

## Chapter 7: System Attachments and Fall Restraint

**Scope:** This chapter serves as an introduction to system attachments and fall restraint.

**Terminal Learning Objective (TLO):** At the end of this chapter, the student will be aware of several methods of system attachments for rescuers and victims.

**Enabling Learning Objectives (ELO):**

1. Describe system attachments and fall protection
2. Demonstrate how to attach a rescuer to a rope rescue system
3. Demonstrate how to attach an ambulatory victim to a rope rescue system
4. Demonstrate how to attach a rescue litter to a rope rescue system
5. Demonstrate how to attach a litter to a rope rescue system with three rescuers
6. Demonstrate how to attach a litter to a rope rescue system with four rescuers
7. Demonstrate how to attach a rescuer to a fall restraint system

This chapter describes several methods of system attachments for rescuers and victims. The systems addressed are:

- Rescuer attachment to a rope rescue system.
- Ambulatory victim attachment to a rope rescue system.
- Litter attachment to a rope rescue system.
- Litter harness (pre-rig) attachments to a rescue system.
  - Three-rescuer configuration.
  - Four-rescuer configuration.
- Rescuer attachment(s) to the litter harnesses.
  - Three-rescuer configuration.
  - Four-rescuer configuration.
- Rescuer attachment to fall restraint systems.

### Rescuer Attachment to a Rope Rescue System

In low angle operations, the main and belay/safety lines are attached to the rescuers pelvic harness.

#### Specifics

- NFPA Class II harness minimum.
- Main line attached to front waist D-ring with NFPA General rated carabiner.
- Belay/safety line attached to front waist D-ring with NFPA General rated carabiner.

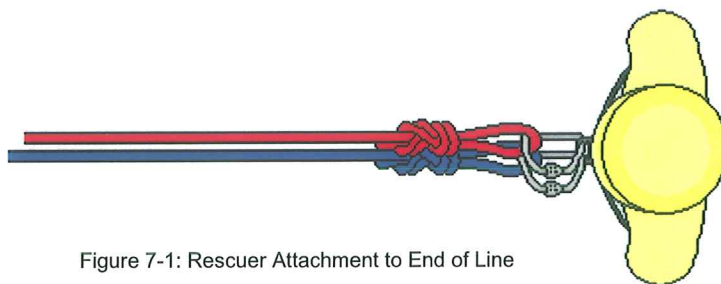


Figure 7-1: Rescuer Attachment to End of Line

## Advantages

- Attachment at front waist D-ring allows excellent mobility for rescuer.
- Allows rescuer's posture to remain perpendicular to the slope.

## Disadvantages

- Attachment at front waist D-ring can allow rescuer to completely invert in the event of a fall, or foot entrapment during lowering operations.

## Ambulatory Victim Attachment to a Rope Rescue System

It is common to encounter an ambulatory victim during rope rescue operations. The victim is packaged in either a commercial victim harness or a hasty pelvic harness. Once the victim is packaged, he or she must be attached with prusiks into the main and the belay/safety lines that are already connected to the rescuer. The longer prusiks are commonly utilized for this attachment. This victim will then be able to walk up or down the slope with controlled assistance from the rope rescue system.

## Specifics

- The preferred victim harness is commercially produced. If such a harness is not available, the hasty harness shown in Chapter 5 can be utilized.
- The victim is secured to the main line with a three-wrap prusik around the main line, connected to the front waist attachment on the harness with a NFPA General Use carabiner.
- The victim is secured to the belay/safety line with a three-wrap prusik around the belay/safety line and connected to the front waist attachment on the harness with a NFPA General Use carabiner.
- Position the victim ahead of the rescuer so that the rescuer can assist the travel of the victim.

