TC 21-24

TOWER AND AIRCRAFT RAPPELLING

FEBRUARY 2025

DISTRIBUTION RESTRICTION: Approved for public release; distribution is unlimited.
This publication supersedes TC 21-24, dated 9 January 2008.

HEADQUARTERS, DEPARTMENT OF THE ARMY

This publication is available at the Army Publishing Directorate site (https://armypubs.army.mil) and the Central Army Registry site (https://atiam.train.army.mil/catalog/dashboard).

Training Circular
No. 21-24

Headquarters
Department of the Army
Washington, DC, 25 February 2025

TOWER AND HELICOPTER RAPPELLING

Contents

Page

Preface ..... **v**
CHAPTER 1 ..... **1**
TOWER RAPPELLING **1**
Section I – Personnel **2**
Rappel Master 2
Rappel Safety Officer 2
Rappel Lane Noncommissioned Officer 3
Rappeller 3
Belayer and Belay Safety 3
Section II – Preoperation Briefings and Safety Procedures **4**
Safety Briefing 4
Tower Safety and Preparation 5
Rappeller Preparation 6
Section III – Rappelling Procedures **6**
Hip-Rappel Seat 6
Hip-Rappel-Seat Hookup 6
Tower Procedures 6
Hand and Arm Signals 7
Rappel Tower Training for Aircraft 12
Emergency Lock-In Procedures 12
Communications 13
CHAPTER 2 ..... **15**
HELICOPTER RAPPELLING **15**
Section I – Personnel and Sustainment Refresher Training **15**
Rappel Master 15
Rappel Safety Officer 15
Ground-to-Air 15
Crew Chief 15

DISTRIBUTION RESTRICTION: Approved for public release. Distribution is unlimited. *This publication supersedes TC 21-24, dated 9 January 2008.

Pilot-in-Command 15
Rappeller 15
Belayer 16
Sustainment Training 16
Section II – Preoperational Briefings and Safety Procedures 16
Medical Coverage 16
Communication Requirements 16
Adverse Weather Conditions 16
Night Operation Requirements 16
Safety Briefing 17
Section III – Deployment of Ropes 17
Deployment Bag Technique 17
Log Coil Technique 18
Section IV – Rappelling Operations for the UH-60 Helicopter 18
Characteristics 19
Rigging the UH-60 for Rappelling 19
Seating Arrangements 20
UH-60 Rappelling Procedures 21
Rappelling Commands 21
Hand and Arm Signals with Commands 22
UH-60 Inspection and Safety Considerations 25
Section V – Rappelling Operations for the CH-47 Helicopter 26
Characteristics 26
Rope Preparation 26
Rigging the CH-47 for Ramp Rappelling 26
Rigging the CH-47 for Cabin Door Rappelling 27
Seating Arrangements 28
Rappelling Procedures 28
Inspection and Safety Considerations 29
CHAPTER 3 31
EQUIPMENT 31
Section I – Ropes and Carabiners 31
Types of Ropes 31
Carabiners 32
Section II – Inspection 34
Ropes 34
Carabiners 34
Gloves and Helmet 34
Section III – Alternate Methods of Descent 34

Figure-Eight Descender 34
Air Traffic Controller 35
CHAPTER 4 37
ROPE MANAGEMENT 37
Section I – Preparation, Maintenance, Inspection, and Terminology 37
Preperation 37
Maintenance and Inspection 37
Terminology 38
Section II – Coiling, Carrying, Throwing 40
Coiling and Carrying the Rope 40
Throwing the Rope 43
Section III – Knots 43
Joining Knots 43
Anchor Knots 47
Class III: Middle Rope Knots 50
Class IV: Special Knots 53
Hip-Rappel Seat 59
APPENDIX A 67
BASIC EQUIPMENT FOR RAPPEL OPERATIONS 67
Glossary 69
References 71
Index 73

Figures

Figure 1-1. Static rappel tower 1
Figure 1-2. Example of rappel tower anchor points 5
Figure 1-3. Example of hand and arm signal, GET READY 7
Figure 1-4. Example of hand and arm signal, POSITION 8
Figure 1-5. L-shape position 9
Figure 1-6. Example of hand and arm signal, GO 10
Figure 1-7. L-shape position while rappelling 11
Figure 1-8. Helicopter rappel training 12
Figure 2-1. Coiling log 18
Figure 2-2. Secondary carabiner attaching point 19
Figure 2-3. Primary and secondary carabiner attaching points 20
Figure 2-4. Primary carabiner attaching point 20
Figure 2-5. UH-60 maximum rappeller seating arrangement 21
Figure 2-6. Hand and arm signal for THROW ROPES 22
Figure 2-7. Hand and arm signal for GET READY 22
Figure 2-8. Primary hand and arm signal for POSITION 23
Figure 2-9. Alternate hand and arm signal for POSITION 24
Figure 2-10. Hand and arm signal for GO 25
Figure 2-11. CH-47 ramp rappelling anchor point configuration 27

Figure 2-12. Cabin door rigging 28
Figure 3-1. Kernmantle rope construction 31
Figure 3-2. Nylon laid rope 32
Figure 3-3. Nonlocking carabiner 33
Figure 3-4. Locking carabiner 33
Figure 3-5. Figure-eight descender 35
Figure 3-6. Air traffic controller 35
Figure 4-1. Examples of rope terminology 39
Figure 4-2. Mountain coil 40
Figure 4-3. Butterfly coil 41
Figure 4-4. Butterfly coil tie-off 42
Figure 4-5. Square knot 43
Figure 4-6. Fisherman's knot 44
Figure 4-7. Double fisherman's knot 45
Figure 4-8. Figure-eight bend 46
Figure 4-9. Water knot 47
Figure 4-10. Bowline 48
Figure 4-11. Round turn and two half hitches 49
Figure 4-12. Figure-eight retrace (rerouted figure eight) 49
Figure 4-13. Middle-of-the-rope clove hitch 50
Figure 4-14. Wireman's knot 51
Figure 4-15. Bowline on a bight 52
Figure 4-16. Two-loop figure eight 52
Figure 4-17. Figure-eight on a bight 53
Figure 4-18. Middle of the rope Prusik knot 54
Figure 4-19. End of the rope Prusik knot 54
Figure 4-20. Three-loop bowline 55
Figure 4-21. Transport knot (overhand slip knot/mule knot) 56
Figure 4-22. Klemheist knot 57
Figure 4-23. Girth hitch 58
Figure 4-24. Munter hitch 59
Figure 4-25. Construction of the hip-rappel seat 61

Tables

Table 1-1. Rappeller commands 13

Preface

TC 21-24 is the primary reference and instruction source providing techniques for all Soldiers and leaders when conducting rappelling operations. Guidelines on how to conduct safe rappelling maneuvers are also contained in this training circular. The safety notes and considerations presented provide only minimal acceptable standards.

The principal audience for TC 21-24 is all members involved with rappelling operations, whether resident or nonresident Soldiers. Rappelling is inherently dangerous. Commanders at all levels analyze completed training events to determine the degree of risk involved for Soldiers and equipment. After determining the dangers, risk reduction options or controls should be integrated into the training activity. These can range from safety briefings, providing additional safety resources, or selecting other means for accomplishing the mission.

Commanders, staffs, and subordinates ensure their decisions and actions comply with applicable United States, international, and in some cases host-nation laws and regulations. Commanders at all levels ensure that their Soldiers operate in accordance with the law of war and the rules of engagement. (See FM 6-27/MCTP 11-10C.) In addition, the use of a trade or brand name does not constitute endorsement of the product.

TC 21-24 applies to the Active Army, Army National Guard/Army National Guard of the United States, and United States Army Reserve unless otherwise stated.

The proponent of TC 21-24 is the Maneuver Center of Excellence. The preparing agency is the U.S. Army Infantry School, Maneuver Center of Excellence. Send comments and recommendations on DA Form 2028 *(Recommended Changes to Publications and Blank Forms)* to Commandant, U.S. Army Infantry School, 1 Karker Street, Fort Moore, Georgia 31905-5410; by e-mail to (usarmy.moore.mcoe.mbx.doctrine@army.mil); or submit an electronic DA Form 2028.

This page intentionally left blank.

Chapter 1

Tower Rappelling

Introduction to rappelling is taught on a static tower (see figure 1-1). Using the building block approach to training, Soldiers systematically progress to more demanding platforms including taller static towers and helicopters. The static tower used may vary in size and height, but a 34-foot minimum is required. The concept of learning basic rappelling techniques before helicopter operations does not vary.

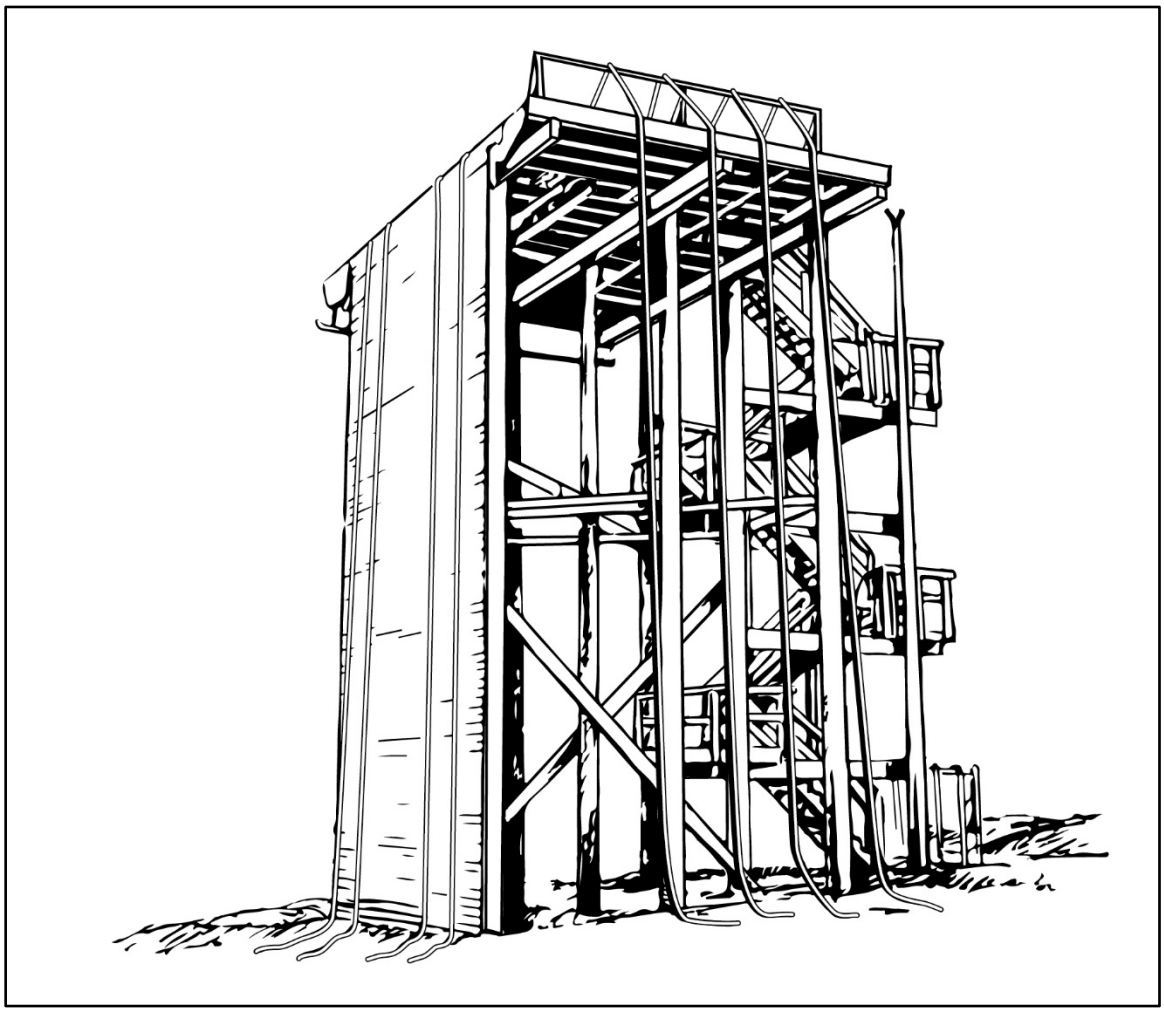


Figure 1-1. Static rappel tower

Note. Static rappel towers should be inspected annually by post safety or post engineers. Anchor points should be load tested every six months. Installations, major Army commands, and unit commanders may establish additional policies and safety procedures, as needed, to ensure safe and effective rappelling operations.

SECTION I – PERSONNEL

RAPPEL MASTER

1-1. Rappel training is overseen by the rappel master (known as RM). The proponent for accreditation, evaluation, and information for Army RM courses is the U.S. Army Infantry School, 1 Karker Street, Fort Moore, Georgia 31905-5410.

1-2. The RM is responsible for rappeller safety, the serviceability of all equipment (installation, unit, and personal property), and the personal supervision of rappelling operations.

1-3. RM qualification is awarded only after successfully completing a U.S. Army Training and Doctrine Command accredited RM course that includes the following subjects:

- Duties and responsibilities of an RM.
- Safety standard operating procedures, regulations, and references.
- Utilization of a deployment bag.
- Conduct an equipment rappel off the rappel tower.
- Conduct a lock-in.
- Talking a rappeller through completion of a rappel.
- Conduct ground training.
- Inspecting for proper hook-ups.
- Inspecting and maintaining equipment (gloves, carabiners, ropes).
- Identifying the rappel capabilities of aircraft used.
- Controlling rappels from UH-60 or CH-47 aircraft.
- Tying knots such as the figure-eight on a bight, end of line bowline, Prusik, clove hitch, Munter hitch, water knot; safety lines; and the hip-rappel seat.
- Inspecting a hip-rappel seat.
- Aircraft rigging for rappelling operations.
- Aircraft command and control.

1-4. To remain current, RMs must execute their duties in a tactical or training exercise once every six months. If RMs do not execute their duties once every six months, they must take a refresher class taught by a current RM. The refresher class includes subjects listed in the RM qualifications listed above.

1-5. Units may conduct ground training and wall-side tower rappelling without a school-trained RM if a fully qualified rappel safety officer (known as RAPSO) is on site to assume the duties and responsibilities of the RM. The RAPSO must be certified and appointed by the commander.

RAPPEL SAFETY OFFICER

1-6. The RAPSO serves as the officer in charge during all rappel operations. Holding the rank of staff sergeant or above, the RAPSO is trained on applicable RM tasks and is certified to serve in the position. Extensive training in rappel operations and risk management, or graduation from one of the following courses are RAPSO requirements: Rappel Master Course; Air-Assault Course, Ranger Course, or Basic Military Mountaineering Course (summer or winter). During open-side rappels, the RM can assume the duties of the RAPSO with the commander's permission.

1-7. The RAPSO is responsible for the overall safety of all rappellers and ensures that all safety precautions are followed. The RAPSO briefs visitors and inspecting authorities on training, safety requirements, and layout of training areas.

RAPPEL LANE NONCOMMISSIONED OFFICER

1-8. Safety is the rappel lane noncommissioned officers (NCOs) number one priority. The rappel lane NCO—

- Ensures proper safety procedures are followed.
- Ensures proper hookup once directed to a rappel lane.
- Issues commands and maintains eye contact with the rappeller at all times.

1-9. The rappel lane NCO is a commander-appointed corporal or above who is trained in the safe and proper execution of rappelling operations. Each tower rappel lane has a qualified rappel lane NCO to supervise lane operations. With the commander's approval, an experienced certified RM lane NCO can supervise two lanes simultaneously.

1-10. The rappel lane NCO is also trained on the following subjects:

- Responsibilities and safety requirements.
- Inspection and maintenance of equipment.
- Identification of satisfactory anchor points.
- Identification of safe and unsafe hookups.
- Establishment of a rappel point.
- Inspection of a hip-rappel seat.
- Rappelling procedures.
- Rescue rappelling.
- Belay control procedures.

1-11. If a rappel lane NCO has not conducted duties within the last six months, they are required to complete the training listed in the above paragraph under the supervision of a current RM.

RAPPELLER

1-12. Participants in tower rappel training complete the following requirements under the supervision of an RM. The unit commander ensures that personnel successfully complete these requirements before beginning aircraft rappelling. Individual rappellers—

- Identify all rappelling equipment.
- Demonstrate construction of the hip-rappel seat and/or donning a manufactured harness, proper use and hook-up of a rappel device and rappel rope.
- Identify unsafe attachments, equipment, rope connections, and seat construction.
- Define terms used in rappelling operations.
- Identify knots used in rappel operations.
- Understand and demonstrate rappel commands.
- Demonstrate rappelling positions.
- Demonstrate belaying procedures.
- Conduct one rappel from the wall side of the tower, then two from the open side. When the rappeller is conducting an aircraft rappel with equipment, then the two open-side rappels are with the equipment that is being used during that rappel.
- Demonstrate the ability to lock-in.

BELAYER AND BELAY SAFETY

1-13. Belay requirements are a subtask of basic rappel training. Soldiers learn to belay before learning rappel training. The belayer—

- Assumes a position at the base of the lane about one pace away from the tower area.
- Removes gloves and rucksack, if worn.
- Loosely holds the rappel rope with both hands to avoid interference with the rappeller while still maintaining control to stop the rappeller should they fall.
- Immediately stops the rappeller by pulling downward on the rappel ropes if the rappeller shouts, FALLING or loses control of their brake hand during descent.
- Watches the rappeller at all times and maintains constant voice or visual contact.
- Wears a helmet to prevent injuries from falling debris.

1-14. The belay safety should be an E-4 or higher and be properly trained in belay responsibilities, ensuring belay personnel are performing their duties properly. Rappel training requires one belay safety for every two rappel stations. The belay safety clears the belay Soldier when an auto-block rappel is performed.

SECTION II – PREOPERATION BRIEFINGS AND SAFETY PROCEDURES

1-15. The RM ensures Soldiers have a basic understanding of requirements and safety procedures before conducting training.

1-16. The following personnel and equipment are present during static tower training:

- One RM for each tower.
- One RAPSO.
- One rappel lane NCO per rappel station.
- One medic equipped with cervical collar, pelvic binder, and backboard.
- One belayer for each rappel lane.
- One safety or medical evacuation vehicle with dedicated driver.
- One belay safety for each two rappel stations (four ropes).
- Two military rappel ropes for each rappel station.

SAFETY BRIEFING

1-17. As in all training, a safety briefing precedes rappel operations. The RM briefs all personnel on safety and include the following instructions:

- Each rappeller ensures loose clothing and equipment is secure.
- Hip-rappel seats are tied (or harnesses donned) by the Soldier and inspected by the RM before climbing the tower. Hip-rappel seats are removed upon completion of every rappel. They are then retied and reinspected by a qualified RM or rappel lane NCO before subsequent rappels.
- Rappellers climb the tower only when directed by the RM or rappel lane NCO.
- Rappellers stay in the center of the tower until instructed to move to a rappel point.
- All personnel working within 3 feet of the edge on the top of the tower are attached to an anchor. The rappeller is properly hooked up to the rappelling ropes.
- When attaching the rappel rope to the carabiner, rappellers pull the slack toward the anchor point. The RM or rappel lane NCO physically check each hookup.
- In the case of an extremely heavy rappeller, a friction hookup is ordered at the discretion of the RM. A friction hookup is created by placing an additional two ropes in the gate of the carabiner (for a total of six ropes in the carabiner).
- Combat equipment is positioned on the rappeller so it does not interfere with the brake hand. The weapon is slung diagonally across the back with the muzzle pointing down and on the opposite side of the brake hand.
- Heavy-duty gloves with friction pads are required for all rappel training. Less preferred but also authorized is using standard-issue leather work gloves with issued liners.
- Ballistic or safety helmets with chin straps fastened are worn during tower rappel training.
- While on the tower, the rappeller maintains eye contact with the RM or rappel lane NCO and receives all commands from them.
- The rappeller ensures that they have a belayer on their rope.
- The belayer always keeps both hands on the rope and faces the rappeller at all times.
- All tower rappelling is performed with a double strand of rope when rappelling with the
- carabiner system.
- No running is allowed on the tower.
- All participants who are unable to rappel, lack confidence, or refuse to rappel are reported to the RM or officer in charge.

TOWER SAFETY AND PREPARATION

1-18. The RM oversees the tower. Duties include conducting a visual and physical inspection of every item of equipment. Other safety and preparations include:

- A tower is not used during thunderstorms. If ice or other inclement weather is present, rappelling is conducted with caution and reflected in the commander's risk mitigation.
- All rappel lanes are rigged with a primary and secondary anchor point (see figure 1-2). Only authorized knots are used. The RM removes all slack between the knots to create equal tension on the anchor points and ensures rappel ropes reach the bottom with an additional 10 feet of additional rope on the ground.
- In the case that a tower has a unique anchor point configuration, a rappel lane must have its own single dedicated primary anchor point. If necessary, a maximum of two rappel lanes may share a secondary anchor point.
- When rigging a lane with a hitching post, although not mandatory, one turn of the rappel ropes may be used to prevent lateral movement along the horizontal beam.

