and rig a safe anchor system.