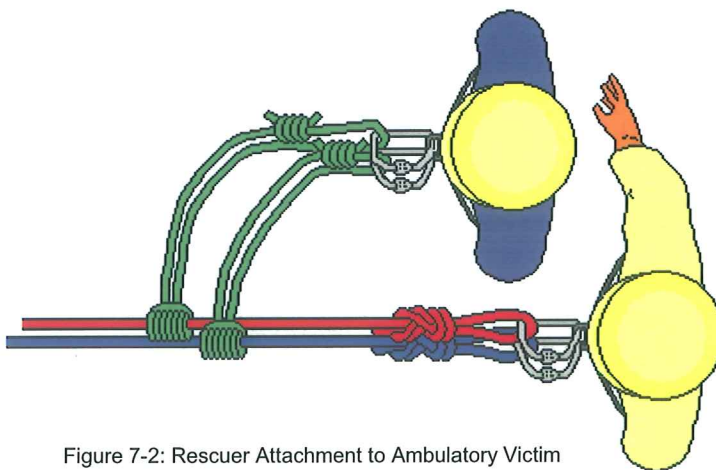


Figure 7-2: Rescuer Attachment to Ambulatory Victim

## Advantages

- Prusik attachments allow victims to be positioned various distances above rescuer depending on situational needs.

## Disadvantages

- In steeper terrain, it becomes difficult to adjust the victim's position when they are dependant on the system to keep from falling.

## **Rescue Litter Attachments to a Rope Rescue System**

Litters are attached to the ends of the main line and the belay/safety line with head lashings. These lashings are constructed of either a 5-foot section of webbing or an 8-foot section of lifeline. Head lashings can be tied on scene or left pre-attached to the litter while in storage. These attachment points are for the commonly used rescue litters.

### **Constructing the Head Lashing (Figures 7-3 and 7-4)**

- Wrap an open 5-foot length of webbing or an 8-foot length of lifeline around the main frame at the head of the rescue litter. Beginning outside one of the skids and ending outside the opposite skid. Some plastic bodied litters do not have skid rails. For these applications, the head lashing will be wrapped around the top handholds.
- Avoid the weld in the middle to prevent abrasion to the webbing or lifeline.
- Tie the webbing or lifeline into a loop with an overhand bend (webbing) or a double overhand knot (lifeline).
- Pull the webbing or lifeline from the center of the main frame (at the weld point) until it reaches the end of the sling.
- Rotate sling until knot is off to one side.
- The head lashing should be connected to a central small hole in a rigging plate with a NFPA General Use carabiner as shown.

### **Constructing the Head Lashing (Figure 7-5)**

- Form one closed (tied) 5-foot sling on one side of the rescue litter around the handrail and main rib.
- Wrap a second closed 5-foot sling on the other side of the rescue litter in the same manner.
- Attach a carabiner to each of the slings.
- Attach both carabiners to the collection plate as shown.

### **Constructing the Head Lashing (Figures 7-6)**

- Wrap an open 5-foot length of webbing or an 8-foot length of lifeline around the main frame at the head of the rescue litter. Beginning outside one of the skids and ending outside the opposite skid. Some plastic bodied litters do not have skid rails. For these applications, the head lashing will be wrapped around the top handholds.
- Avoid the weld in the middle to prevent abrasion to the webbing or lifeline.
- Tie the webbing or lifeline into a loop with an overhand bend (webbing) or a double overhand knot (lifeline).
- Pull the webbing or lifeline from the center of the main frame (at the weld point) until it reaches the end of the sling.
- Rotate sling until knot is off to one side.
- The head lashing should be connected with two NFPA General Use carabiners directly into both the main and safety/belay lines as shown.

