

Chapter 9: Belay/Safety Line Systems

Scope: This chapter serves as an introduction to belay/safety line systems.

Terminal Learning Objective (TLO): At the end of this chapter, the student will be aware of the importance of utilizing a back-up line to catch the load in the event of a failure of the main line.

Enabling Learning Objectives (ELO):

1. Define key points regarding the operation of a belay/safety line system
2. Demonstrate belay/safety line configurations
3. Demonstrate lowering operations – basic configuration
4. Demonstrate retrieval operations – basic configuration
5. Demonstrate lowering operations – PMP configuration
6. Demonstrate retrieval operations – PMP configuration
7. Describe system variations

In all emergency operations, the words "Safety First" need to be more than a catchy phrase. Rope rescue operations are no exception to this rule. An important part of ensuring safety is the utilization of a back-up line to catch the load in the event of a failure of the main line.

Many teams refer to this back-up line as the "belay line." This is a mountaineering term meaning, "To hold fast or provide security."

Other teams refer to this line as the "safety line." With this orientation, the term "Safety First" can provide a verbal reference to the back-up line and reinforce the concept of staffing, checking, and attaching the safety line first in all operations.

This manual will use both terms with the understanding that local agencies will use one or the other as their reference. With that being said, the belay/safety line systems and operations that are presented here *must be followed without exception*.

Key Points Regarding the Operation of Belay/Safety Line Systems

- The entire operation is only as safe as the belay/safety line system, its anchor, and its operator.
- Personnel staffing the belay/safety line must have sound operational skills. These skills are perishable and their maintenance requires regular hands-on practice under the supervision of a qualified person.
- Communication is essential during the operation of these systems.** The "edge" position is a critical link in the safe operation of the belay/safety line system. The edge person will communicate to the belay/safety line tender the amount of line and speed needed to accommodate the rescuer's needs. On occasion, the rescuer may need to move rapidly over an area. **The edge person will direct the belay/safety line tender regarding the operation of the system during these situations.**
- The Technical Safety Officer or Rescue Group Supervisor may fill the roll of "edge" as dictated by staffing and operational needs.
- Rope rescue operations are a go only when the "edge" position is filled.**

Belay/Safety Line Configurations

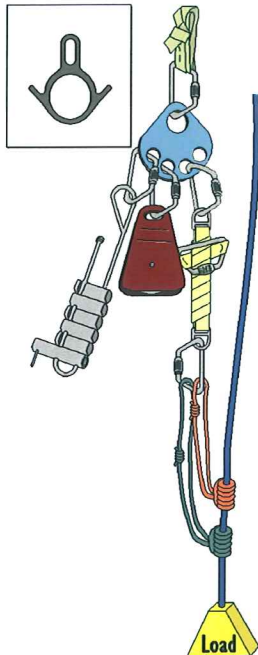


Figure 9-1: Basic Configuration

The basic belay/safety line configuration does not utilize the prusik minding pulley. This configuration does not provide for rapid retrieval of an unloaded line, however, it will allow the tender better "feel" of systems operation.

This configuration will minimize the potential of prusiks to grab or jam. The basic belay/safety line configuration also reduces the potential for damage to system components (line and prusiks) caused by the heat of friction. The potential for system problems associated with the use of the prusik minding pulley in the systems is eliminated.

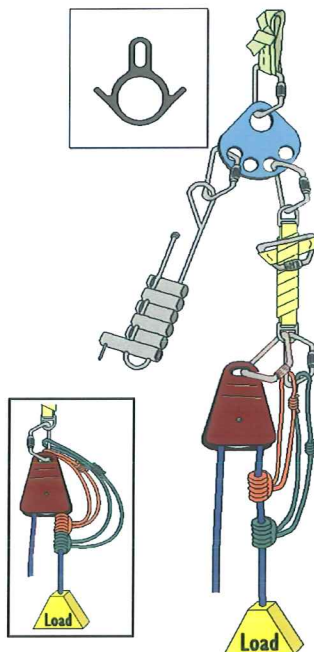


Figure 9-2: PMP Configuration

The prusik minding pulley (PMP) allows the belayer to retrieve the belay/safety line with hand over hand motion. This provides a quick method of retrieving a line that has been disconnected from the load.