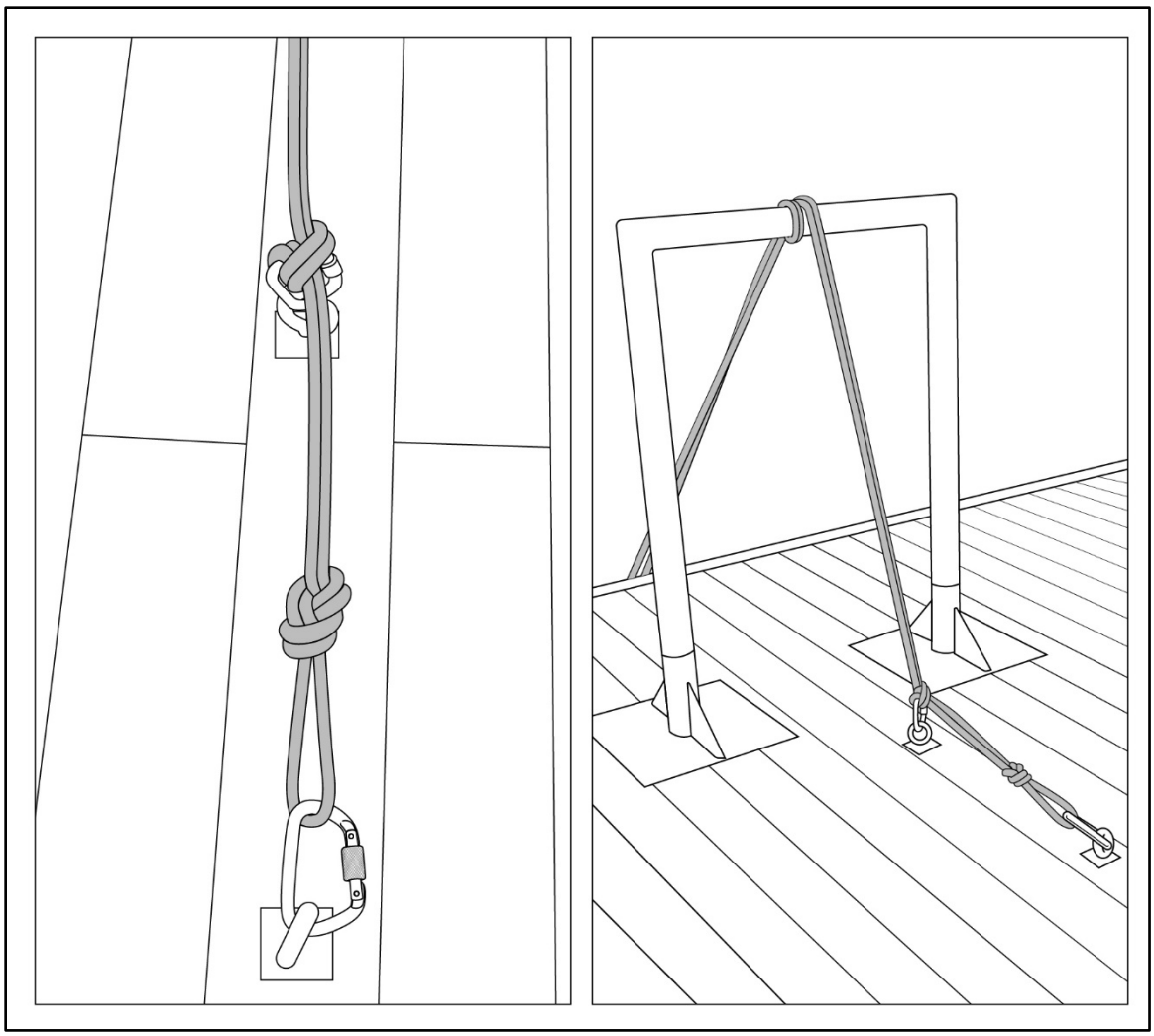


Figure 1-2. Example of rappel tower anchor points

Note. The clove hitch-figure-eight on a bight anchor system is shown, but other authorized anchor knots may be preferred when the tower has nonconventional anchor points.

RAPPELLER PREPARATION

1-19. Before conducting a rappel, every rappeller prepares their individual clothing and equipment. Strict attention is paid to the following:

- Secure shirt tails, loose clothing, equipment, straps, and long hair.
- Wear a helmet during rappelling. Properly fasten all straps and buckles.
- Wear heavy duty leather gloves with friction pads.
- Wear identification tags.
- Fasten equipment in the front or in a manner that allows visual inspection and does not impede the use of rappelling equipment when rappelling with authorized load-bearing equipment.
- Wear the rucksack high and tight on the back of the rappeller to allow the brake hand to reach the small of the back. Rucksack adjustment straps are fastened across the chest or tucked away.
- Sling weapons diagonally across the back with the muzzle down. Ensure the muzzle is on the guide-hand side and the stock is toward the brake hand.

SECTION III – RAPPELLING PROCEDURES

1-20. This section discusses procedures used in tower rappelling.

HIP-RAPPEL SEAT

1-21. There are two types of rappel seats: the manufactured harness and the hip-rappel seat. The manufactured harness is a preconstructed webbing loop system that connects the rappeller's body to the carabiner. It is industry produced rather than being tied by the rappeller. The hip-rappel seat is a field expedient harness that is tied by the rappeller using rope. When using a rappel seat, friction is created between the connecting carabiner and the rappelling rope. This method provides an efficient and controlled descent. Wear heavy-duty leather gloves with friction pads to prevent rope burns.

HIP-RAPPEL-SEAT HOOKUP

1-22. To hookup using the hip-seat method, perform the following:

- Place the square knot with two overhand knots toward the anchor point for all hip-rappel seats. When using a manufactured harness, the rappeller's guide hand side is toward the anchor point.
- Grasp the two ropes with both hands and drop them through the gate of the carabiner. (At this point, two ropes should be running through the carabiner.)
- Using the hand closest to the anchor point, pull the slack toward the anchor point. Rotate the slack under and then over the top of the carabiner.
- Drop the two ropes a second time through the gate of the carabiner. (At this point, four ropes should be running through the carabiner.)
- Lock the carabiner.
- Place the guide hand on the rope between the anchor point and the carabiner (palm facing up).
- Place the brake hand around the running end of the rope (palm facing down). Place the brake hand with the rope in the small of the back.

TOWER PROCEDURES

1-23. After the rappeller climbs the tower, the following procedures are adhered to:

- The RM waives the rappeller forward to their rappel lane and ensures a proper hookup.
- The RM tells the rappeller their lane number and gives the command GET READY, accompanied by the hand and arm signal.
- The rappeller looks over the edge of the tower, makes eye contact with the belayer, and states their lane number followed by ON RAPPEL. The belayer acknowledges by replying with the lane number followed by ON BELAY.

- The RM then gives the hand and arm signal for POSITION. The rappeller assumes the L-shaped position at the edge of the tower.
- At this point, the RM gives any instruction, then the hand and arm signal GO. The rappeller
- rappels down the tower.

Note. Do not grip the rope firmly with the brake hand while the brake hand and brake arm are extended at a 45-degree angle. If this is done while rappelling, the brake hand and glove may become entangled in the carabiner causing injury to the hand and causing the rappeller to become hung up on the ropes.

HAND AND ARM SIGNALS

1-24. GET READY-RM or lane NCO extends both arms to the front with fists clenched and thumbs pointing upward (see figure 1-3). This alerts the rappeller. Each rappeller looks over their brake hand shoulder to check for the belayer. The rappeller then looks at the RM. The RM or lane NCO ensures a proper hookup.

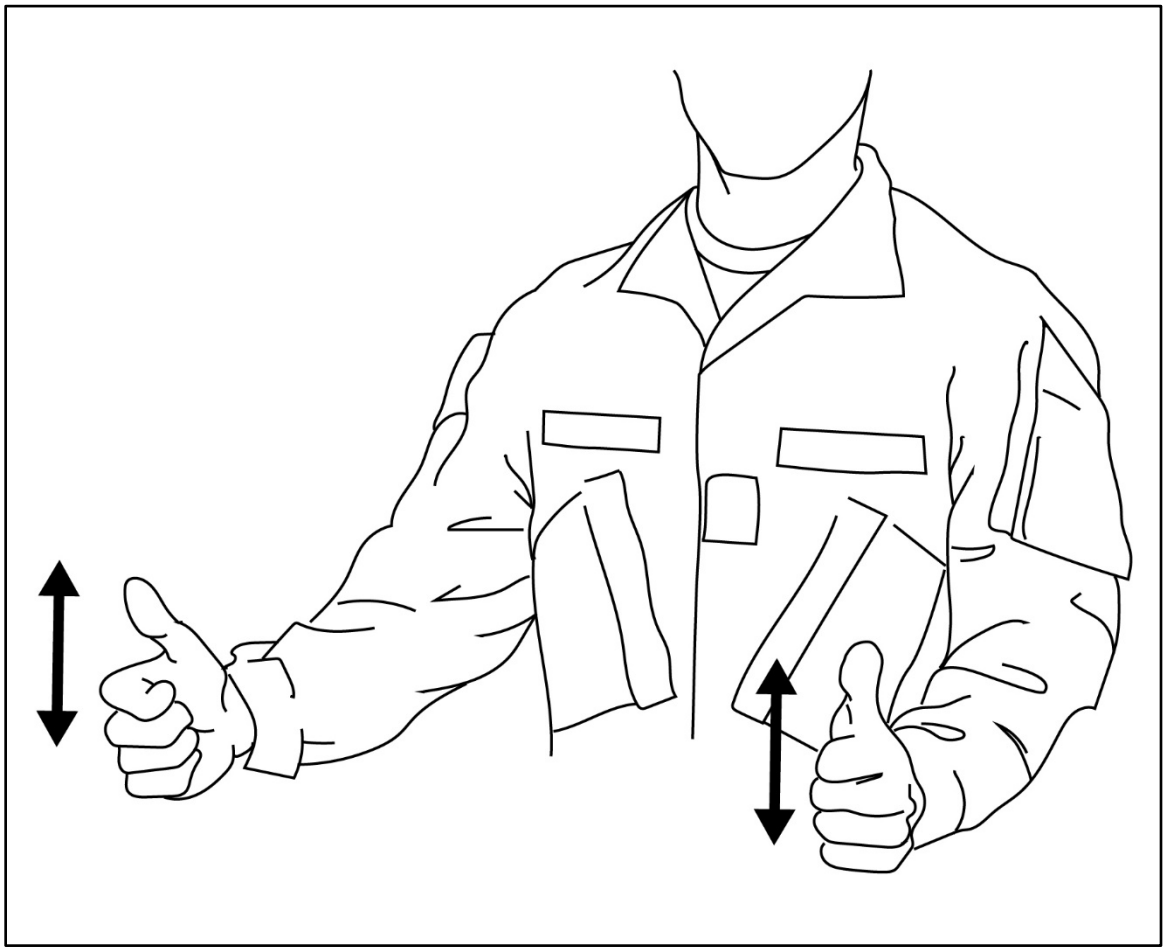


Figure 1-3. Example of hand and arm signal, GET READY

1-25. POSITION-the lane NCO extends both arms to the front, elbows locked, forearms pointed downward, and fingers extended and makes a circular motion with both forearms rotating in opposite directions (see figure 1-4).

1-26. With the brake hand in the small of the back, the rappeller rotates 180 degrees out onto the edge and assumes an L-shaped position. The feet should be shoulder width apart, balls of feet on the edge, knees locked, and body bent at the waist (see figure 1-5).

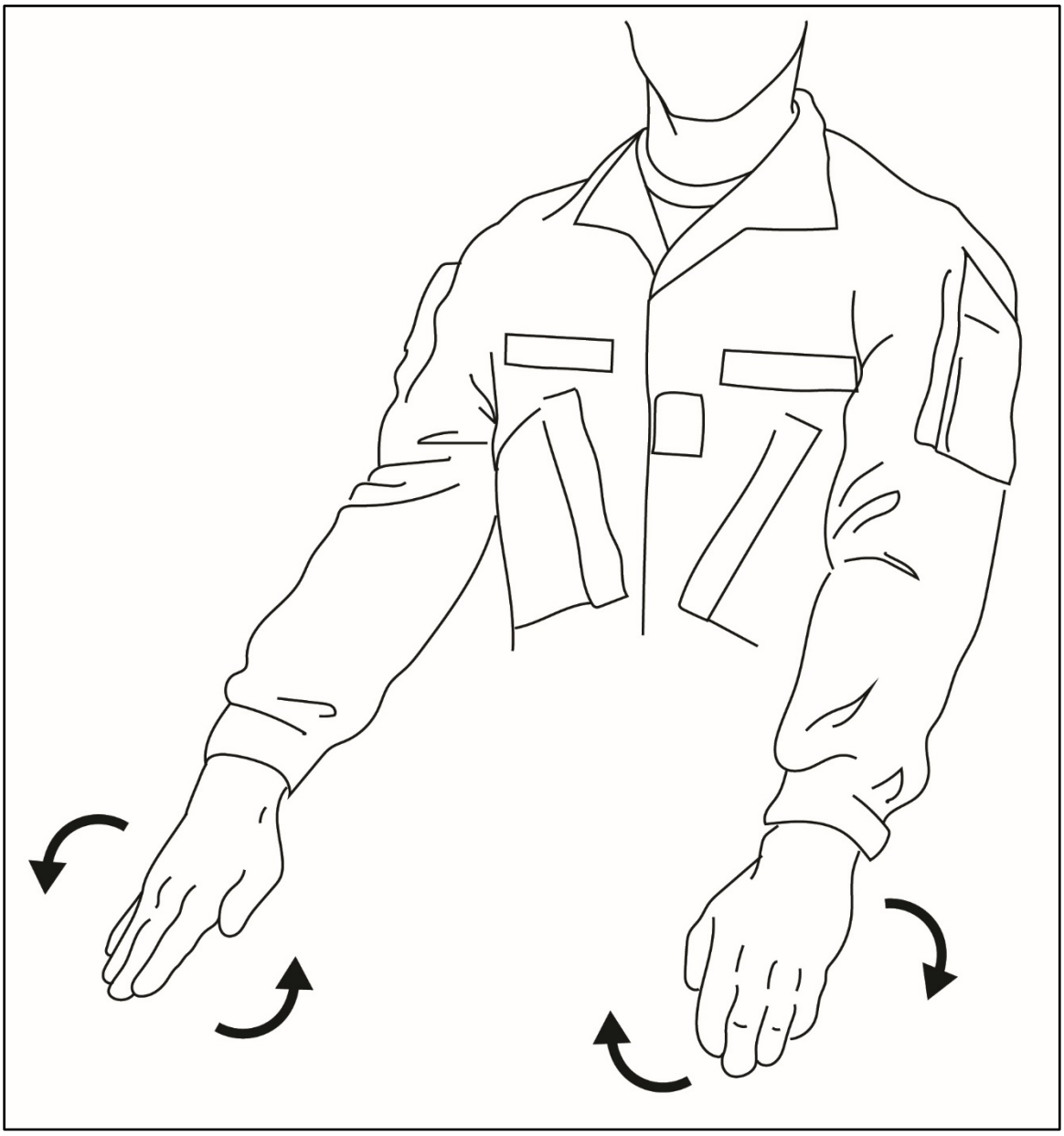


Figure 1-4. Example of hand and arm signal, POSITION



Figure 1-5. L-shape position

1-27. GO-the lane NCO extends their right arm with the elbow locked, fingers extended, thumbs around the index fingers, and points directly at the rappeller (see figure 1-6). This initiates the rappel. The rappeller lets the brake hand out at a 45-degree angle, letting the rope slide through the brake hand and the guide hand. The rappeller looks over the brake hand shoulder when descending and-

- Descends in a smooth, controlled manner.
- Maintains eye contact with the ground when descending.

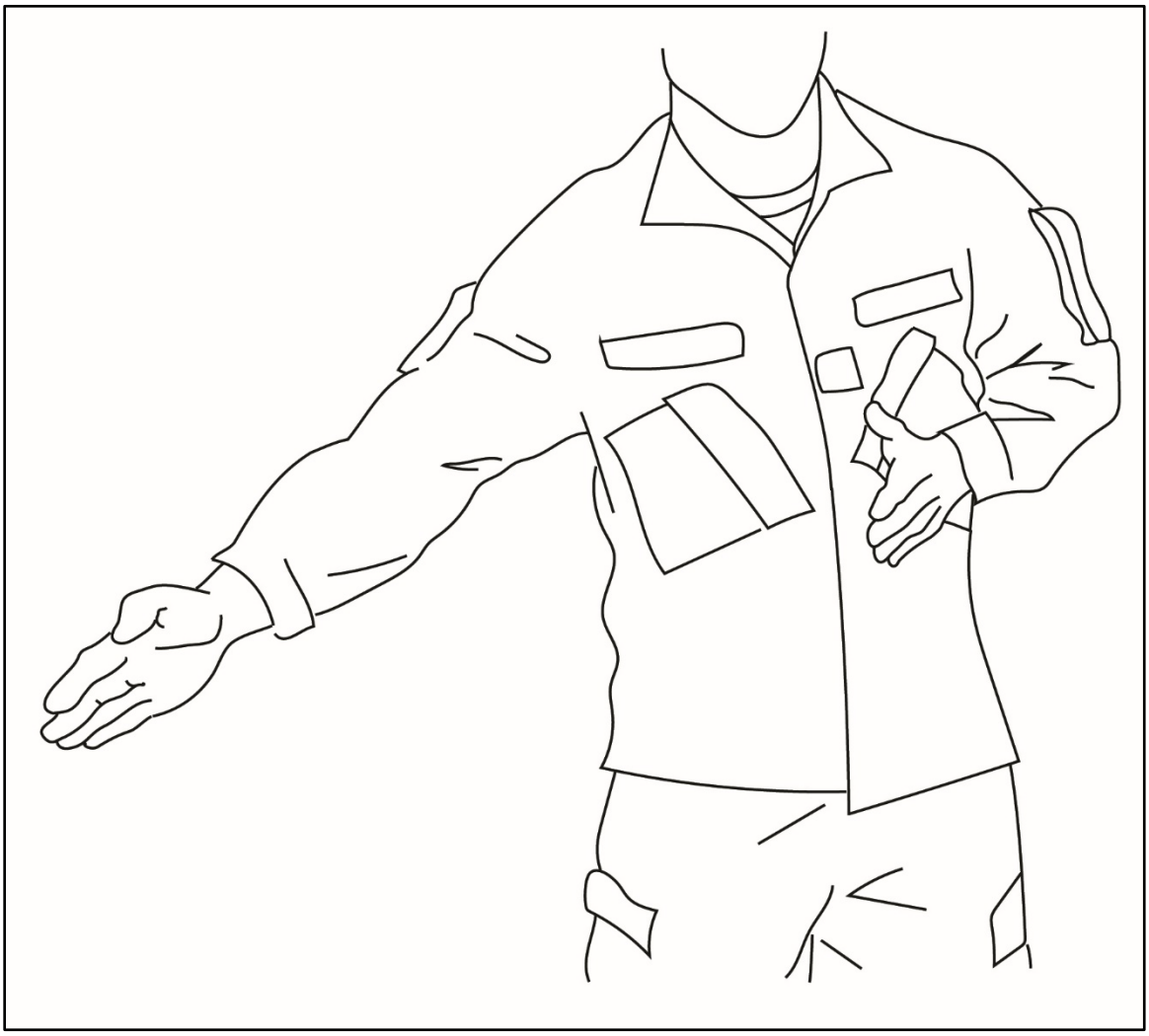


Figure 1-6. Example of hand and arm signal, GO

- Maintains a modified L-shape position during descent with feet and knees together, knees flexed, and buttocks parallel to the ground. (see figure 1-7).
- Uses a modified L-shape with the legs slightly lower than the buttocks to compensate for the added weight when carrying equipment or additional weight.
- Keeps back straight while looking over the brake hand shoulder.



Figure 1-7. L-shape position while rappelling

- Extends the guide hand on the rope with the elbow extended and locked.
- Allows the rope to slide freely through the guide hand, which is used to adjust equipment and assist balance during descent.
- Places the brake hand (with rope in hand) in the small of the back and then grasps the rope firmly with the brake hand to brake.

- Releases tension on the rope and moves the brake hand out to the rear at a 45-degree angle to regulate the rate of descent.
- Never releases the rope with the brake hand until the rappel is completed.
- Acts as the belayer for the next rappeller after the rope is cleared and the rappeller is off rappel.