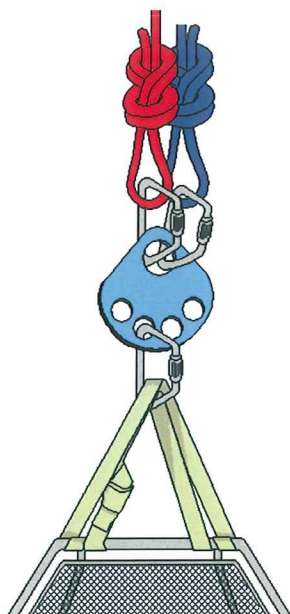


Figure 7-3: 5-foot Webbing

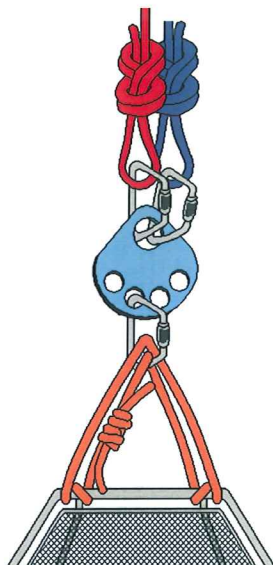


Figure 7-4: 8-foot Lifeline

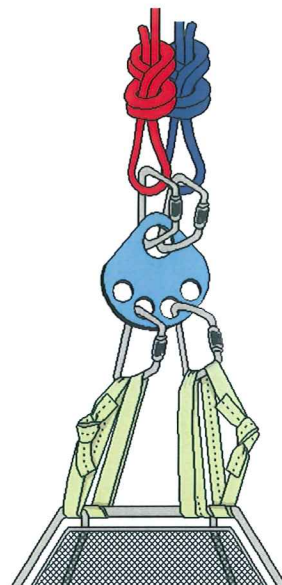


Figure 7-5: Pre-rig

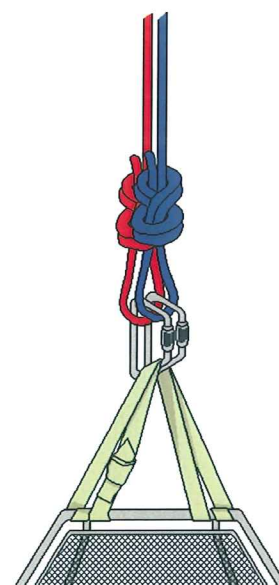


Figure 7-6: Without an anchor plate

|            | <i>Advantages of Each</i>                    | <i>Disadvantages of Each</i>       |
|------------|--|------------------------------------|
| Figure 7-3 | Compact, simple to tie, pre-rig, and attach. | Least strength.                    |
| Figure 7-4 | Strong and abrasion resistant.               | May be bulky to tie and attach to. |
| Figure 7-5 | The webbing is backed up and separate.       | Most complicated to construct.     |
| Figure 7-6 | Requires less equipment.                     | Difficult to modify configuration. |

## Rescuer Attachment to the Litter System

Rescuers are attached to the litter system using a litter harness pre-rig (pre-rig), made up of two bridles. The configuration of the pre-rig is determined by the number of rescuers used to support the litter. The use of a three- or four-rescuer configuration is determined by the victim weight and size, availability and strength of personnel, incline of slope, and type of terrain.

### Litter Harness Pre-rig

The rescuers are attached to the litter with a litter harness pre-rig. A pre-rig is an adjustable pre-tied combination of lifeline, prusiks, and carabiners. It is used to connect the rescue lines, litter, and rescuers together. The adjustability of the pre-rig allows it to be used in low angle, high angle, or high line operations. A pre-rig consists of two bridles as shown in Figure 7-7.