This configuration can also be used while retrieving a belay/safety line during raising operations. The operator must ensure that the proper amount of tension is maintained in the prusik hitches around the belay/safety line. Excessive grip of the prusik to the line will cause the tandem prusiks to jam and/or be damaged due to the heat of friction.

Extreme caution must be used if utilizing this system to protect the load during lowering operations. The weight of the additional hardware can cause the tandem prusiks to grab unexpectedly. The system may be placed flat on the ground to prevent this. Prusik hitches that are too loose or improperly tended will not arrest a fall.

Lowering Operations – Basic Configuration

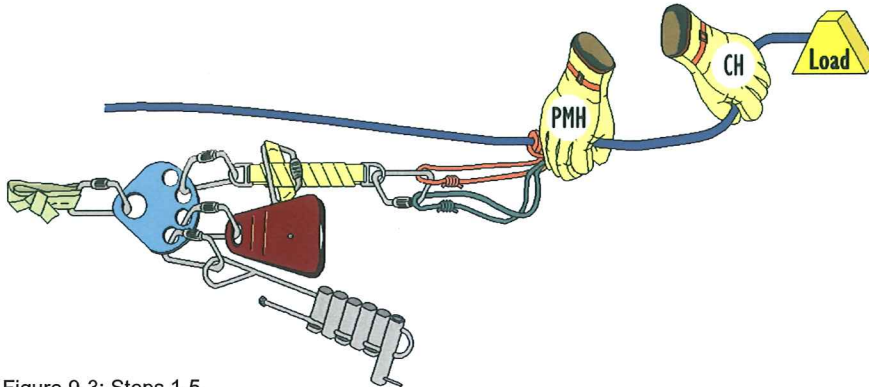


Figure 9-3: Steps 1-5

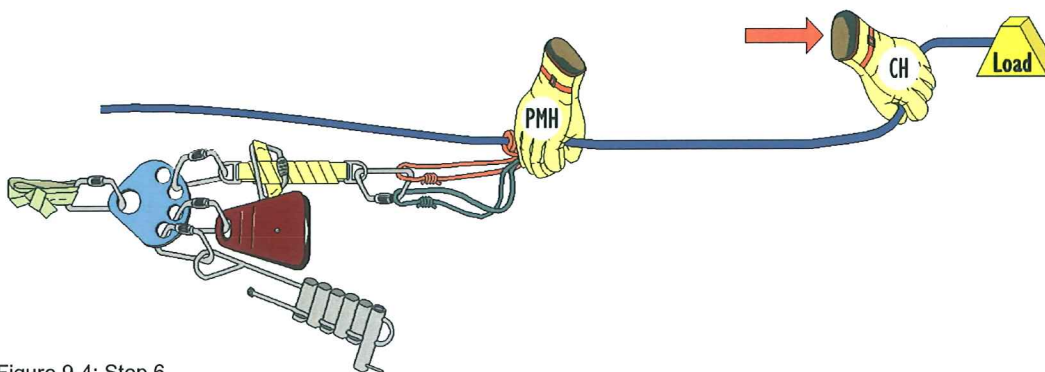


Figure 9-4: Step 6

- 1) **Prusik Minding Hand (PMH)** – Form a circle with the index finger and thumb around the line and against the load side of the long prusik.
- 2) **Control Hand (CH)** – Grasp the line on the load side of the tandem prusiks.
- 3) **Control Hand** – Angle the line with the hand as shown.
- 4) **Prusik Minding Hand** – Slide the long prusik toward the anchor until it contacts the short prusik and rest the remaining fingers of the **prusik minding hand** on the short prusik.
- 5) **Prusik Minding Hand** – Slide the tandem prusiks toward the anchor to develop 2"–3" of slack.
- 6) **Control Hand** – As the load moves away from the anchor, pull the line through the tandem prusiks to maintain less than 2 feet of slack in the line.
- 7) **Control Hand** – When arm's length is reached, repeat Step 6.

When pull straightens the angle at the control hand, set the prusiks unless otherwise directed.