RAPPEL TOWER TRAINING FOR AIRCRAFT

1-28. Rappel tower training for the UH-60 Blackhawk is similar to that for the CH-47 with the exception that if the RM chooses, they are not required to use a hitching post when training for CH-47 rappels. The edge of the rappel tower is used as a pivot point to assume the L-shape position (see figure 1-8).

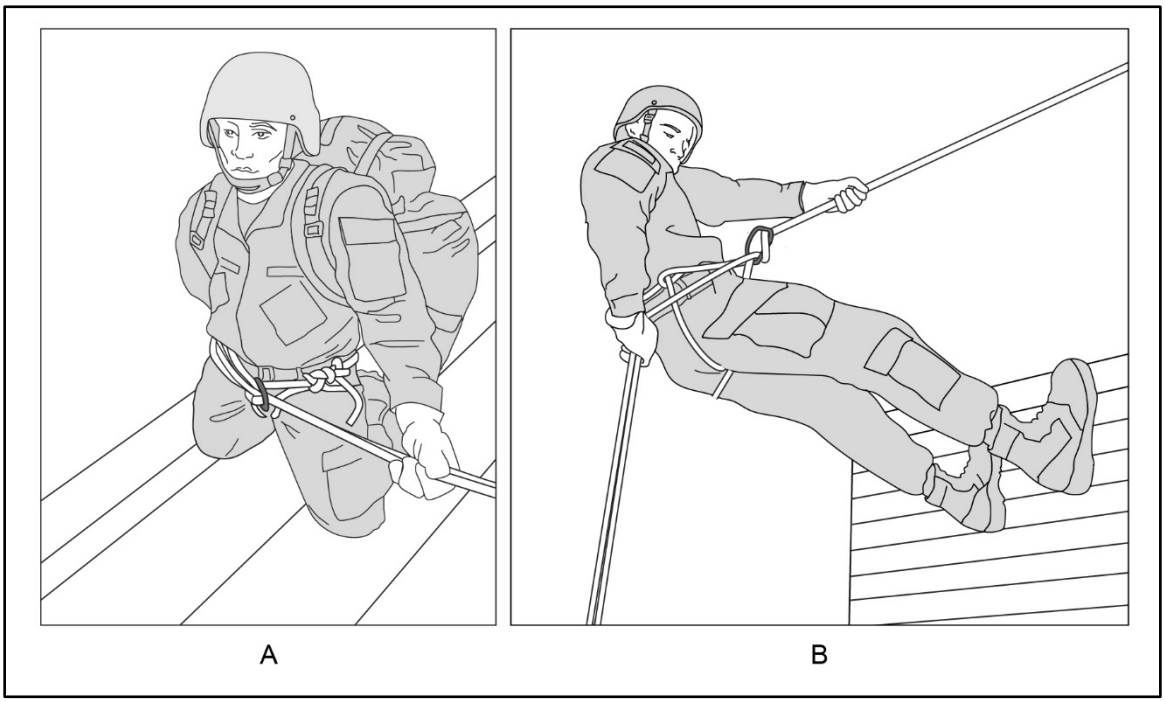


Figure 1-8. Helicopter rappel training

EMERGENCY LOCK-IN PROCEDURES

1-29. Mastering the lock-in procedure during tower training is important for tower and aircraft rappelling. Using the lock-in procedure allows Soldiers to hold in position for an extended period of time.

1-30. If the helicopter gains altitude above the length of the rappel ropes, the rappeller immediately brakes, locks-in, and waits for the descent of the aircraft. Procedures for lock-in are as follows:

- Place the brake hand in the small of the back and brake to a complete stop.
- Release the guide hand from the ropes.
- With a scooping motion, bring the guide hand around the back and grasp the running end of the two rappel ropes behind the brake hand.
- Using the guide hand, bring the two running ends of the rappel ropes around to the front.
- Secure these two running ends of the rappel ropes with the two anchor ends of the rappel ropes in the guide hand. This is now the new brake hand.
- Remove the old brake hand from the small of the back. Bring it around to the front and grasp the two ropes from the anchor point at a point just above the new brake hand. The old brake hand is now the new guide hand.

- Face the RM and wait for their command to lower to the ground.
- When the command is received from the RM to continue the descent, bring the brake hand to a 45-degree angle to the rear. When it is time to brake, bring the new brake hand around to the front diagonally across the chest.

1-31. If an engine fails or an aircraft emergency occurs during rappelling, the rappellers on the ropes descend as rapidly as possible and move from beneath the aircraft to the sides. If possible, rappellers maintain control of the ropes.

COMMUNICATIONS

1-32. The rappeller at the top of a rappel point must be able to communicate with those at the bottom. Radios, hand signals, and rope signals are considerations during a tactical rappel. For training situations, use the commands in table 1-1.

Table 1-1. Rappeller commands

COMMAND	*GIVEN BY*	*MEANING*
LANE NUMBER, ON RAPPEL	Rappeller	I am ready to begin rappelling.
LANE NUMBER, ON BELAY	Belayer	I am on belay and you may begin your rappel.
LANE NUMBER, OFF RAPPEL	Rappeller	I have completed the rappel, cleared the rappel line, and am off the rope.
LANE NUMBER, OFF BELAY	Belayer	I am off belay.
LANE NUMBER, FALLING	Rappeller	I am falling. Be alert below—belay man brake.

1-33. After explaining the procedures to all rappellers, the RM should have an assistant demonstrate one complete cycle of rappelling from the static tower. This ensures that the rappellers can hear all the proper commands and see the actions and techniques used on the static tower.

This page intentionally left blank.

Chapter 2

Helicopter Rappelling

Helicopter rappelling can provide a means of quick insertion with or without a landing zone. The following chapter discusses how to conduct a safe and effective helicopter rappel.

SECTION I – PERSONNEL AND SUSTAINMENT REFRESHER TRAINING

2-1. Personnel required for helicopter rappelling include the RM, RAPSO, crew chief, pilot-in-command (known as PIC), the rappellers, and belayers. The following section describes additional responsibilities and requirements for each duty position when conducting a helicopter rappel.

RAPPEL MASTER

2-2. A qualified RM is aboard each aircraft. The RM—

- Ensures internal communication between the pilot and RM, and external communication between the aircraft and the ground.
- Inspects all equipment and uses only authorized, serviceable equipment.
- Inspects all anchor points and knots before the mission starts.
- Ensures all rappellers receive a safety briefing, and the pilots and aircrew receive an air mission brief.
- Ensures rappellers are rappel qualified before conducting helicopter rappelling.

RAPPEL SAFETY OFFICER

2-3. The RAPSO is a staff sergeant or above. Having overall responsibility for the safety of all rappellers, the RAPSO ensures safety precautions are followed, and communication is maintained with the pilot and RM through frequency modulation (FM) radio at all times. The RM and pilot are alerted about any unsafe acts.

GROUND-TO-AIR

2-4. The designated ground-to-air is a subtask of the RAPSO. The ground-to-air maintains communication with the PIC.

CREW CHIEF

2-5. The crew chief is responsible for configuring the aircraft for rappels and testing the anchor points. The crew chief is also the alternate for communications between the RM and PIC.

PILOT-IN-COMMAND

2-6. The PIC of the aircraft-

- Ensures that the aircrew and all non-aircrew personnel are briefed and understand
- their responsibilities during rappelling operations, including aircraft safety and action in the
- event of an emergency.
- Emphasizes procedural techniques for clearing, recovery, and/or jettison of ropes.
- Keeps the aircraft centered over the target with corrections from the RM, as required.

RAPPELLER

2-7. Individual rappellers complete training under the supervision of a qualified RM to participate in helicopter rappelling operations. The required prerequisite training is outlined in chapter 1, paragraphs one through twelve.

BELAYER

2-8. A belayer is assigned to each rope and is responsible for walking the rope beneath the helicopter during the ascent and away from the aircraft during the descent. Walking the rope is defined as minimizing the slack from underneath the helicopter but not removing all the slack. This would prevent the rappeller from descending. The belayer also makes sure the ropes are not caught on the aircraft.

SUSTAINMENT TRAINING

2-9. Before conducting helicopter rappel training, the unit or element conducts sustainment training. This includes-

- Reviewing the construction of a hip-rappel seat, all equipment to be used, and hook-up procedures.
- Conducting rappels on one wall-side Hollywood rappel and two open-side rappels (one of these must be a lock-in). If the aircraft rappel is an equipment rappel, then at least one open-side rappel is done with equipment.

SECTION II – PREOPERATIONAL BRIEFINGS AND SAFETY PROCEDURES

2-10. This section discusses safety, medical and communications requirements, and the procedures to follow during unusual conditions such as adverse weather or terrain conditions, and night operations. Personnel must use sound judgment to determine what action to take depending on the nature and severity of the conditions.

MEDICAL COVERAGE

2-11. A qualified and equipped medic is present to respond to any mishap. Medical transportation is also available. Absence of a medic, medical equipment, or transportation terminates the training. If the situation warrants (and with permission of the aircrew) the aircraft can be used as a medical evacuation vehicle.

COMMUNICATION REQUIREMENTS

2-12. During helicopter rappel training, the RAPSO has radio communication with the aircraft. Communications with the air crew is established before rappelling operations begin. Additionally, the RAPSO informs the PIC to stop operations if any unsafe condition develops.

ADVERSE WEATHER CONDITIONS

2-13. Rappel operations are not conducted under the following conditions:

- Winds more than 30 knots.
- Lightning strikes within 1 nautical mile of rappelling operations.
- Wind chill factors caused by the helicopter's rotor wash or air speeds that can cause cold
- weather injuries.
- Water or ice on the rope inhibiting the ability of the rappellers to control their descent.
- Blowing particles produced by rotor wash causing the aircrew or RM to lose visual contact
- with the ground.

NIGHT OPERATION REQUIREMENTS

2-14. The following requirements are necessary for night rappelling operations:

- Chemical lights are attached to the end of the rope and on each rappeller.
- One chemical light is secured at the attachment point of the rope.
- Night vision goggles are not worn by rappellers during the descent. Aircrew members wear night vision goggles when required during night operations. Night vision goggle lighting criteria is according to Army regulations, specific aircraft aircrew training manuals, unit standard operating procedures, or the tactical environment.

SAFETY BRIEFING

2-15. The following safety measures are enforced:

- Loose clothing and equipment are secured.
- Helmets are worn with chin straps fastened.
- Rappellers wear identification tags, earplugs, carry identification cards, and roll down
- their sleeves.
- Weapons are slung diagonally across the back with the muzzle pointing down on the guide
- hand side.
- All hip-rappel seats and rappelling equipment is inspected by an RM before rappelling.
- The proper approach for UH-60 is 90 degrees from the side, away from the front of the aircraft and tail rotor. When approaching or departing the helicopter, Soldiers bend their bodies forward at the waist to ensure clearance of the rotor blades.
- The proper approach for CH-47 is 45 degrees from the rear, away from the engine exhaust.
- Upon boarding UH-60 aircraft for elevators, the first rappellers kneel, hook up, and apply their brake hands to the small of their backs. Any subsequent rappellers hook up to a safety line and sit down where instructed by the RM.
- Upon boarding the CH-47 aircraft, rappellers sit where instructed by the RM, either seated on the floor with a safety restraint or on seats with a seatbelt on.
- While in the helicopter, the rappeller maintains eye contact with the RM and receives commands from the RM.
- The rappeller ensures they have a belayer on their rope at all times when conducting training
- at a hover site.
- During the descent, the rappeller maintains eye-to-ground contact.
- If the rappeller sees their rope coming off the ground or sees their belayer has lost control of
- the rope, they immediately brake and execute a lock-in. The rappeller then waits for commands from the RM.
- The rappeller brakes once every 30 feet during descent.
- The belayer does not wear gloves. They keep both hands on the rope and their eyes on the
- rappeller at all times.
- All rappelling is conducted using a double strand of rope.

SECTION III – DEPLOYMENT OF ROPES

2-16. Deployment of the ropes from a helicopter is a critical task. To prevent ropes becoming entangled, ropes are deployed using a positive control technique. Two techniques that may be used are the deployment bag technique and the log coil technique. This deployment bag technique applies to the original deployment bag.

DEPLOYMENT BAG TECHNIQUE

2-17. The rappeller places the deployment bag (known as a D-bag) (standard) on a flat surface with the stow loop facing upward. If the D-bag still has a static line, the rappeller removes it by cutting the static line where it attaches to the bag. A 12-foot section of the static line can be used as a safety line in the helicopter.

- Use a sandbag with about one E-tool spade full of sand as a weight in the deployment system. Roll the sandbag into a rectangular shape, tie it, then place it in a small plastic bag, rolled and taped. Place a retaining band over the middle of the weight and place the weight on top of the D-bag. The weight should be about the same width as the D-bag.
- Lay out and inspect the two ropes. The working ends (closest to the D-bag) should be even. Place a round turn with the two working ends of the ropes on the weight's retaining band. Working on top of the deployment bag, start forming zigzags. The stack should consist of 8 to 10 zigzags, one on top of another-do not exceed the width of the D-bag. Then, starting from either side, center a retaining band over the stack. Ensure that it is over all the zigzags in the stack. Repeat the process each time, placing one stack in front of the other. Continue until about 10 feet of rope remains. If

one rope is shorter than the other, the end of the shorter rope should be about 10 feet from the last stack.

- For a secondary anchor point, tie a figure-eight on a bight. Ensure that 6 feet of rope remain out from the rope stowed in the deployment bag.
- For the primary anchor point, use both ropes to tie a clove hitch.
- To place the ropes in the D-bag, remove the bag from under the stack of rope. Place the weight into the bottom of the D-bag, and place all the stacks of zigzags, in the order they were made, one on top of the other into the bag.
- Use two left, two right, and two rear loops for the opening of the D-bag. Do not use the two rear loops. Close the flap on the D-bag and push the loops through the aligning holes on the flap. Using an 8-inch piece of gutted 550-pound cord, tie the two loops together with a square knot and two hitches. Ensure that two 120-foot ropes are coming out of the center of the flap-not to one side. Repeat the process and tie the right loops together. Wrap the excess rope lengthwise around the bag.

LOG COIL TECHNIQUE

2-18. The rappeller lays the running end of the double rope along the length of the coiling log. The Solider then coils the double rope around the running end of the rope and the coiling log. The rope is coiled evenly and tightly (see figure 2-1).

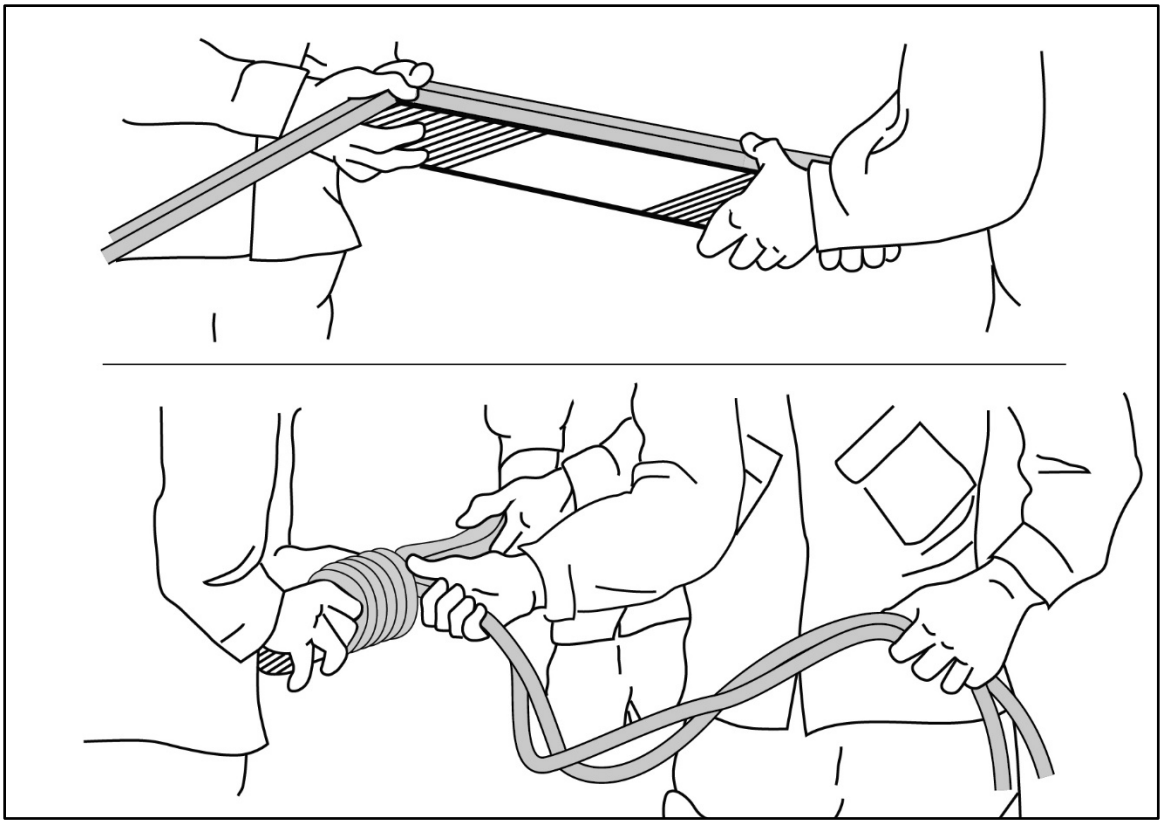


Figure 2-1. Coiling log

SECTION IV – RAPPELLING OPERATIONS FOR THE UH-60 HELICOPTER

2-19. The techniques used by the rappeller when rappelling from different aircraft are similar. However, positioning, seating, and the tie-down anchor point are different. Before aircraft rappelling, each rappeller is trained on the specific aircraft used for the operation.

CHARACTERISTICS

2-20. The UH-60 is a twin-engine, medium-speed, single main-rotor helicopter that can transport a maximum of ten rappellers, one RM, and one four-man crew. It is equipped with four 3,500-pound rated capacity cabin ceiling tie-down fittings (rings) located on the ceiling of the troop/cargo compartment. The ceiling fittings are used as the primary and secondary rappelling rope anchoring points.

RIGGING THE UH-60 FOR RAPPELLING

2-21. The RM rigs the UH-60 helicopter by performing the following:

- Tapes any sharp edges or protrusions on the cargo floor and door edges that may come in contact with the rappeller or the rappelling rope.
- Extends the RM's intercom cord to the rear over the aft utility drain line and tapes the cord to the overhead troop seat support tube.
- Verifies presence of floor restraint provisions for rappellers.
- Rigs and connects rappelling ropes to the aircraft's primary and secondary anchor points.
- Installs the recovery rope for endangered rappellers.
- Tapes the unused floor rings.

SECONDARY ANCHOR POINT

2-22. The RM ties a figure-eight on a bight on the standing end of the rope and attaches the secondary carabiner to the adjacent overhead cargo restraint net ring (see figures 2-2 and 2-3 on page 20). The carabiner is locked and taped to ensure the vibration from the aircraft does not loosen the carabiner bezel.