## Bridle Construction

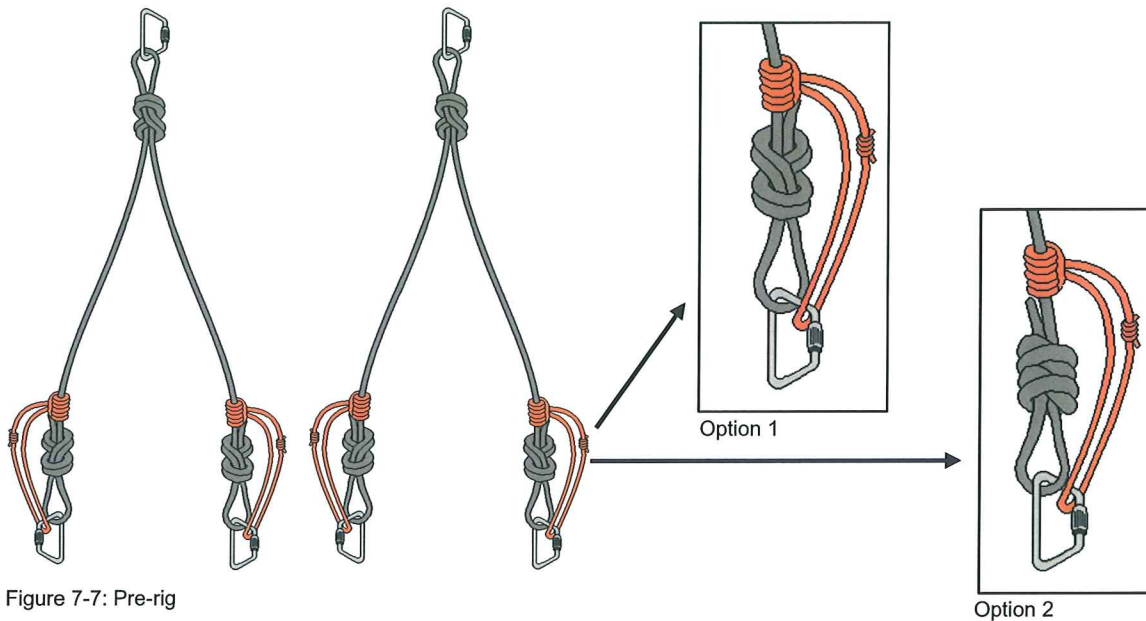


Figure 7-7: Pre-rig

Option 2

- Tie a figure eight on a bight or a double overhand on a bight in the middle of a 16-foot section of lifeline and attach a NFPA General Use carabiner to this knot.
- Tie a figure eight on a bight into each end of the 16-foot section of lifeline and attach NFPA General Use carabiner to each knot.
- Attach a three-wrap prusik to each leg of the pre-rig and clip the prusik loop into the carabiner at the end of each leg.

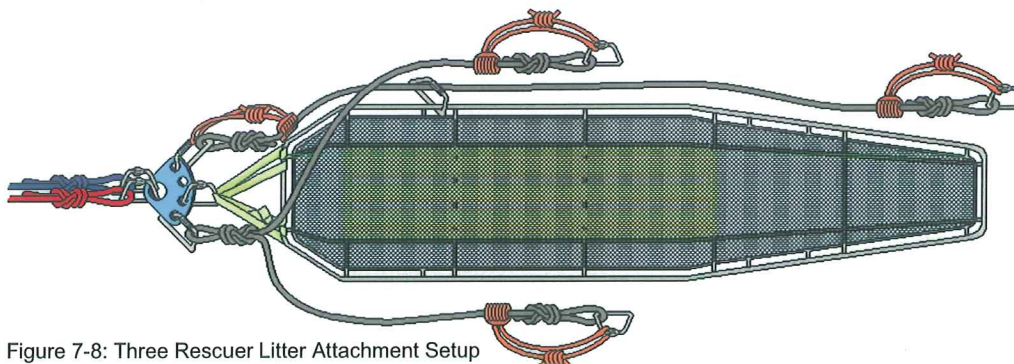


Figure 7-8: Three Rescuer Litter Attachment Setup

## Three Rescuer Litter Attachment

In this orientation, the rescuers will be positioned as follows:

- One rescuer at the foot of the litter.
- One rescuer on each side of the litter located near the victim's shoulder.

### Setup Specifics

- One pre-rig bridle is connected to an outside hole on the rigging plate with a carabiner at the midpoint knot.
- The second bridle of the pre-rig has the midpoint knot untied.
  - One end of the untied bridle is secured to the unused outside hole of the rigging plate.
  - The other end of untied bridle is placed near the foot of the litter.
  - This section of the bridle is attached to shoulder of the litter with the carabiner freed up from untying the midpoint knot. This helps keep the line clear of the victim.
- The three rescuers attach the front waist D-rings on their harnesses to the carabiner attached to the figure eight knot and prusik loop on the end of the pre-rigs.
  - They then slide the prusik along the pre-rig to position themselves.

### Key Points

- The victim, personnel, slope, and terrain will determine the need for either three rescuers or four rescuers.