Tandem prusiks are commonly set by "throwing" them towards the load with the prusik minding hand.

Retrieval Operations – Basic Configuration

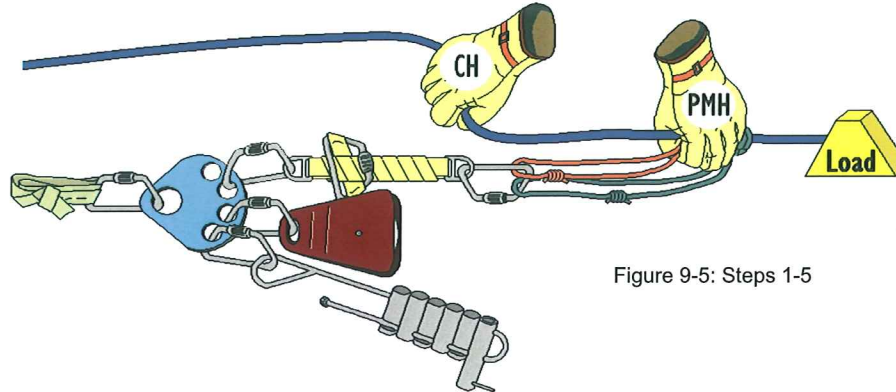


Figure 9-5: Steps 1-5

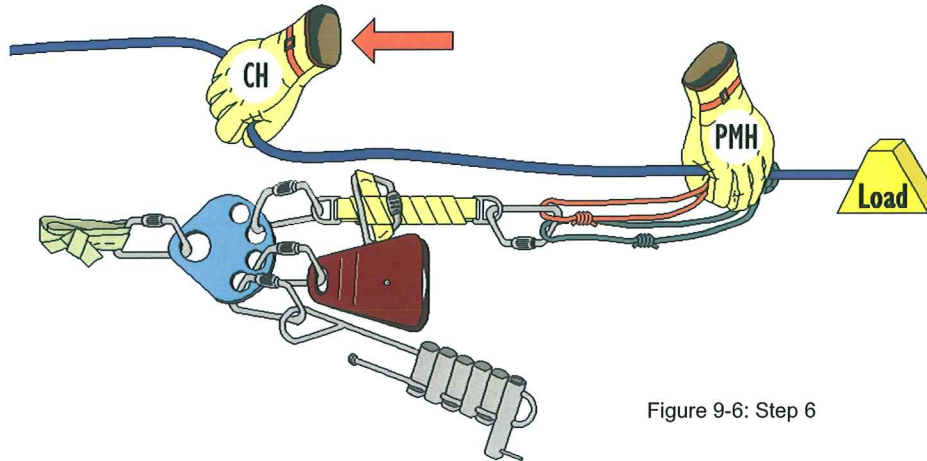


Figure 9-6: Step 6

- 1) **Prusik Minding Hand** – Form a circle with the index finger and thumb around the line and against the anchor side of the short prusik.
- 2) **Prusik Minding Hand** – Short prusik remains taut throughout the operation.
- 3) **Control Hand** – Grasp the line on the anchor side of the tandem prusiks.
- 4) **Control Hand** – Angle the line with the hand as shown.
- 5) **Control Hand** – As slack develops during retrieval, pull the line through the tandem prusiks to maintain a taut line.
- 6) **Prusik Minding Hand** – As the line is retrieved by the control hand, the long prusik will move to contact the short prusik. Rest the remaining fingers of the **prusik minding hand** on the long prusik.
- 7) **Control Hand** – When arm's length is reached, repeat Steps 3, 4, and 5.

When direction of travel reverses, properly tended prusiks will set.

Tandem prusiks are commonly set by "throwing" them towards the load with the prusik minding hand.