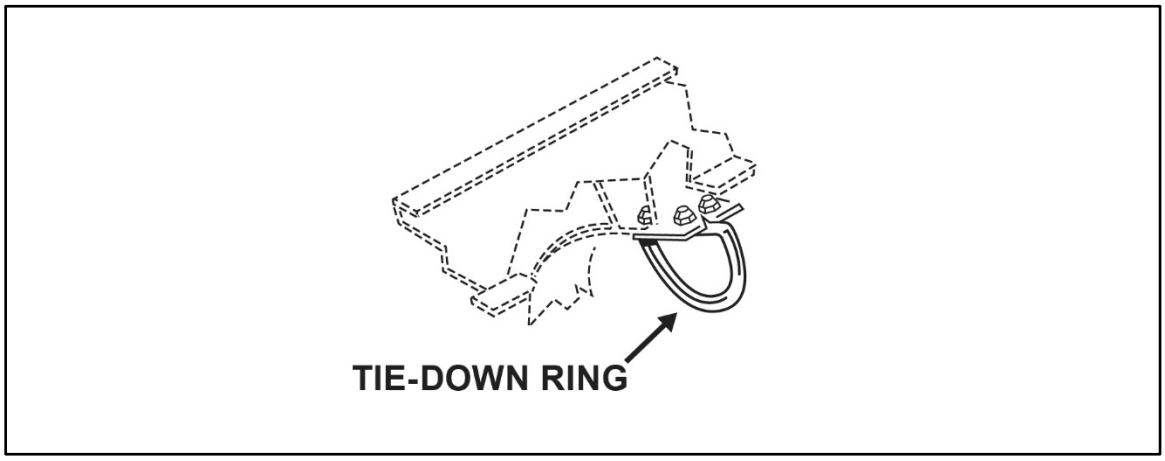


Figure 2-2. Secondary carabiner attaching point

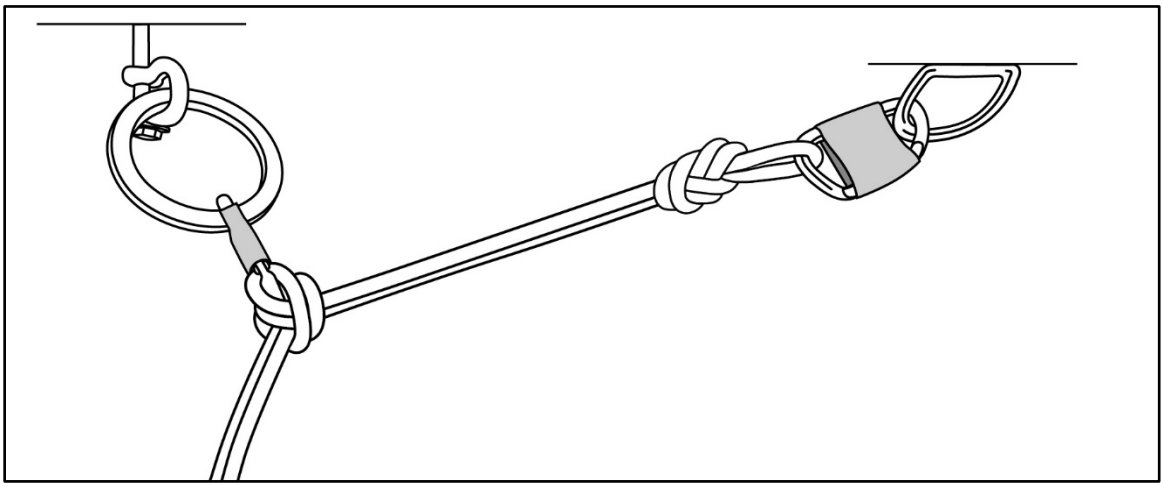


Figure 2-3 Primary and secondary carabiner attaching points

PRIMARY ANCHOR POINTS

2-23. The RM attaches a carabiner to the primary tie-down ring. The RM then ties a clove hitch and inserts the knot into the carabiner. Then the RM works out all the slack between the primary and secondary anchor points. Finally, locks and tapes the carabiner (see figure 2-4).

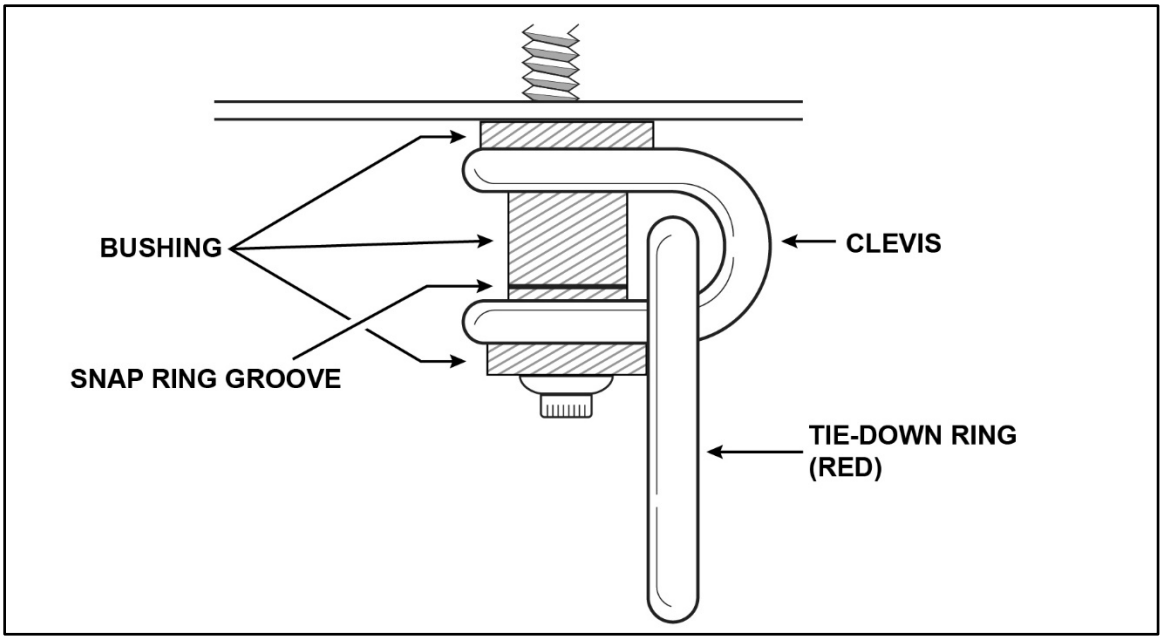


Figure 2-4. Primary carabiner attaching point

SEATING ARRANGEMENTS

2-24. All rappellers should know the seating arrangements and loading procedures. They are rehearsed under supervision of the RM before conducting the operation.

- A maximum of ten rappellers, with or without combat equipment, and one static RM is seated and restrained aboard the UH-60 helicopter (see figure 2-5). Rappellers number 1 through 6 and the RM are seated on the cargo floor. The rappellers are restrained using safety lines that are attached to the cargo tie-down rings on the floor of the aircraft. The safeties are attached to the rappellers with carabiners that are attached to their hip-rappel seats. The RM is also secured, extends the RM's

intercom cord to the rear over the aft utility drain line and tapes the cord to the overhead troop seat support tube.

- Rappellers 7 through 10 are seated on the troop seats. They are secured by the seat belts. If all the seats are removed from the aircraft, rappellers 7 through 10 are restrained in the same manner as rappellers 1 through 6.

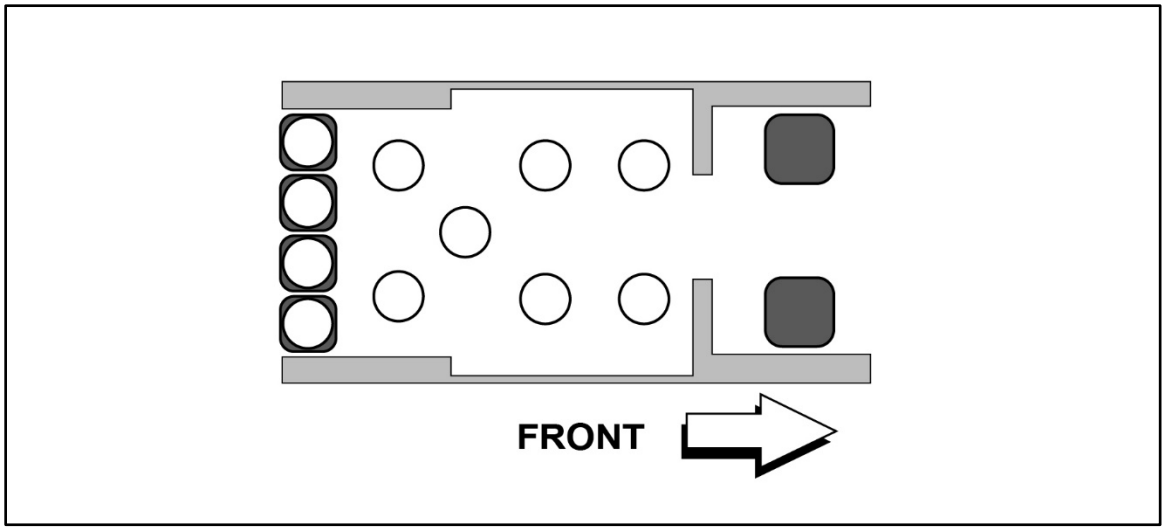


Figure 2-5. UH-60 maximum rappeller seating arrangement

UH-60 RAPPELLING PROCEDURES

2-25. The RM ensures all Soldiers follow rappelling procedures for the safe and efficient execution of the operation. These procedures are rehearsed under the supervision of the RM. This includes:

- The RM is equipped with a headset and maintains communications with the pilot at all times. The RM is restrained and positioned in the center of the cargo floor to maintain control of the rappellers, their ropes, and all anchor attaching points.
- After all rappellers are in the aircraft, they hook up their safety restraint to the hip-rappel seats, or fasten their seat belts. When conducting elevators, the first four hook up to the rappelling ropes.
- After the first four rappellers exit and clear their ropes, the RM places the subsequent rappellers in position to hook up. When hooked up, the RM releases the rappellers' safety lines.
- After checking the rappellers for the correct hookup, and the four rappellers exit and clear ropes, and the RM hooks up the final two rappellers.
- After checking the final rappellers for correct hookup and the rappellers clear the ropes, the RM releases the ropes. If conducting elevators, the RM tells the PIC that they are cleared to descend.

RAPPELLING COMMANDS

2-26. The same commands are used for the UH-60 and CH-47. The rappelling commands are as follows:

- THROW ROPES. This command is given when the helicopter reaches a stable hover.
- HOOKUP. The rappellers hook up in their respective lanes.
- GET READY. This alerts the rappeller. The rappeller and the RM perform final checks of the hookup, hip-rappel seat, carabiner, and equipment.
- POSITION. From a kneeling position with the brake hand in the small of the back, the rappeller rotates 90 degrees so they are facing the inside of the aircraft and the RM. The rappeller then places their heels on the edge of the floor of the helicopter doorway and leans out into an L-shaped position. The rappellers' feet are shoulder-width apart, the balls of their feet are on the edge of the helicopter doorway. Their knees should be locked with their bodies bent at the waist toward the helicopter.
- GO. The RM initiates the rappel with this command. The rappeller lets their brake hand out at a 45-degree angle, letting the running ends of the ropes slide through both the brake hand and guide hand.

HAND AND ARM SIGNALS WITH COMMANDS

2-27. The hand and arm signals that are used with rappelling commands are as follows:

- THROW ROPES (see figure 2-6). The RM extends both arms to the front with elbows locked, and fists clenched. The RM brings their fists to their chest and extends them back out.

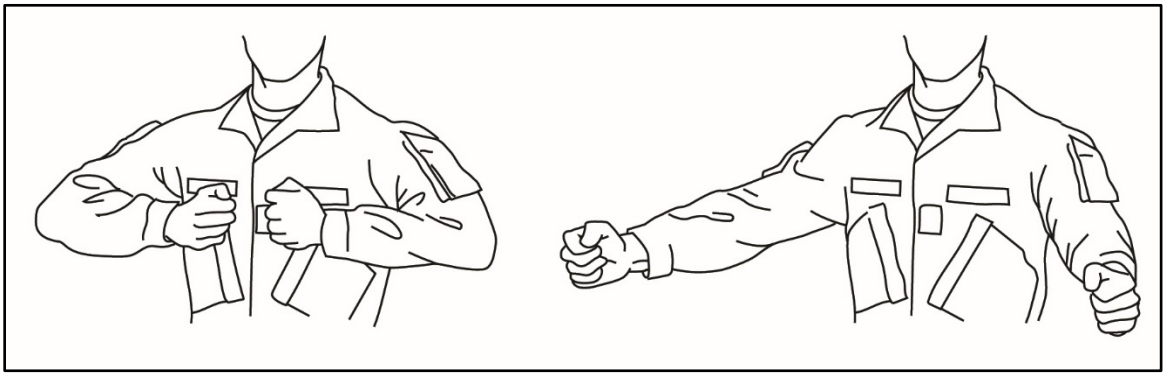


Figure 2-6. Hand and arm signal for THROW ROPES

- GET READY (see figure 2-7). The RM extends both arms to the front with fists clenched and thumbs pointing upward. The RM moves hands in an up-and-down motion.

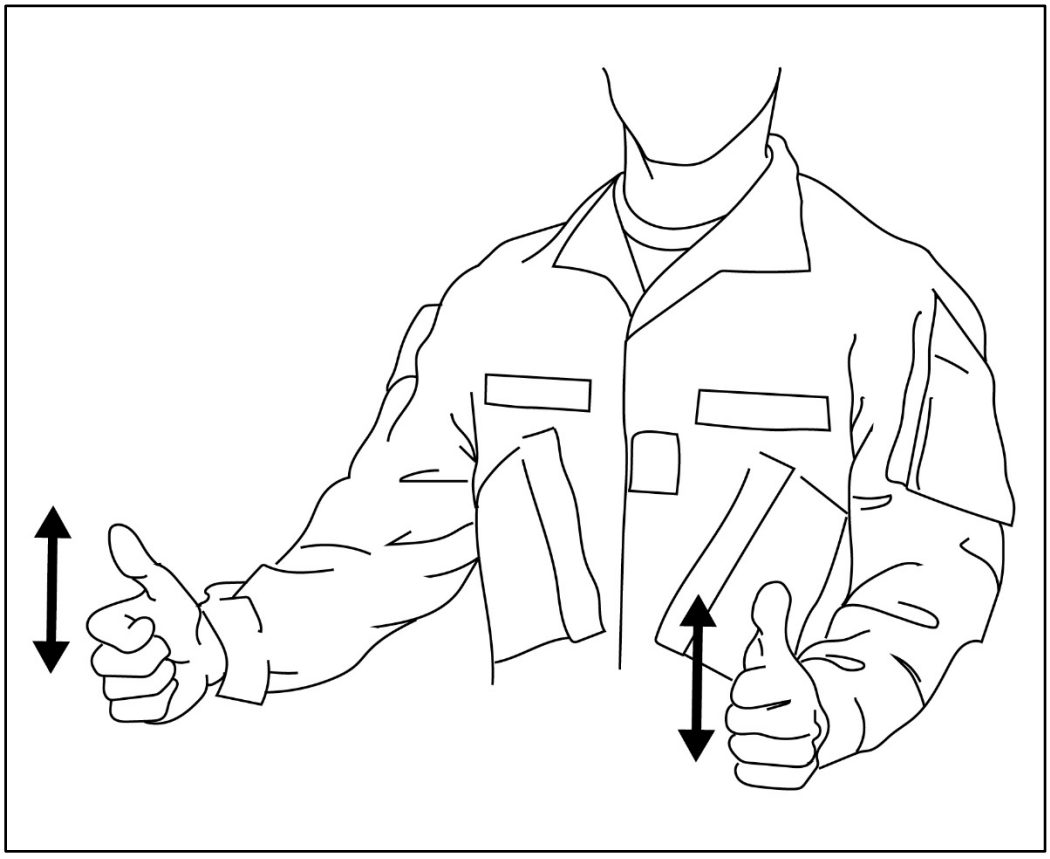


Figure 2-7. Hand and arm signal for GET READY

- POSITION can be depicted by two hand and arm signals. Figure 2-8 depicts the primary signal and figure 2-9 on page 24 depicts the alternate signal.
- For the alternate signal for POSITION, The RM extends both arms to the front with elbows locked, fists clenched, and index fingers extended. The RM bends at the waist so their arms are below their waist and makes a circular motion with arms rotating in opposite directions.

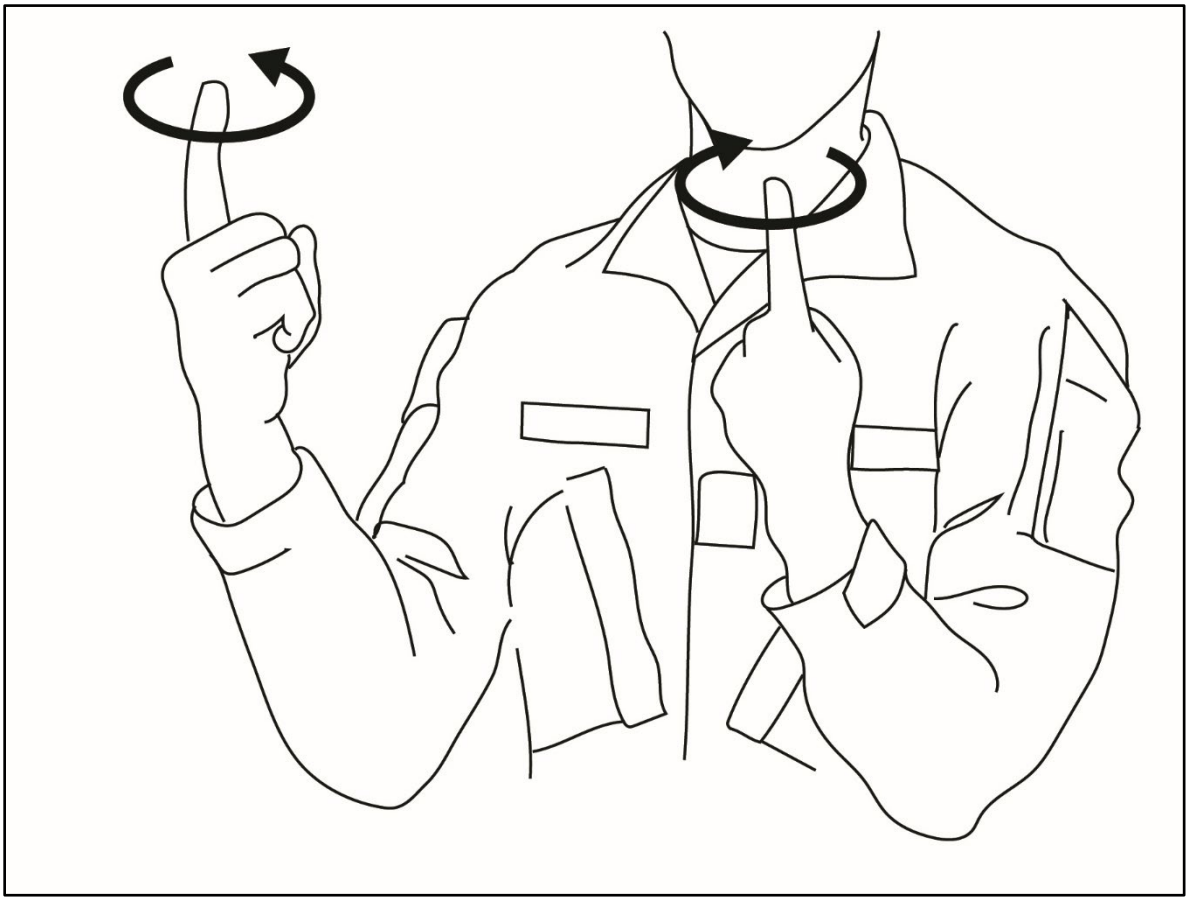


Figure 2-8. Primary hand and arm signal for POSITION

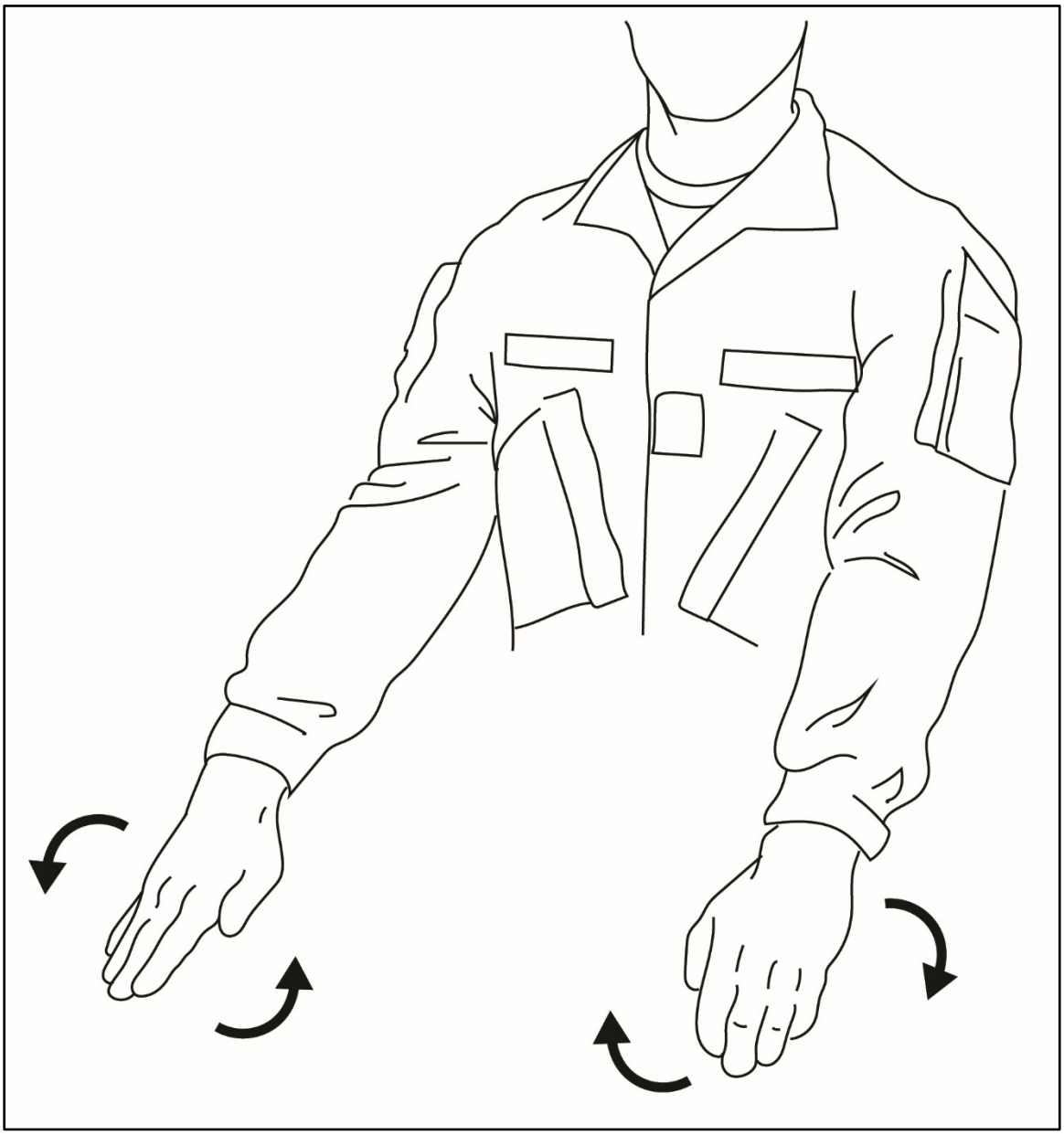


Figure 2-9. Alternate hand and arm signal for POSITION

- GO (see figure 2-10). The RM extends an arm with elbow locked, fingers extended, thumb along the index finger, and points directly at the rappeller.