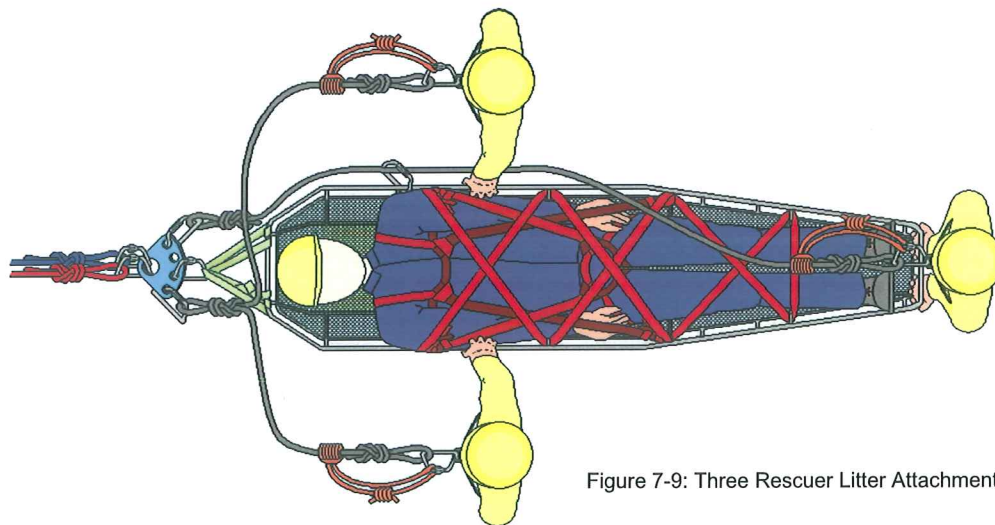


Figure 7-9: Three Rescuer Litter Attachment

### Advantages

- Fewer personnel required.
- Less equipment necessary.
- Steep slopes place more of the victim's weight on the ropes.

## Disadvantages

- Shallower slopes place more of the victim's weight on the rescuers.
- Difficult for Foot Person to see path of travel.

## Four Rescuer Litter Attachment

In this orientation, rescuers will be positioned at the shoulders and the knees on each side of the litter.

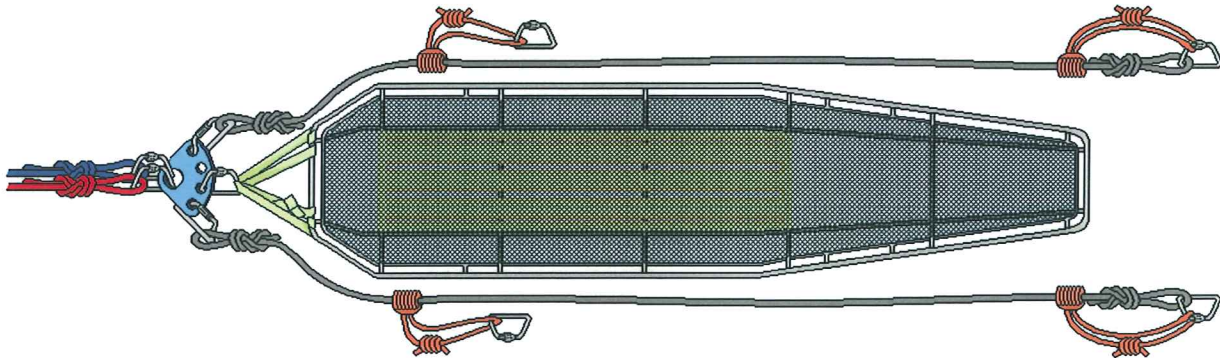


Figure 7-10: Four Rescuer Litter Attachment Setup

## Setup Specifics

- Untie the midpoint knot from both bridles of the pre-rig after removing the carabiners.
- Attach the figure eight knot on the end of the bridle to an outside hole on the rigging plate.
- Extend the bridle along the side of the litter so that the figure eight knot on the opposite end of the bridle from the rigging plate is at the foot of the litter.
- Detach the prusik loop from the bridle carabiner at the rigging plate and slide the prusik down the bridle to the shoulder of the litter.
- Attach the carabiner removed from the midpoint knot to this prusik.
- Repeat above steps with the second bridle on the other side of the litter.
- Rescuers at the shoulders will attach the front waist D-rings on their harnesses to the prusik loop at the shoulders of the litter and position themselves by adjusting the prusiks.
- Rescuers at the knees of the litter will attach the front waist D-ring of their harnesses to the carabiner attached to the figure eight knot and prusik loop on the end of the bridle. They will position themselves by sliding the prusik up as needed.

## Key Points

- The victim, personnel, slope, and terrain will determine the need for either three rescuers or four rescuers.

## Advantages

- More rescuers to support the victim's weight on shallower slopes.
- All personnel can see terrain for footing.

## Disadvantages

- More personnel required.
- More equipment required.
- Greater load applied to the system than 3-person.