Lowering Operations – PMP Configuration (Optional)

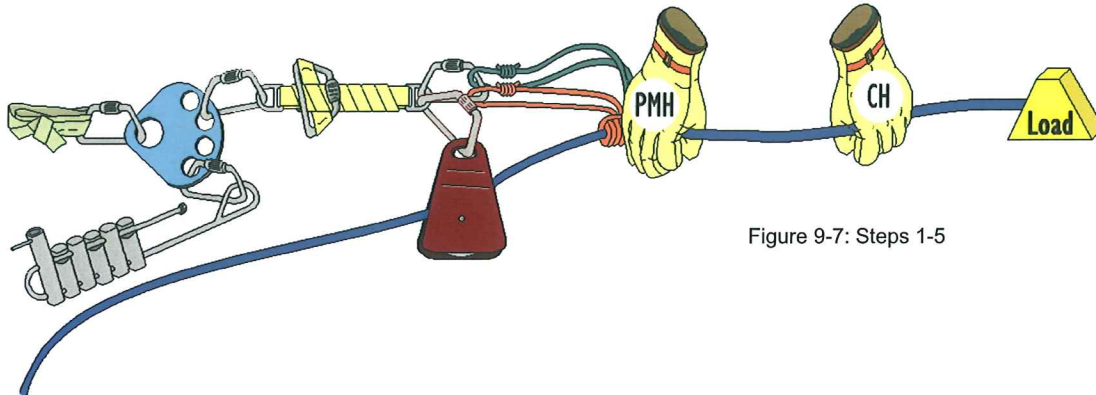


Figure 9-7: Steps 1-5

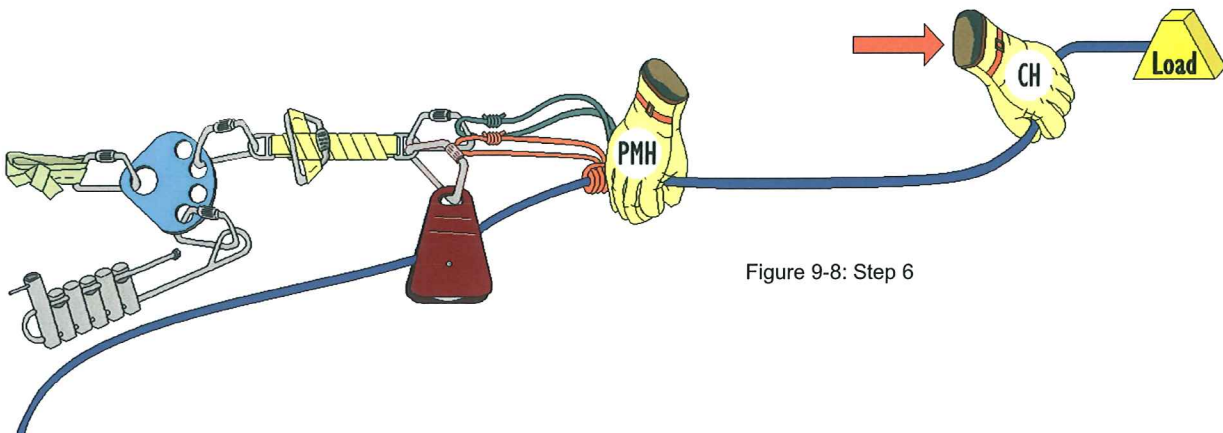


Figure 9-8: Step 6

If possible, open the angle of the line in the pulley as shown. This will allow the line to feed through the system more easily.

- 1) **Prusik Minding Hand** – Form a circle with the index finger and thumb around the line and against the load side of the long prusik.
 - 2) **Control Hand** – Grasp the line on the load side of the tandem prusiks.
 - 3) **Control Hand** – Angle the line with the hand as shown.
 - 4) **Prusik Minding Hand** – Slide the long prusik toward the anchor until it contacts the short prusik and rest the remaining fingers of the **prusik minding hand** on the short prusik.
 - 5) **Prusik Minding Hand** – Slide the tandem prusiks toward the anchor to develop 2" – 3" of slack.
 - 6) **Control Hand** – As the load moves away from the anchor, pull the line through the tandem prusiks to maintain less than 2 feet of slack in the line.
 - 7) **Control Hand** – When arm's length is reached, repeat Step 6.
- When pull straightens the angle at the control hand, set the prusiks unless otherwise directed. Tandem prusiks are commonly set by "throwing" them towards the load with the prusik minding hand.