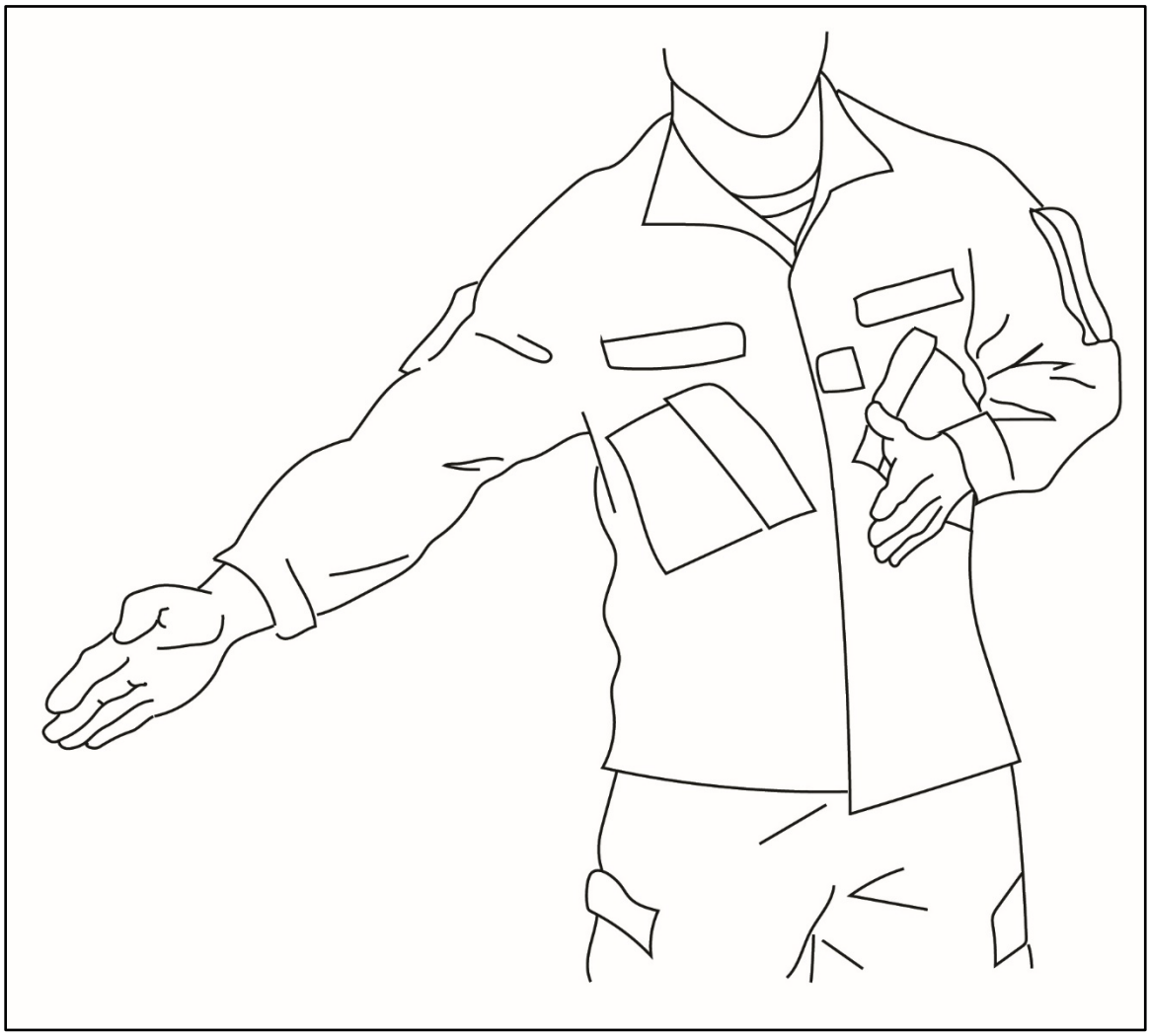


Figure 2-10. Hand and arm signal for GO

UH-60 INSPECTION AND SAFETY CONSIDERATIONS

2-28. Before rappelling operations, the RM and a member of the aircrew inspect for the following:

- Cargo doors are locked in the open position, removed, or cleared for closing, depending
- on the mission.
- All loose objects in the cargo compartment are removed or secured forward.
- Sharp edges or protrusions on the cargo floor and door edges that may come in contact with the rappeller, or the rappelling rope are taped.
- Primary and secondary rappelling anchor point knots are correct and securely attached
- to the anchor points.
- A headset/helmet and intercom jack for the RM is available and operational, and the intercom extension cord is secured overhead.
- Serviceable safety restraints are available for the RM.

SECTION V – RAPPELLING OPERATIONS FOR THE CH-47 HELICOPTER

CHARACTERISTICS

2-29. The CH-47 is a twin-engine, tandem rotor, heavy-lift helicopter. It has a wide loading ramp at the rear of the fuselage and a side passenger door at the fore behind the pilot. It is equipped with 8 10,000-pound load-limit floor tie-down rings on the inside of the cargo area that can be used for personnel tie downs. They are also used for the secondary anchor point for the rappelling ropes. Along the floor are 87 5,000-pound load-limit floor tie-down rings.

ROPE PREPARATION

2-30. When cutting a rope for a helicopter rappel, the RM starts with the desired rappel height and then adds the amount of rope required to tie down the anchor knots on the ramp (approximately 15 feet). The last length that is added is the additional 20 feet of rope that is required to stay on the ground during helicopter rappels. The sum of these distances is doubled if the RM is using one rope with a bight as opposed to two separate ropes. The last 20 feet of the rope is marked every 5 feet with brightly colored tape that is visible from the aircraft.

RIGGING THE CH-47 FOR RAMP RAPPELLING

2-31. The RM rigs the CH-47 helicopter by—

- Ensuring the ramp is lowered into the open position and the cabin door is removed or secured
- in the open position.
- Taping and covering any sharp edges or protrusions on the cargo floor, doorway, and ramp edges that may come in contact with the rappeller or rappelling rope.
- Stowing loose equipment forward in the cargo compartment.
- Extending the RM's intercom cord to ensure it does not impede operations while still allowing the RM to move to the rear of the ramp.
- Attaching safety restraints for RMs.
- Attaching safety lines for rappellers.
- Rigging and connecting rappelling ropes to the aircraft's secondary and primary anchoring points.

SECONDARY ANCHOR POINT

2-32. The RM ties the secondary anchor knot first. The secondary anchor can be attached to a 10,000-pound (see figure 2-11, anchor ring D19 or E19) or a 5,000-pound (figure 2-11, anchor ring B18 or D18) tie-down ring. When tying two ropes, the RM ties a figure-eight on a bight at the end of each rope. When using a single rope, the RM ties one figure-eight on a bight at the center point of the rope. The figure eight on bight(s) are attached to one locking carabiner and connected to the tie down ring, gate up. The carabiner is locked and taped to ensure vibration from the aircraft does not loosen the carabiner bezel.

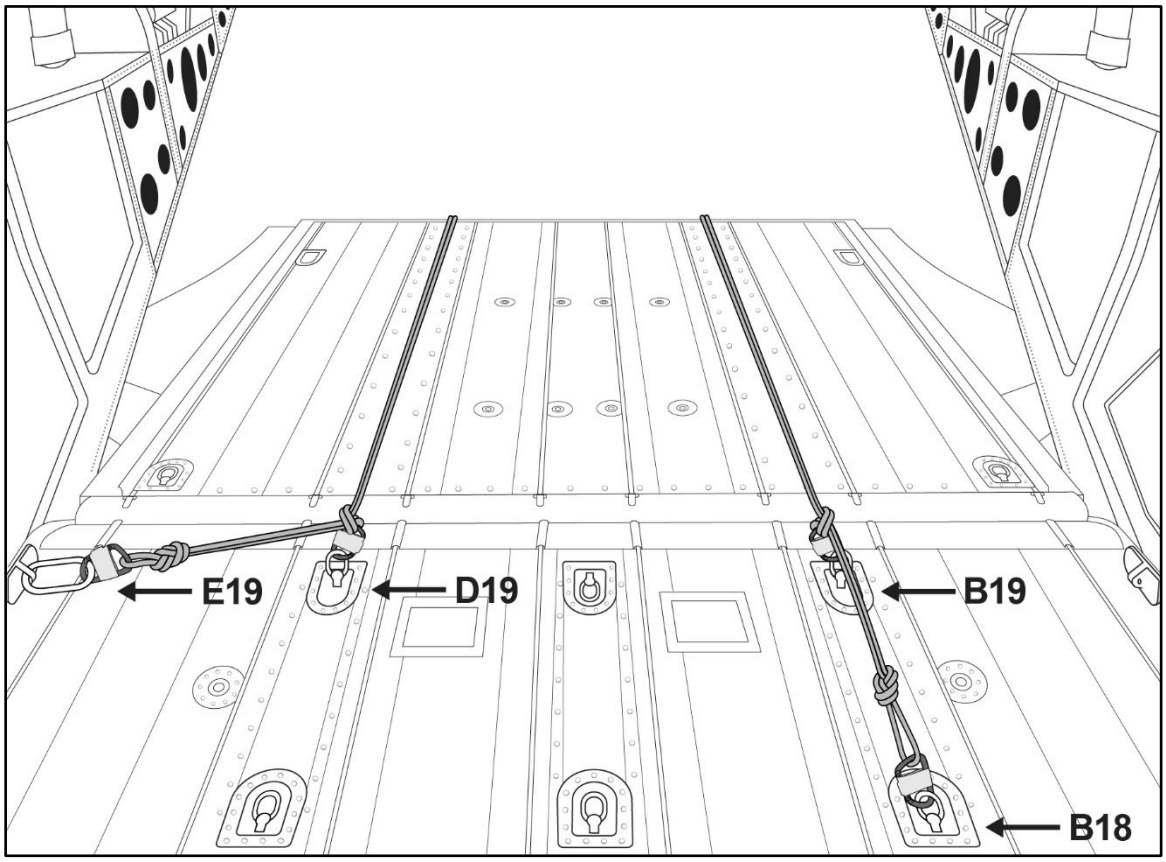


Figure 2-11. CH-47 ramp rappelling anchor point configuration

PRIMARY ANCHOR POINT

2-33. The primary anchor point is attached to the 5,000-pound ring closest to the ramp (B19 or D19 in the figure above). The RM ties a double strand clove hitch and inserts it into a locking carabiner. The RM increases or decreases slack until it is equalized where the carabiner can be attached to the 5,000-pound anchor point without slack. Anchor points cannot be located on the ramp. If an anchor point is attached on the ramp, failure of the ramp may occur.

RIGGING THE CH-47 FOR CABIN DOOR RAPPELLING

2-34. The CH-47 can be configured to allow a third rappel station at the cabin doorway behind the pilot. In addition to the cabin door, the seats in the immediate doorway area are removed.

SECONDARY ANCHOR POINT

2-35. The RM ties the secondary anchor point first. The RM ties a figure-eight on a bight and attaches it to a locking carabiner. The carabiner is then attached to 5,000-pound tie-down ring C2 (see figure 2-12 on page 28).

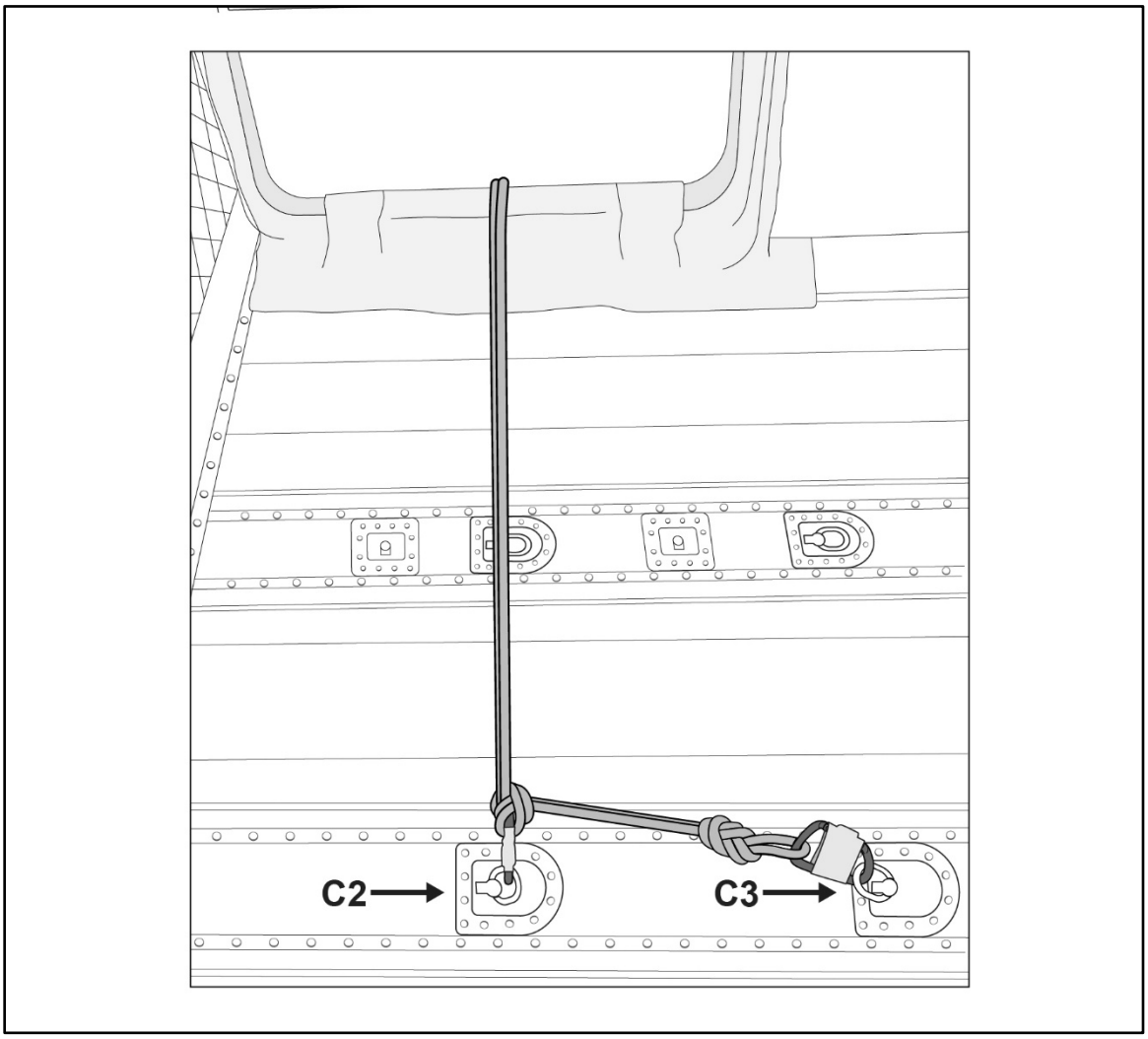


Figure 2-12. Cabin door rigging

PRIMARY ANCHOR POINT

2-36. The RM ties a double strand clove hitch and inserts it into a locking carabiner. The carabiner is then attached to 5,000-pound tie-down ring C3. The RM increases or decreases slack until equalized where the carabiner can be attached to the 5,000-pound tie-down ring without slack.

SEATING ARRANGEMENTS

2-37. All rappellers must know the seating arrangements and procedures prior to loading the aircraft. With a three-person flight crew and two RMs, the CH-47 can fit 31 rappellers. The final number of rappellers is dependent upon the aviation unit's standard operating procedure. Rappellers approach the CH-47 at a 45-degree angle from the rear when loading to avoid the aircraft's exhaust. When rappellers load the aircraft, they are seated on the floor with a safety restraint, or in seats with a seatbelt on.

RAPPELLING PROCEDURES

2-38. The RM ensures that rappelling procedures are adhered to. These procedures are rehearsed under the supervision of the RM:

- The RMs man the ramp and cabin doorway, then attach their safety line.
- The RM tests and maintains communication with the PIC and/or crew chief.

- When all rappellers are in the aircraft, they take seats and attach safety lines or fasten seatbelts.
- When the aircraft is at a hover, if the ropes are not already deployed, the RM deploys them.
- The primary RM checks if the aircraft is at the correct height by observing the tape on the rappel ropes. The RM signals to the other lanes when they are clear to send rappellers.
- The RM calls the first three rappellers forward. The rappellers are restrained until they hook up.
- After the rappeller hooks up, the RM inspects the hook-up and sends the rappeller. This process is repeated until all rappellers have exited the aircraft.
- If the aircraft is not landing, the RM releases the ropes.

INSPECTION AND SAFETY CONSIDERATIONS

2-39. Inspection of the UH-60 and CH-47 follow the same procedures. This is also true when examining safety considerations.

This page intentionally left blank.

Chapter 3

Equipment

This chapter discusses the basic equipment used for rappelling operations (see appendix A). Chapter 4 continues the discussion of rope care, maintenance, preparation, and knots.

SECTION I – ROPES AND CARABINERS

3-1. Ropes are the rappellers' most important items of equipment. They provide access down the obstacle or aerial platform while ensuring individual safety.

TYPES OF ROPES

3-2. The following describes kernmantle and laid ropes:

- Kernmantle rope. Static kernmantle rope is the preferred rope for military rappelling due to its strongly rated capacities and resistance to wear with minimal stretch. Construction includes a core of nylon fibers protected by a woven sheath (see figure 3-1). The internal core (kern) of kernmantle rope is made of a continuous multifilament-nylon yarn that is spun into continuous parallel strands. Over 70 percent of the rope's overall strength comes from the kern. The kern is then covered with a nylon-braided outer sheath (mantle). The minimum required tensile strength for rope used in military rappelling is 4,500 pounds.
- There are two different types of kernmantle rope available to the rappeller-static and dynamic:
  - Static kernmantle rope allows for minimal stretch and is preferred for rappelling operations. It stretches about 5 to 15 percent at the point of failure, and about 2 percent under a working load. Eleven-millimeter rope is the preferred size for military rappelling.
  - Dynamic kernmantle rope allows for stretch within the fibers of the rope. This can be a disadvantage in rappelling, Prusik climbing, and other applications. It has about a 5 percent to 10 percent working stretch.

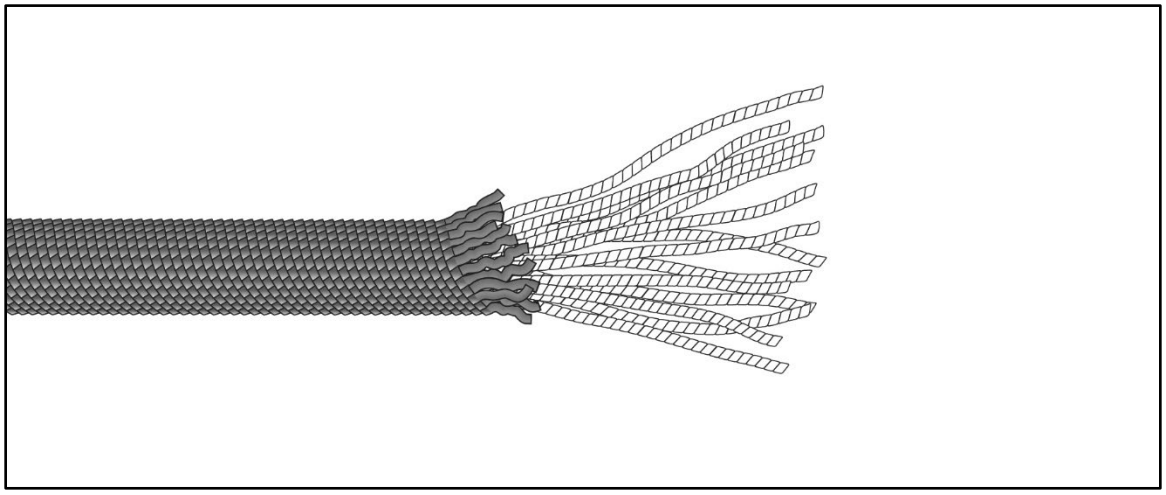


Figure 3-1. Kernmantle rope construction

- Laid rope was the standard workhorse rope for all mountaineering and rappelling operations for many years. It is a 7/16-inch laid nylon that is easy to inspect for serviceability just by twisting the fibers (see figure 3-2). Laid rope can untwist slightly when under a load, which might cause kinking and spinning, and is highly susceptible to abrasion. In addition, a tubular nylon auto-block does not descend due to the composition of the laid rope. Laid rope should only be used for rappelling if kernmantle rope is unavailable.