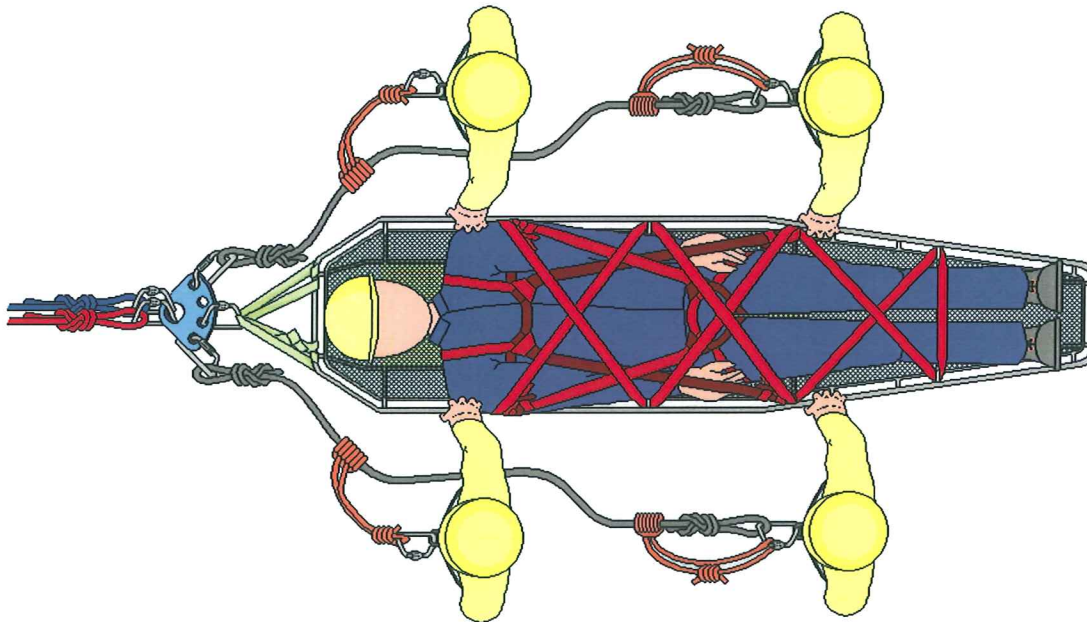


Figure 7-11: Four Rescuer Litter Attachment

## Fall Restraint

Personnel exposed to a potentially hazardous fall should be protected with a fall restraint system. A fall restraint system is assembled to prevent the rescuer from falling off an edge. The purpose of a fall restraint system is to prevent injury by limiting the distance a person can fall while still allowing the necessary degree of movement to perform their assignment. The fall restraint system consists of an anchor, approved harness, lifeline, and related hardware and software adjusted to limit the potential fall to two (2) feet.

## Standard

The standard that governs fall protection is in Title 8 of the California Code of Regulations, §1670. This standard specifically defines industry standards for the construction industry. These standards may not be applicable to fire and rescue emergency operations.

## Considerations

When should a fall restraint system be attached to a rescuer working on or near an edge in a low angle operation?

- ① Always make this consideration.
- ② Is there a real potential for a rescuer to fall? An example would be a rescuer assigned to manage rope protection that is positioned at the edge of a steep, slippery bank.



- ③ Will fall restraint lines create more hazard potential than protection potential for the rescuer?
- ④ When the Safety Officer and/or an appointed lookout is not available to provide visual supervision to keep rescuers from moving in and out of fall-risk areas.
- ⑤ Continue to evaluate the scene as the operation progresses.

## **Components of a Fall Restraint System**

- An adequate anchor that is able to support a single-person load and in line with the working area and the rescuer to be restrained.
- An appropriate length of lifeline attached to the anchor and rescuer.
  - At the most 2 feet of extra line beyond the edge.
  - With a device or mechanism of adjusting the length at one or both ends of the line.
    - Having adjustment mechanisms at both ends of the system allows large adjustments to be made at the anchor end and fine adjustments to be made at the rescuer's end.
      - ♦ This allows fine-tuning of the line length by the rescuer while limiting the potential for extra rope to gather near the rescuer's feet, creating a tripping hazard.

## **How to Construct a Fall Restraint System**

- Identify the anchor point to be used.
  - If the anchor is a picket, drive it into the soil with the proper angle to the load.
- Tie a figure eight on a bight on one end of the lifeline and toss it from a safe distance to the edge of the bank.
- Extend the line to the anchor.
- Attach the line to the anchor using either of the following methods.

### ***Using a Picket***

This method reduces the equipment needed to a picket and a lifeline.