Retrieval Operations – PMP Configuration (Optional)

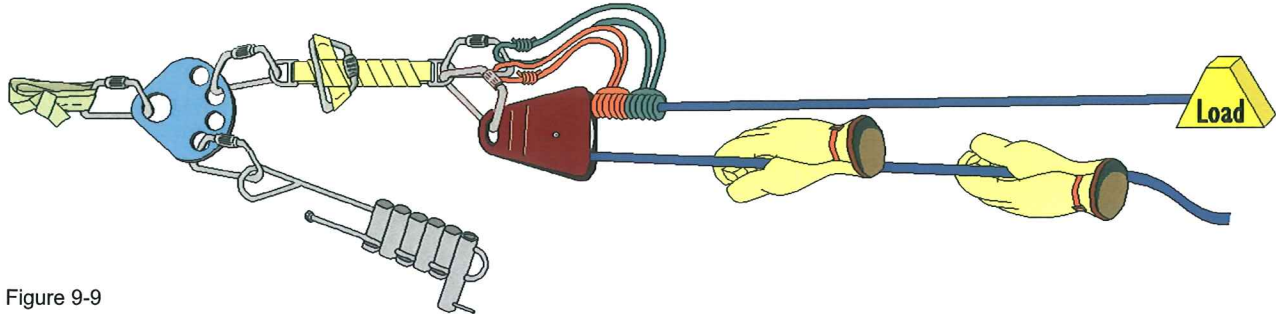


Figure 9-9

- 1) With one hand, grasp the line on the side opposite the tandem prusiks 2 feet below the pulley.
- 2) With the other hand, grasp the line on the same side of the pulley a comfortable distance away from the first hand.
- 3) Pull the line hand-over-hand, away from the anchor.

Key Points

- Maintain a two-foot spacing between hands and pulley to avoid possible entanglement in pulley.
- The line must be maintained at 180° in and out of the prusik minding pulley.
- Prusiks must ride squarely on the bottom edge of the pulley.
- Prusiks allowed to ride up the side of the pulley may jam or be damaged by the heat of friction.
- When direction of travel reverses, the prusiks will set.

System Variations

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

Dual RPMs Configuration

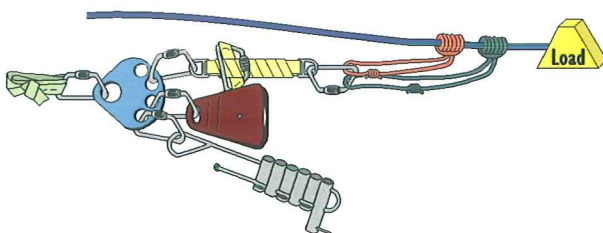


Figure 9-10: Basic Configuration – Lower

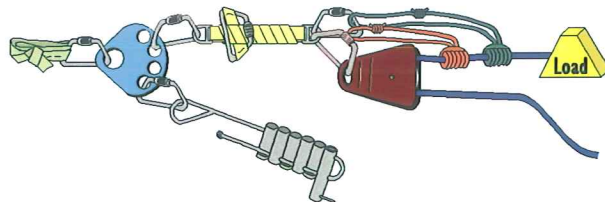


Figure 9-11: PMP Configuration – Retrieve

Belay/Safety Line Single Configuration (as shown in Chapter 8)

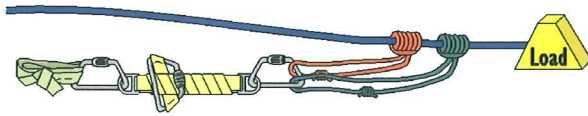


Figure 9-12: Single Configuration without PMP

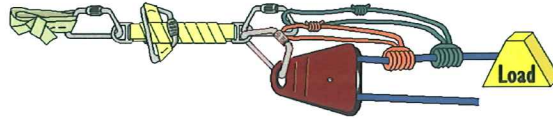


Figure 9-13: Single Configuration with PMP

Key Points

- A belay/safety line system shall be utilized any time a main line is used (two line systems).
- The belay/safety line system is the most critical part of any rope system as it provides for fall arrest in the event of main line system failure.
- The operation of this system is a critical skill requiring a high degree of knowledge and understanding.