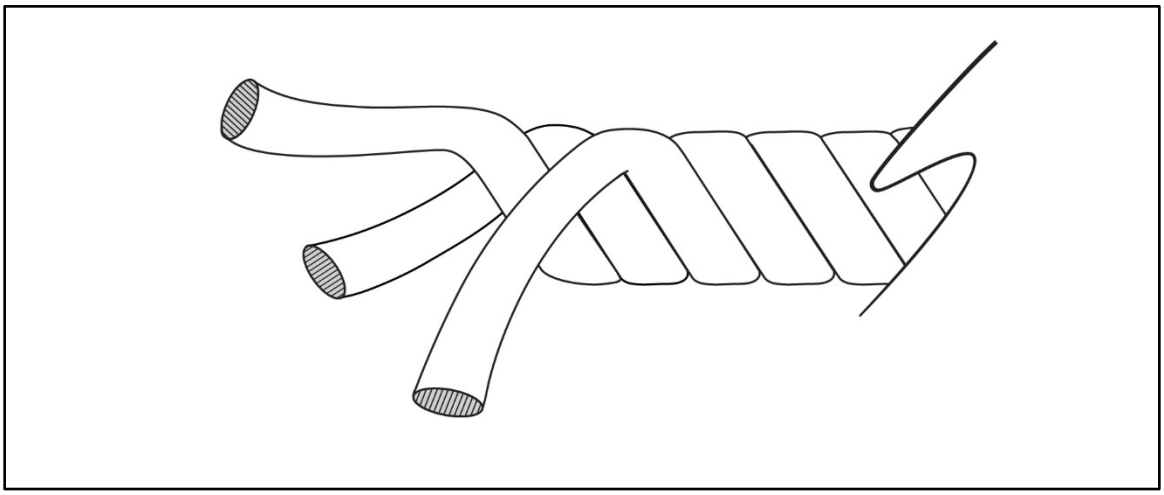


Figure 3-2. Nylon laid rope

CARABINERS

3-3. Carabiners are coupling links with a safety closure/gate. They are used to attach personnel and equipment, and to create a friction brake during rappelling operations. Carabiners are made of steel, aluminum, or alloy, and are available in many sizes and shapes to suit different needs.

3-4. The two common types of carabiners used during rappelling operations are characterized as nonlocking (see figure 3-3) and locking (see figure 3-4). Locking carabiners are preferred for critical points such as anchor points. However, two opposite and opposed nonlocking carabiners can be used at critical points if a locking carabiner is unavailable.

3-5. Carabiners that are used for rappelling are placed through the sewn loops, D-rings of the seat harness, or the sewn loops of the seat-chest combination.

3-6. The following characteristics apply to carabiners:

- Oval and D-shaped carabiners are most common for rappelling operations.
- A carabiner has significantly less strength when side loaded (across the gate).
- The weakest part of a carabiner is the gate. The gate should be closed when applying a load.
- A carabiner's strength rating is labeled on the side in kilonewtons. (One kilonewton
- is 224.8 pounds).
- If military-issued carabiners are unavailable, the carabiners being used should meet
- the International Climbing and Mountaineering Federation or the National Fire Protection Association standards.

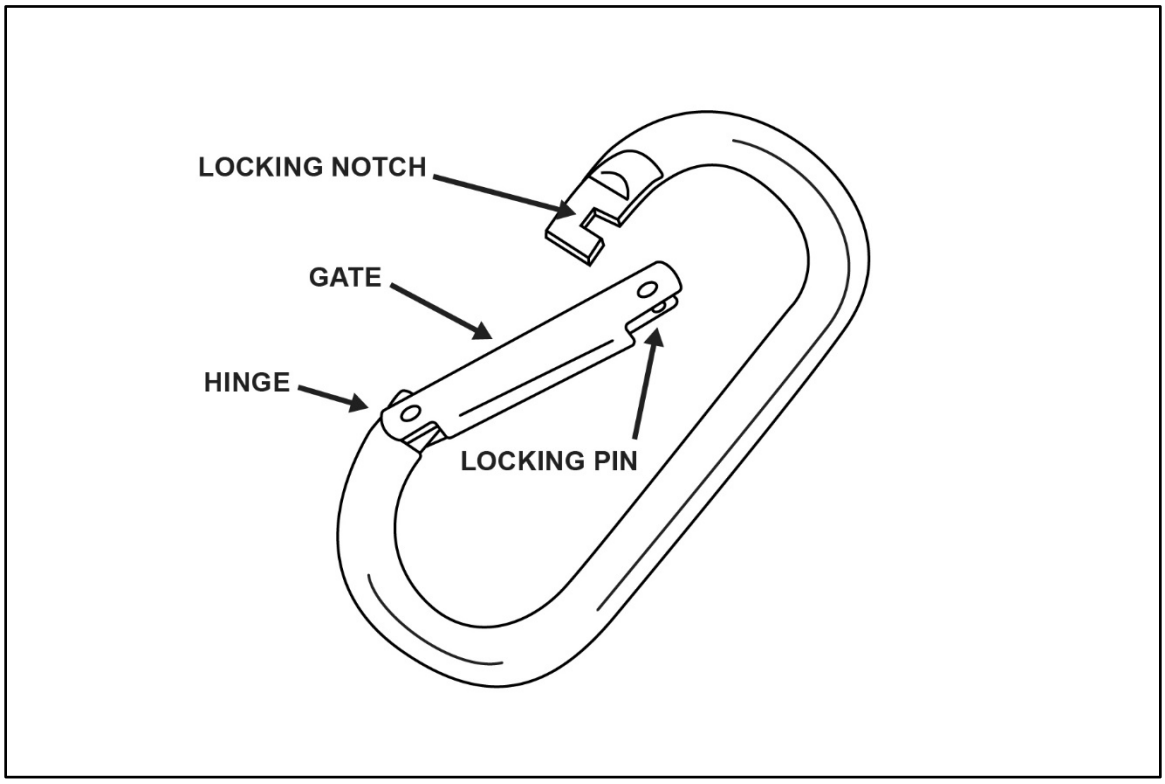


Figure 3-3. Nonlocking carabiner

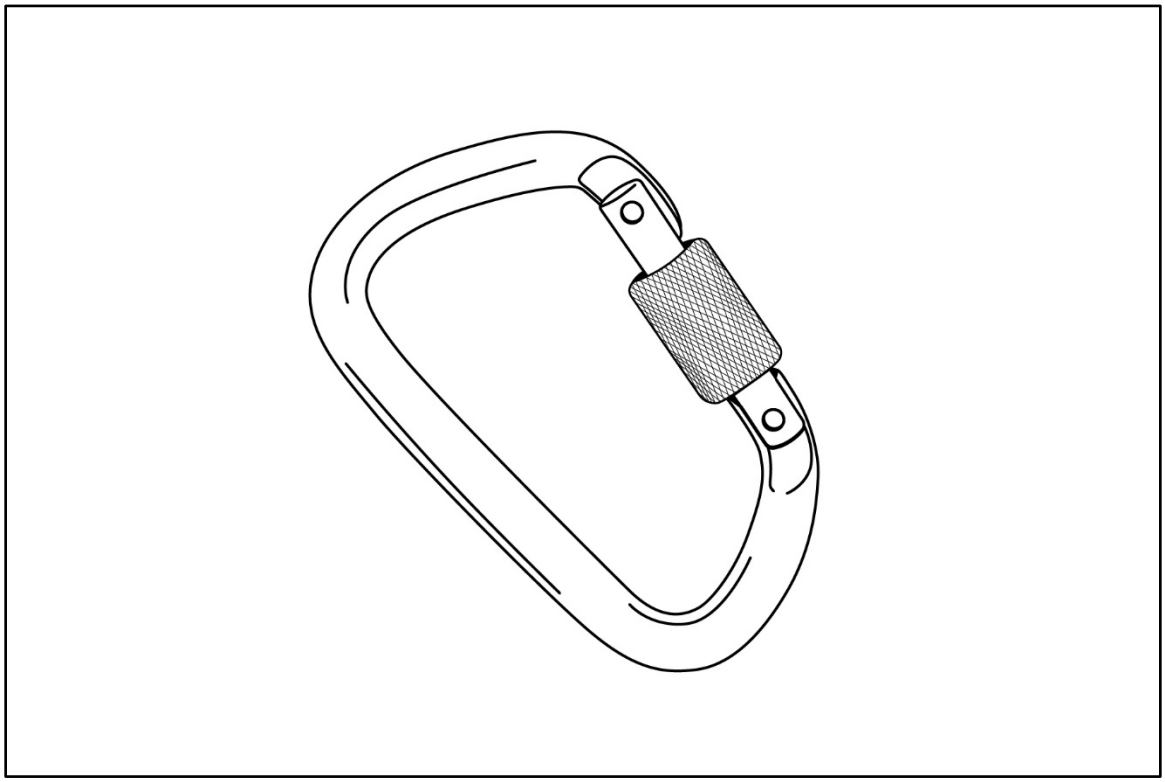


Figure 3-4. Locking carabiner

SECTION II – INSPECTION

3-7. All rappelling material and individual rappelling equipment is inspected before conducting any rappelling operation. The RM is responsible for ensuring the serviceability of rappelling material and individual rappelling equipment.

ROPES

3-8. Ropes should be inspected before and after use. If any of the following deficiencies are identified, the rope is unserviceable. Deficiencies include:

- Any cuts, frays, or burnt sections larger than one third the diameter of the rope.
- Rope ends that are not whipped with at least a 1-inch wrap with thin cord, dipped in enamel or lacquer, or burned to the melting point to obtain a solid end.
- Excessive damage to the kern.

CARABINERS

3-9. Carabiners should be inspected before and after use. If any of the following deficiencies are identified, the carabiner is unserviceable. Deficiencies include-

- Lateral movement when the carabiner gate is open.
- Locking pins that are loose, worn, or corroded.
- Any cracks, distortion, corrosion, rust, and sharp edges on the carabiner.
- The spring-loaded gate does not automatically close securely from an open to closed position, with gaps between the locking pin and notch.

GLOVES AND HELMET

3-10. Gloves are unserviceable if any of the following deficiencies are identified:

- Absence of a friction-bearing pad for rappelling operations. (In absence of the friction-bearing pad, glove inserts must be worn underneath.)
- There are three or more consecutive broken stitches, or five in a stitch line.
- Cuts, rips, burns, or tears that show exposed skin (except when cutting a slit or hole in the back to remedy a broken or missing cinch strap).

3-11. The helmet is the major protection against head injuries. It should be inspected to ensure that the chinstrap is serviceable and bisecting the rappellers chin when worn.

SECTION III – ALTERNATE METHODS OF DESCENT

FIGURE-EIGHT DESCENDER

3-12. The rappeller attaches a locking carabiner to the harness (see figure 3-5), routing the rappel rope up through the large hole and placing the bight over the collar. Insert the figure eight with the rappel rope attached into the locking carabiner and lock it down.

3-13. The rappeller brakes to the rear and descends as in a hip-rappel seat. If descending heavy loads, use a double wrap around the collar.

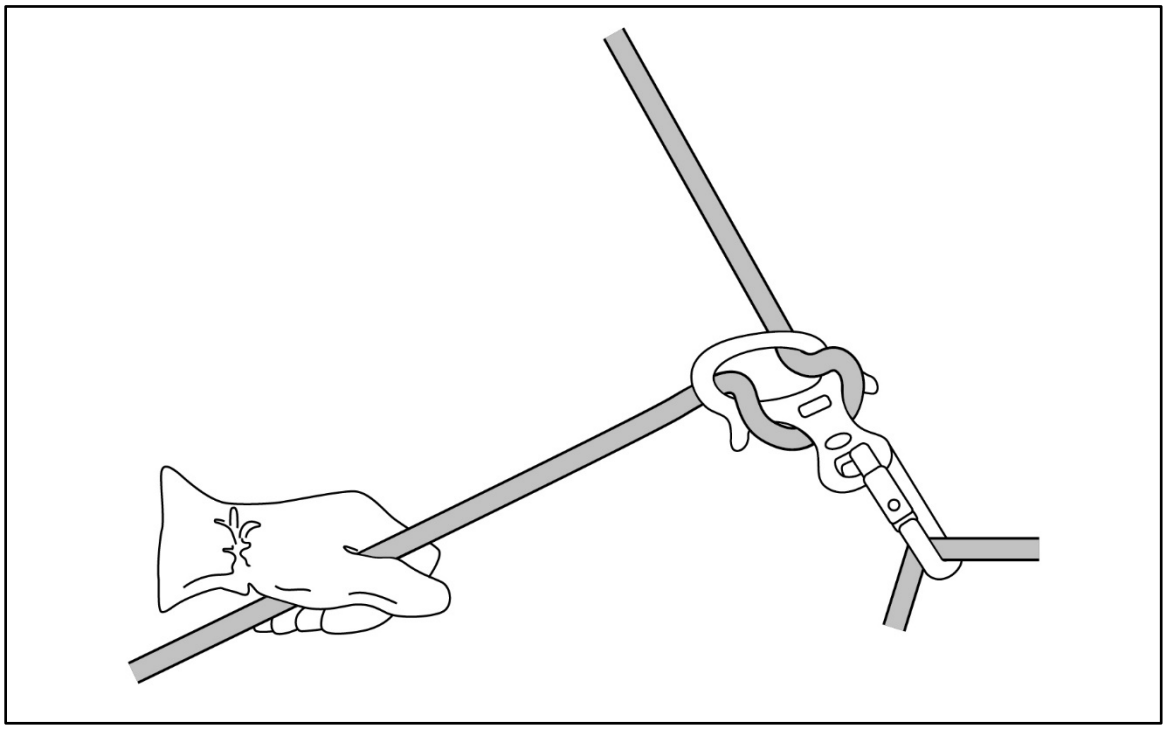


Figure 3-5. Figure-eight descender

AIR TRAFFIC CONTROLLER

3-14. The air traffic controller (ATC) is an aperture belay device that can also be used for descending. rappeller forms a bight with each rope and inserts each bight into respective rope slots. The rappeller then puts the carabiner through both bights, and the cable loop through the carabiner (see figure 3-6).

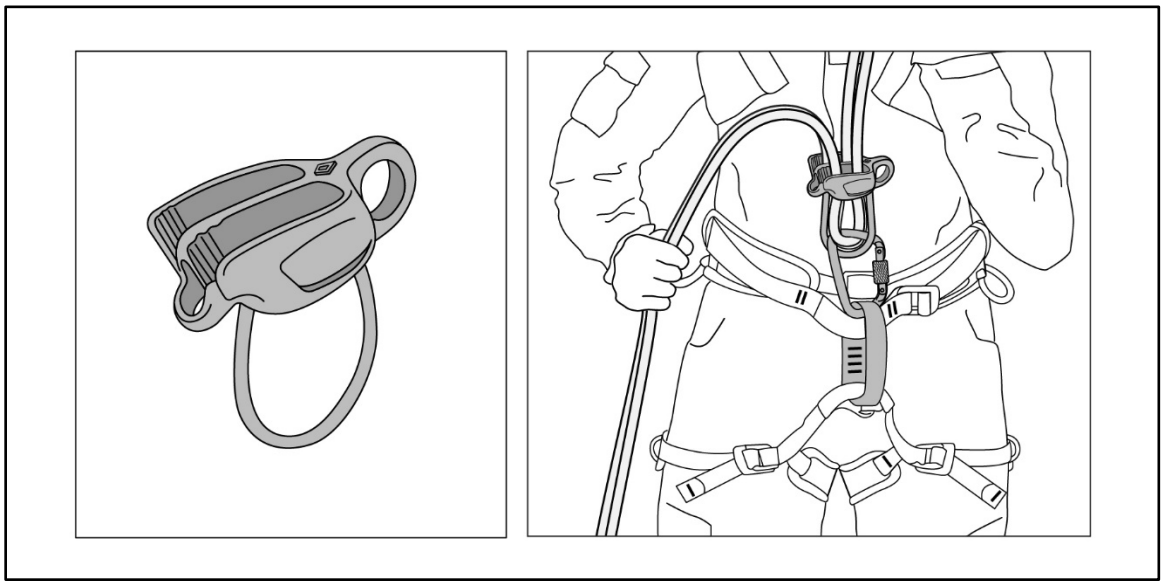


Figure 3-6. Air traffic controller

This page intentionally left blank.

Chapter 4

Rope Management

Chapter 4 discusses common rope terminology, management techniques, maintenance procedures, and knots. More detailed information about rope management can be found in TM 3-34.86/MCRP 3-17.7J.

SECTION I – PREPARATION, MAINTENANCE, INSPECTION, AND TERMINOLOGY

4-1. The service life of a rope depends on the frequency of use in applications such as rappelling, climbing, or during rope installation training; speed of descent; surface abrasion; terrain and climate conditions; and quality of maintenance. Regular rope inspection and maintenance ensures rappelling safety.

Note. Any rope can fail under extreme conditions such as shock load, sharp edges, or misuse.

PREPERATION

4-2. The RM selects the proper rope for the intended task according to type, diameter, and tensile strength. All ropes are inspected and prepared before rappelling operations.

PACKAGING

4-3. New rope comes from the manufacturer in different configurations; boxed on a spool in various lengths or coiled and bound. Precut ropes are usually packaged in protective covers made of plastic or burlap. Do not remove the protective cover until the rope is ready for use.

SECURING THE ENDS OF THE ROPE

4-4. If still on a spool, the rope is cut to the desired length. Laid rope frays at the ends unless it is whipped and dipped or taped and burned. Static and dynamic kernmantle rope ends are secured in the same manner. The ends are heated to the melting point using a proper rope cutter, so that the inner core strands are melted to the outer sheath. By fusing the two together, the sheath cannot slide backward or forward. Make sure this is done only to the ends of the rope. If the body of the rope is exposed to extreme temperatures, the sheath and inner core could be weakened, reducing overall tensile strength.

MAINTENANCE AND INSPECTION

4-5. Rope is a rappeller's lifeline and should be cared for and used properly. Use the following general guidelines when handling ropes:

- Do not unnecessarily step on or drag ropes on the ground.
- While in use, do not allow the rope to come into contact with sharp edges. If it must be used over a sharp edge, pad the edge for protection.
- Always keep the rope as dry as possible. If it becomes wet, hang it in large loops off the ground and allow it to dry. Never dry a rope with high heat or in direct sunlight.
- Never leave a rope knotted or tightly stretched any longer than necessary. Over time, this reduces the strength and life of the rope.
- Never allow one rope to continuously rub over or against another. When using nylon rope, allowing rope-on-rope contact is extremely dangerous. Heat produced by the friction can cause the nylon to melt.
- Inspect ropes before each use for frayed or cut spots, mildew, or rot. New rope is also inspected before first use.
- The ends of the rope should be whipped or melted to prevent unraveling.
- Do not splice ropes for use in rappelling.

- Do not mark ropes with paints or allow them to come in contact with oils or petroleum products. Some of these products can weaken and deteriorate nylon.
- Each rope should have a corresponding DA Form 5752-R (*Rope Log [Usage and History])* or a similar type of log. Rope logs serve as safety record that annotate use, terrain, weather, application, and current condition every time the rope is used.
- Never subject the rope to high heat or flame.
- All ropes can be washed and rinsed periodically to remove dirt and grit. Commercial rope washers are made from short pieces of modified pipe that connect to any faucet. Pinholes within the pipe force water to circulate around the rope to scrub it as it is slowly fed through the washer. Another method is to machine wash on a gentle cycle in cold water with a nylon-safe soap. Never bleach or use harsh cleansers. Ensure that only front-loading washing machines are used to clean ropes.
- When not in use, ropes should be loosely coiled and hung on wooden pegs. They can also be loosely stacked and placed in rope bags for storage on shelves. Storage areas should be relatively cool with low humidity levels to prevent mildew or rotting.
- Ropes should not be stored in direct sunlight.