- Form a clove hitch over the picket.
- Pay out 3 feet of slack from behind the knot.
- Form a figure eight on a bight and place it over the picket.
- The clove hitch can be used for adjustment.
- The figure eight on a bight is a backup to the clove hitch.

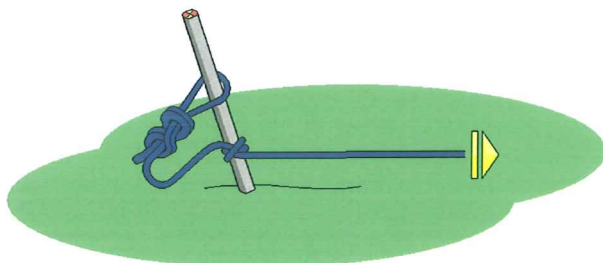


Figure 7-12: Using a Picket

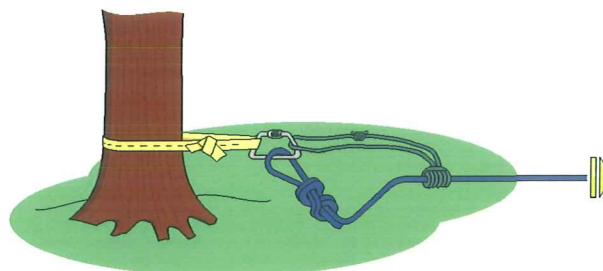


Figure 7-13: Other than a Picket

## ***Using an Anchor Other than a Picket***

This method can also be used with a picket anchor.

- Attach a sling and carabiner to the selected anchor.
- Form a three-wrap prusik on the line and attach it to the carabiner on the anchor sling.
- Pay out 3 feet of slack from behind the prusik and tie a figure eight on a bight.
- Attach the figure eight on a bight to the carabiner on the anchor sling.
- The prusik can be used for adjustment.

## **How to Construct a Fall Restraint System – Rescuer Connections**

- Retrieve the end of the rope with the figure eight on a bight from the edge.
- Attach the end of the line to the rescuer using either of the following methods.

### ***Direct, Nonadjustable Attachment***

This method uses the least amount of equipment to connect and results in less slack line to maintain, reducing tripping hazards.

- Attach the figure eight on a bight knot in the end of the fall restraint line to the rescuer's harness with a carabiner.
  - Attachment can be made to either the front or rear D-ring attachment on the harness.

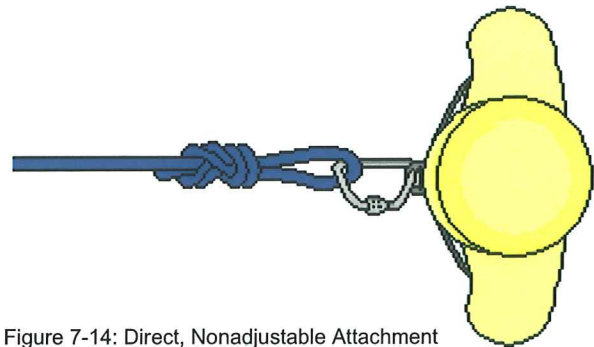


Figure 7-14: Direct, Nonadjustable Attachment

### ***Adjustable Attachment***

- Place a three-wrap prusik just behind the figure eight on a bight in the end of the fall restraint line.
- Attach a carabiner to both the figure eight on a bight and the prusik.
- Connect the carabiner to the front D-ring on the rescuer's harness.
- The prusik allows the rescuer to make his or her own adjustments as needed.

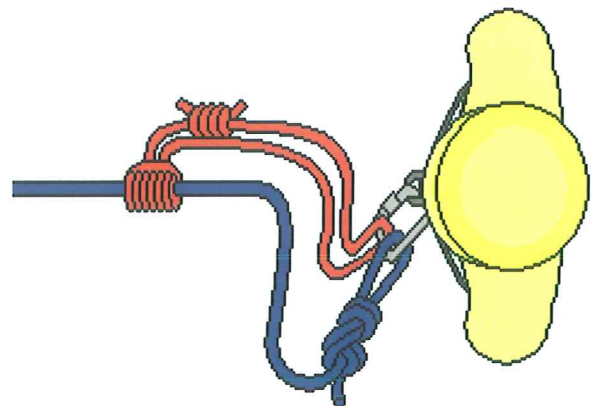


Figure 7-15: Adjustable Attachment