4-6. Ropes should be inspected before and after each use. Chapter 3, section II of this publication details rope inspection information.

TERMINOLOGY

4-7. It is important to understand basic terminology when using ropes. The following terms are commonly used in rappelling (see figure 4-1 for visual illustrations):

- A bight of rope is a simple bend of rope where the rope does not cross over itself.
- A loop is a bend of a rope that the rope crosses over itself.
- A half hitch is a loop that runs around an object in such a manner as to lock or secure itself.
- A turn wraps around an object, providing 360-degree contact.
- A round turn wraps around an object one and a half times. It is used to distribute the load over a small diameter anchor (3 inches or less). A round turn may also be used around larger diameter anchors to reduce tension on the knot or provide added friction.
- A running end is the loose or working end of the rope.
- The standing part is the static, stationary, or nonworking end of the rope.
- The lay is the direction of twist as in construction of the rope.
- The pigtail (tail) is the remaining portion of the rope's running end after tying a knot.
- Dress is the proper arrangement of all knot parts. All unnecessary kinks, twists, and slack
- have been removed.

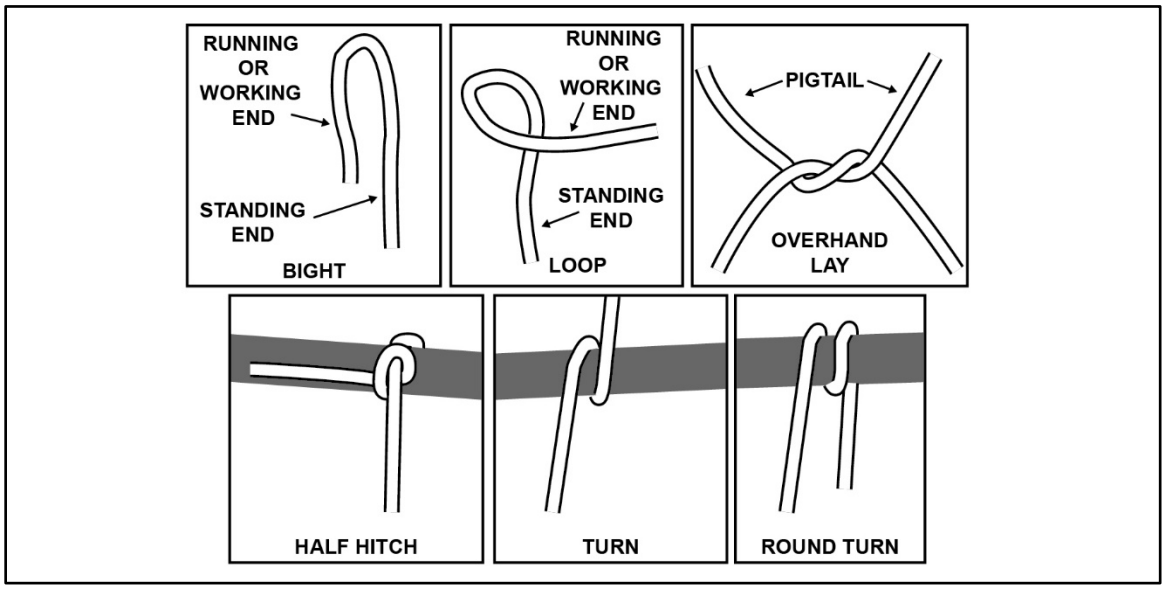


Figure 4-1. Examples of rope terminology

SECTION II – COILING, CARRYING, THROWING

4-8. The ease and speed of rope deployment and recovery greatly depends upon technique and practice. The following procedures are recommended for optimal performance.

COILING AND CARRYING THE ROPE

4-9. Use the mountain coil or butterfly to prepare and carry the rope. Each coil technique is easy to accomplish and has a minimal number of kinks, twists, and knots during deployment.

MOUNTAIN COIL

4-10. To start a mountain coil (see figure 4-2), grasp the rope approximately 3 feet from the end with one hand. Run the other hand along the rope until both arms are outstretched. Grasping the rope firmly, bring the hands together forming a loop, then lay the loop in the hand closest to the end of the rope. This is repeated forming uniform loops that run in a clockwise direction until the rope is completely coiled. The rope may be given a quarter twist as each loop is formed to overcome any tendency for it to twist or form figure eights.

4-11. When finishing the mountain coil, form a bight approximately 1 foot long with the starting end of the rope and lay it along the top of the coil. Uncoil the last loop. Using this length of rope, begin making wraps around the coil and the bight, wrapping toward the closed end of the bight. Make the first wrap bind across itself to lock it into place, followed by six to eight wraps. Route the end of the rope through the closed end of the bight, pulling the running end of the bight tight, securing the coil.

4-12. The mountain coil can then be carried in the pack by forming a figure eight, doubling it, and placing it under the flap; or by placing it over the shoulder and under the opposite arm, slung across the chest. Figure 4-2 shows the steps involved in routing and wrapping a mountain coil.

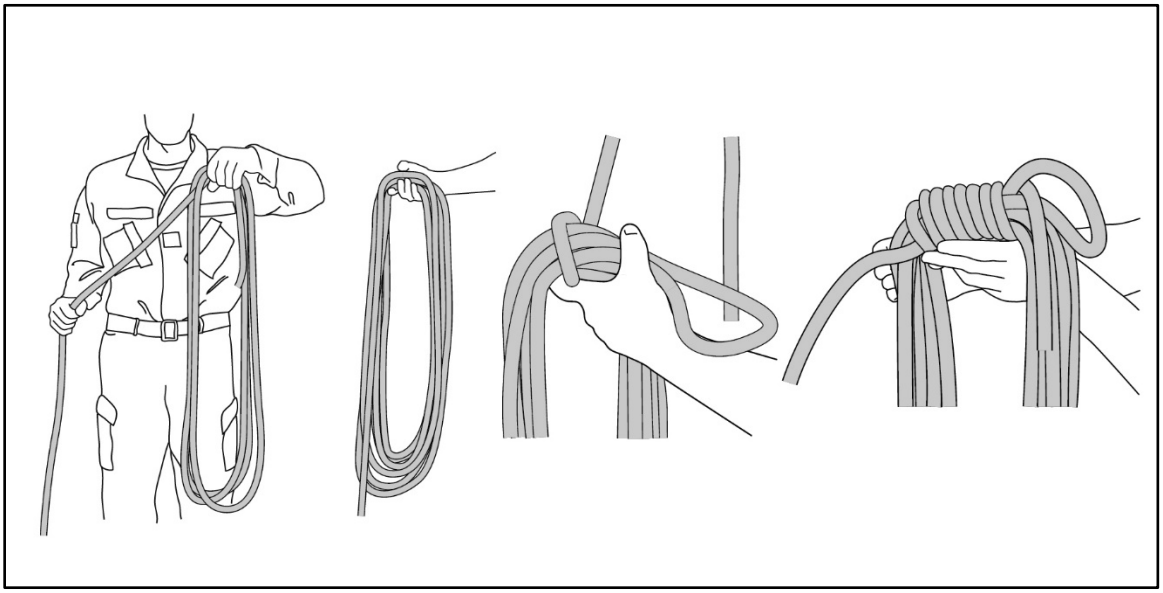


Figure 4-2. Mountain coil

4-13. The butterfly coil is the quickest and easiest technique for coiling. See figure 4-3 for the steps involved in performing this procedure. Steps for the butterfly coil include:

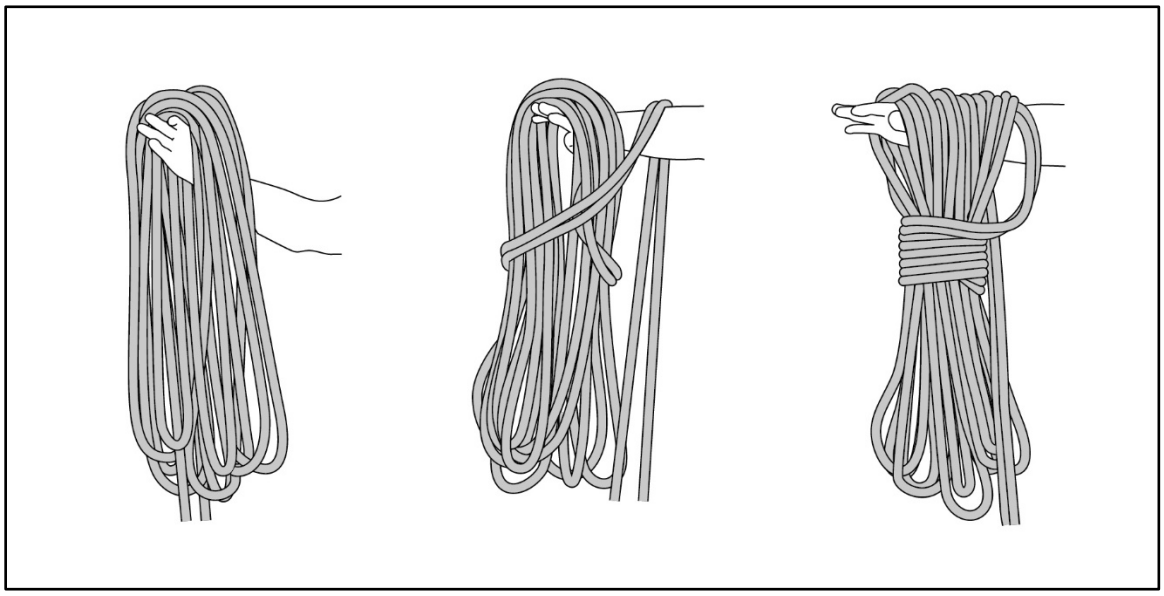


Figure 4-3. Butterfly coil

- Coiling. To start the butterfly coil, grasp both ends of the rope and begin a double back stack. Find the center of the rope forming a bight. With the bight in the left hand, grasp both ropes and slide the right hand out until there is approximately one arm's length of rope. Place the doubled rope over the head, draping it around the neck and on top of the shoulders. Ensure that it hangs no lower than the waist. With the rest of the doubled rope in front of you, make doubled bights placing them over the head in the same manner as the first bight. Coil alternating from side to side (left to right, right to left) while maintaining equal-length bights. Continue coiling until approximately two arm-lengths of rope remain. Remove the coils from the neck and shoulders carefully and hold the center in one hand. Wrap the two ends around the coils a minimum of three doubled wraps, ensuring that the first wrap locks back on itself.
- Tie-off and carrying. Take a doubled bight from the loose ends of rope and pass it through the apex of the coils. Pull the loose ends through the doubled bight and dress it down. Place an overhand knot in the loose ends, dressing it down to the apex of the bight securing coils. Ensure the loose ends do not exceed the length of the coils. In this configuration the coiled rope is secure enough for hand carrying, carrying in a rucksack, or for storage. Figure 4-4 portrays a butterfly coil tie-off.

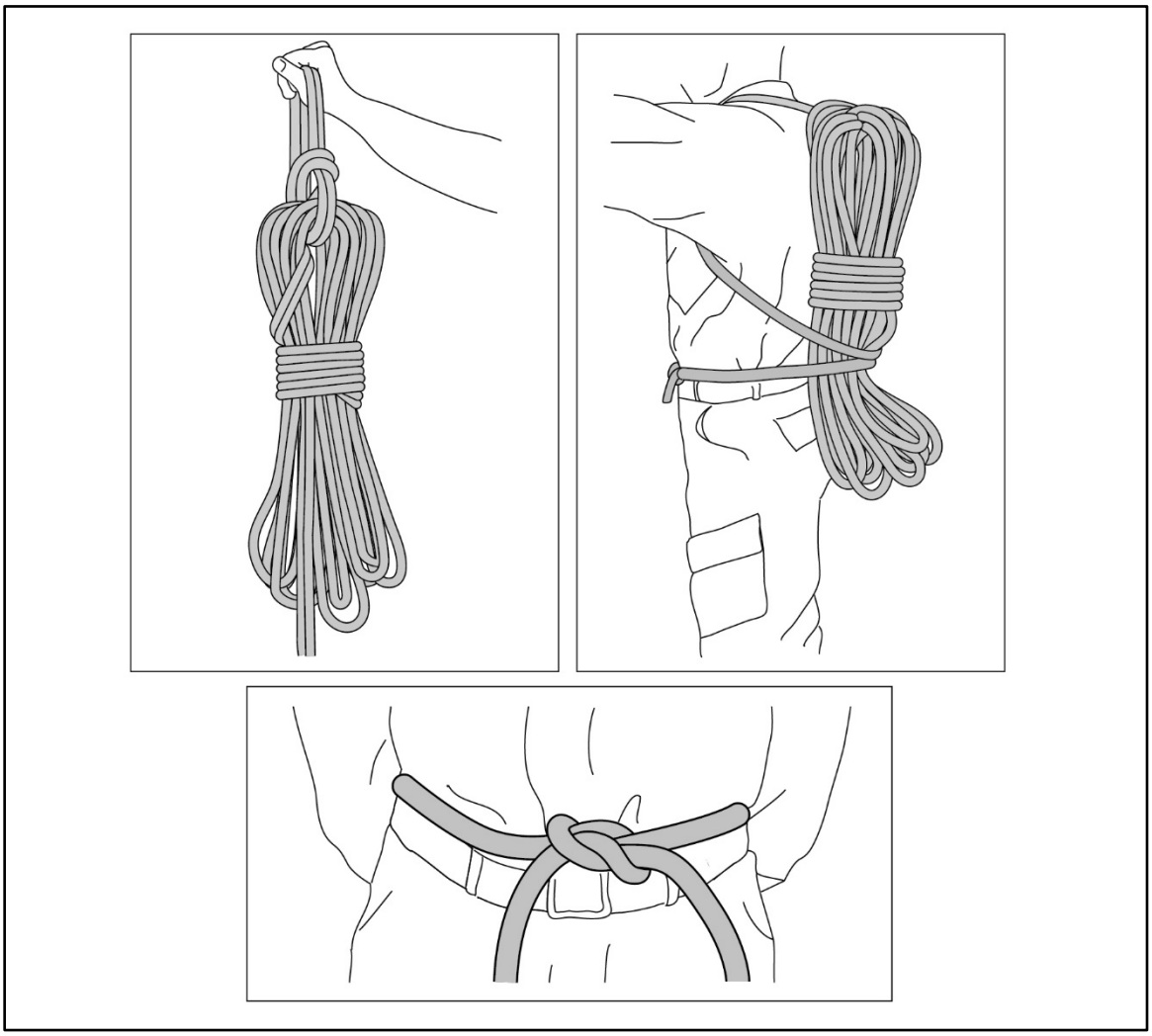


Figure 4-4. Butterfly coil tie-off

COILING SMALLER DIAMETER ROPE

4-14. Ropes of smaller diameters may be coiled using the butterfly or mountain coil depending on the length of the rope. Pieces 25 feet and shorter may be coiled so they can be hung and carried from equipment. Bring the two ends of the rope together, ensuring no kinks are in the rope. Place the rope ends in the left hand with the two ends facing the body. Coil the doubled rope in a clockwise direction forming 6-inch to 8-inch coils (coils may be larger depending on the length of rope) until an approximate 12-inch bight is left. Wrap that bight around the coil, ensuring that the first wrap locks on itself. Make three or more wraps. Feed the bight up through the bights formed at the top of the coil. Dress it down tightly.

UNCOILING AND BACK-STACKING

4-15. When the rope is needed for use, it is uncoiled and stacked on the ground properly to avoid tangling:

- Untie the tie-off and lay the coil on the ground. Back-stack the rope to minimize tangling. Take one end of the rope in the left hand and run the right hand along the rope until both arms are outstretched. Lay the end of the rope in the left hand on the ground. With the left hand, regrasp the rope next to the right hand and continue laying the rope on the ground.
- Stack the rope in a pile on the ground to prevent it from becoming tangled and knotted when throwing the rope. This technique can also be started using the right hand.

THROWING THE ROPE

4-16. Before throwing the rope, it is properly managed to prevent it from tangling during deployment. The rope should first be anchored to prevent its loss over the edge when thrown. Basic techniques for throwing the rope are as follows:

- Back-stack the rope beginning with the anchored end of the rope working toward the running end.
- Once stacked, make six to eight smaller coils in the left hand. Pick up the rest of the larger coils in the right hand. The arm should be generally straight when throwing.
- Prior to throwing the rope, the thrower should sound off with the warning ROPE, ROPE, ROPE to alert anyone below the site.
- Throw up and out. A slight twist of the wrist so the palm of the hand faces up as the rope is thrown allows the coils to separate easily without tangling.
- When a slight tug on the left hand is felt, toss the six to eight smaller coils out. This prevents the ends of the rope from becoming entangled with the rest of the coils as they deploy.

SECTION III – KNOTS

4-17. All knots used by a rappeller are divided into four classes. The knot classes are provided as a general guide. Some knots may fall under more than one class. The classes are:

- Class I: Joining knots.
- Class II: Anchor knots.
- Class III: Middle rope knots.
- Class IV: Special knots.

JOINING KNOTS

4-18. Joining knots connect two ropes together, not necessarily of the same size. They typically consist of loops and are sometimes referred to as bends.

SQUARE KNOT

4-19. The square knot is used to tie the ends of two ropes of equal diameter under tension (see figure 4-5). It is a joining knot. To tie a square knot:

- Step 1. Holding one working end in each hand, place the working end in the right hand over the one in the left hand.
- Step 2. Pull the working end under and back over the top of the rope in the left hand.
- Step 3. Place the working end in the left hand over the one in the right hand and repeat step 2.
- Step 4. Dress the knot down and secure it with an overhand safety knot on each side of
- the square knot.

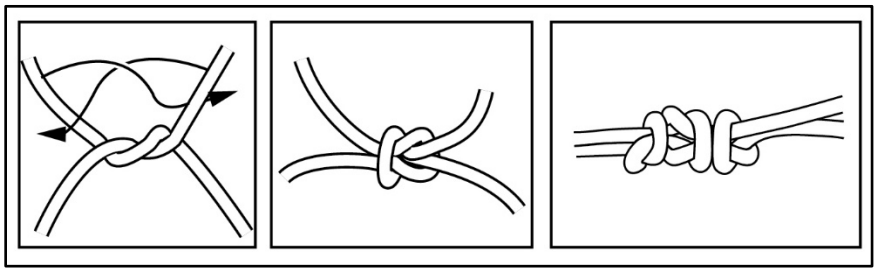


Figure 4-5. Square knot

4-20. Follow these three checkpoints to ensure safety:

- There are two interlocking bights.
- The running end and standing part are on the same side of the bight formed by the other rope.
- The running ends are parallel to and on the same side of the standing ends with 4-inch (minimum) pig tails after the overhand safeties are tied.

FISHERMAN'S KNOT

4-21. The fisherman's knot is used to tie two ropes of the same or approximately the same diameter (see figure 4-6). To tie the fisherman's knot:

- Step 1. Tie an overhand knot in one end of the rope.
- Step 2. Pass the working end of the other rope through the first overhand knot. Tie an overhand knot around the standing part of the first rope with the working end of the second rope.
- Step 3. Tightly dress down each overhand knot and tightly draw the knots together.

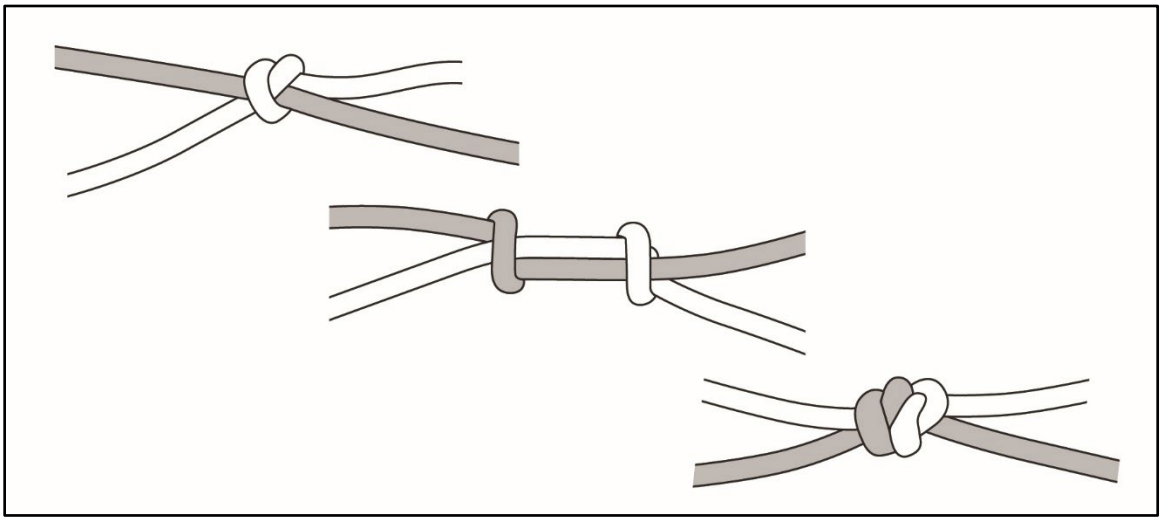


Figure 4-6. Fisherman's knot

4-22. Follow these three checkpoints to ensure safety:

- The two separate overhand knots are tied tightly around the long-standing part of the
- opposing rope.
- The two overhand knots are drawn snug.
- Ends of rope exit knot opposite each other with 4-inch pigtails.

DOUBLE FISHERMAN'S KNOT

4-23. The double fisherman's knot (also called double English or grapevine) is used to tie two ropes of the same or approximately the same diameter (see figure 4-7). To tie a double fisherman's knot:

- Step 1. With the working end of one rope, tie two wraps around the standing part of another rope.
- Step 2. Insert the working end (step 1) back through the two wraps and draw it tight.
- Step 3. With the working end of the other rope, which contains the standing part (steps 1 and 2), tie two wraps around the standing part of the other rope (the working end in step 1). Insert the working end back through the two wraps and draw tight.
- Step 4. Pull on the opposing ends to bring the two knots together.

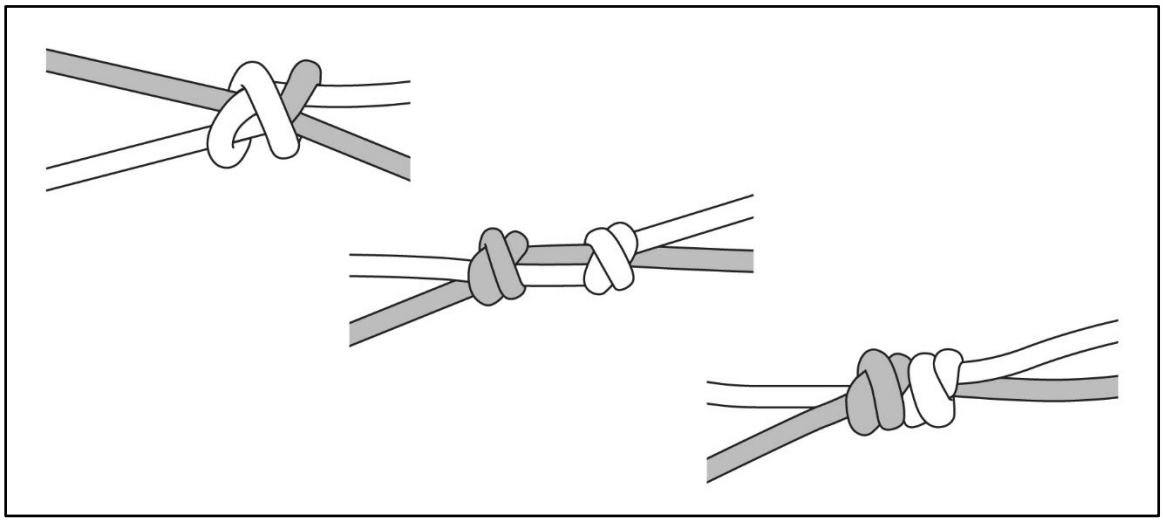


Figure 4-7. Double fisherman's knot

4-24. Follow these three checkpoints:

- The two double overhand knots securing each other as the standing parts of the rope are pulled apart.
- Four rope parts on one side of the knot form two "X" patterns. Four rope parts on the other side of the knot are parallel.
- The ends of the rope exit knot opposite each other with 4-inch pigtails.

FIGURE-EIGHT BEND

4-25. The figure-eight bend is used to join the ends of two ropes within a 5-milimeter diameter difference (see figure 4-8). To tie a figure-eight bend:

- Step 1. Grasp the top of a 2-foot bight.
- Step 2. With the other hand, grasp the running end (short end) and make a 360-degree turn around the standing end.
- Step 3. Place the running end through the loop just formed, creating an in-line figure eight.
- Step 4. Route the running end of the other rope back through the figure eight starting from the original rope's running end. Trace the original knot to the standing end.
- Step 5. Remove all unnecessary twists and crossovers. Dress the knot down.

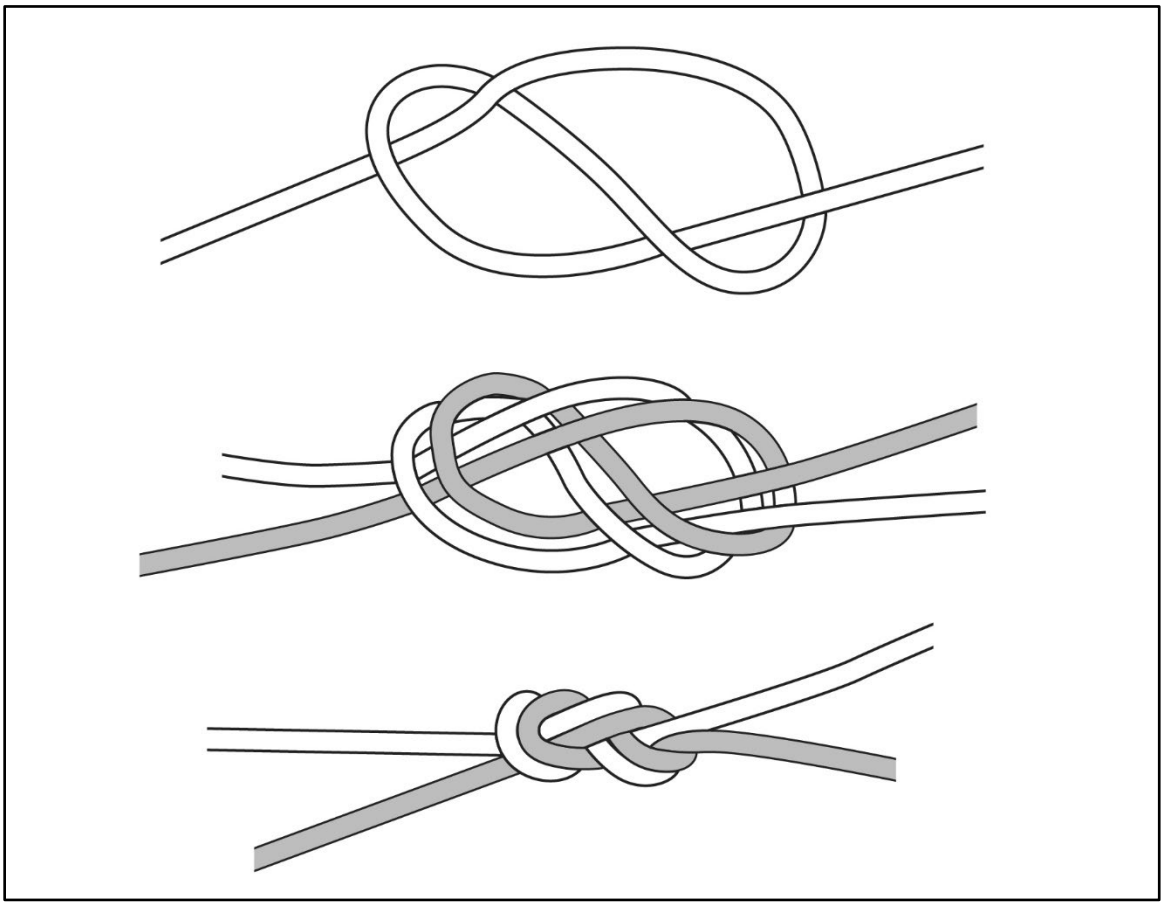


Figure 4-8. Figure-eight bend

4-26. Follow these three checkpoints to ensure safety:

- There is a figure-eight with two ropes running side by side.
- The running ends are on opposite sides of the knot.
- There is a minimum 4-inch pigtail.

WATER KNOT

4-27. The water knot is used to attach two webbing ends (see figure 4-9). It is also called a ring bend, overhand retrace, or tape knot. It can be used in the construction of runners and harnesses when using webbing. To tie a water knot:

- Step 1. Tie an overhand knot in one of the ends.
- Step 2. Route the other end of the webbing back through the overhand knot. Follow the course of the original overhand knot.
- Step 3. Ensure all the webbing is lying flat within the knot.
- Step 4. Dress the knot down.

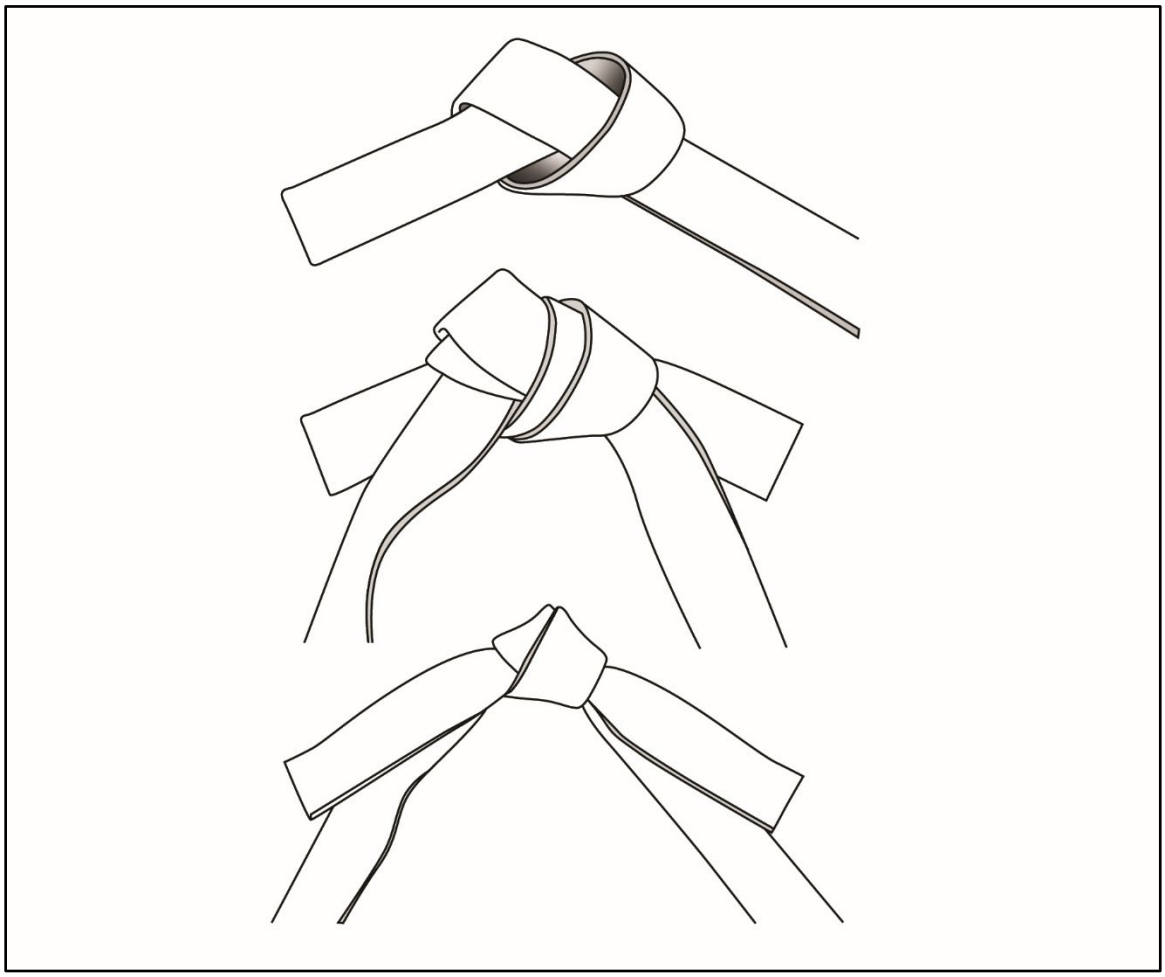


Figure 4-9. Water knot

4-28. Follow these three checkpoints to ensure safety:

- There are two overhand knots, one retracing the other.
- There is no slack in the knot, and the working ends come out of the knot in opposite directions.
- There is a minimum 4-inch pigtail.

ANCHOR KNOTS

4-29. Anchor knots are firmly attached to solid objects. When conducting a tower or aircraft rappel, anchor knots attach the rappelling rope to fixed anchor points on the tower or aircraft.

BOWLINE

4-30. The bowline is used to tie the end of a rope around an anchor. It may also be used to tie a single fixed loop in the end of a rope (see figure 4-10). To tie a bowline knot:

- Step 1. Bring the working end of the rope around the anchor, from right to left (as the RM
- faces the anchor).
- Step 2. Form an overhand loop in the standing part of the rope (on the RM's right) toward the anchor.
- Step 3. Reach through the loop and pull up a bight.
- Step 4. Place the working end of the rope (on the RM's left) through the bight and bring it back onto itself. Now dress the knot down.
- Step 5. Form an overhand knot with the tail from the bight.

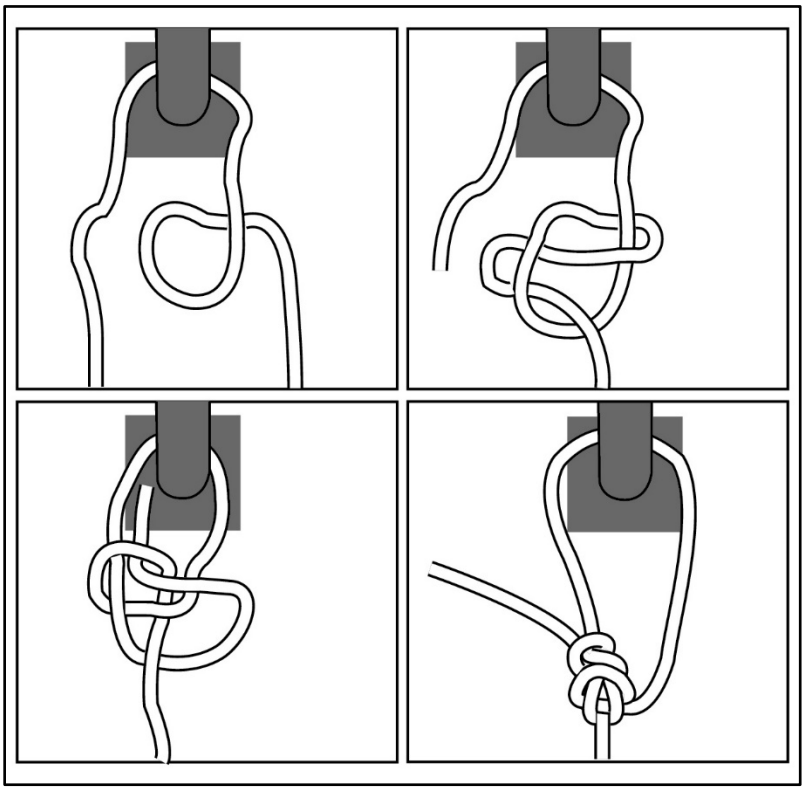


Figure 4-10. Bowline

4-31. Follow these three checkpoints to ensure the knot is tied correctly:

- The bight is locked into place by a loop.
- The bight short portion is on the inside and on the loop around the anchor (or inside the fixed loop).
- There is a minimum 4-inch pigtail after tying the overhand safety.

ROUND TURN AND TWO HALF HITCHES

4-32. This knot is used to tie the end of a rope to an anchor under tension (see figure 4-11). To tie a round turn and two half hitch knots:

- Step 1. Route the rope around the anchor from right to left and wrap down with two wraps in the rear of the anchor, and one in the front. Run the loop around the object to provide 360-degree contact, distributing the load over the anchor.
- Step 2. Bring the working end of the rope left to right and over the standing part, forming a half hitch (first half hitch).
- Step 3. Repeat step 2 (last half hitch has a 4-inch pigtail).
- Step 4. Dress the knot down.

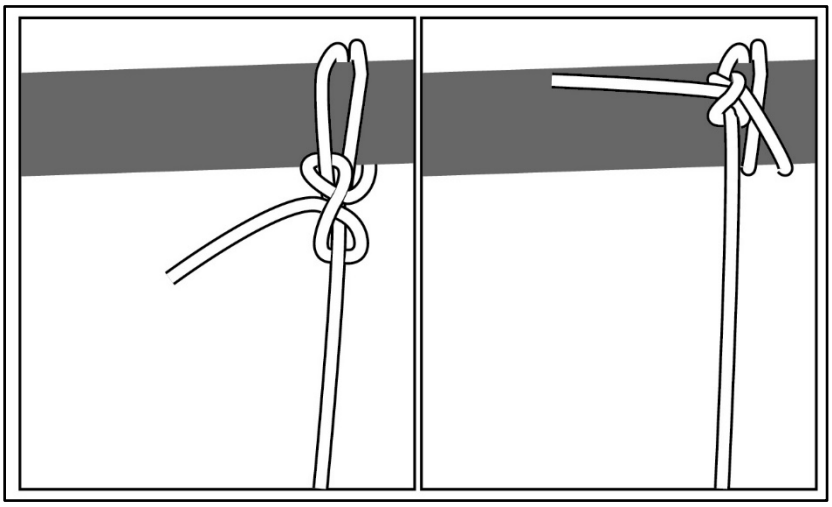


Figure 4-11. Round turn and two half hitches

4-33. Follow these two checkpoints to ensure the knot is tied correctly:

- A complete round turn should exist around the anchor with no crosses.
- Two half hitches should be held in place by a diagonal locking bar with no less than a 4-inch pigtail remaining.

FIGURE-EIGHT RETRACE (REROUTED FIGURE EIGHT)

4-34. The figure-eight retrace knot produces the same result as a figure-eight loop. However, by tying the knot in a retrace, it can be used to fasten the rope to fixed closed anchors where the loop cannot be used (see figure 4-12). To tie a figure-eight retrace knot:

- Step 1. Use a length of rope long enough to go around the anchor, leaving enough rope
- to work with.
- Step 2. Tie a figure-eight knot in the standing part of the rope, leaving enough rope to go around the anchor. To tie a figure-eight knot form a loop in the rope, wrap the working end around the standing part and route the working end through the loop. The finished knot is dressed loosely.
- Step 3. Take the working end around the anchor point.
- Step 4. With the working end, insert the rope back through the loop of the knot in reverse.
- Step 5. Keep the original figure eight as the outside rope and retrace the knot around the wrap and back to the long-standing part.
- Step 6. Remove all unnecessary twists and crossovers; dress the knot down.
- Step 7. Ensure there is a minimum 4-inch pigtail.

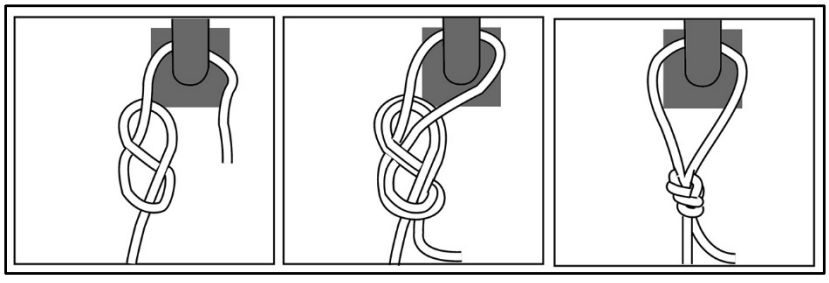


Figure 4-12. Figure-eight retrace (rerouted figure eight)

CLOVE HITCH

4-35. The clove hitch can be used as a middle of the rope anchor or end of the rope anchor knot. Once tied, the knot must have constant tension on it to prevent slipping (see figure 4-13). To tie a clove hitch:

- Middle-of-the-rope:
  - Step 1. Hold rope in both hands, palms down with hands together. Slide the left hand to the left from 8 to 10 inches.
  - Step 2. Form a loop away from and back toward the right.
  - Step 3. Slide the right hand from 8 to 10 inches to the right. Form a loop inward and back to the left hand.
  - Step 4. Place the left loop on top of the right loop. Place both loops over the anchor and pull both ends of the rope in opposite directions. The knot is tied.
- End of the rope:
  - Step 1. Place 8 to 10 inches of rope over the top of the anchor. Hold the standing end in the left hand. With the right hand, reach under the horizontal anchor, grasp the working end, and bring it inward.
  - Step 2. Place the working end of the rope over the standing end (to form a loop). Hold the loop in the left hand. Place the working end over the anchor from 8 to 10 inches to the left of the loop.
  - Step 3. With the right hand, reach down to the left-hand side of the loop under the anchor. Grasp the working end of the rope. Bring the working end up and outward.
  - Step 4. Dress down the knot.
  - Step 5. Tie a safety knot.

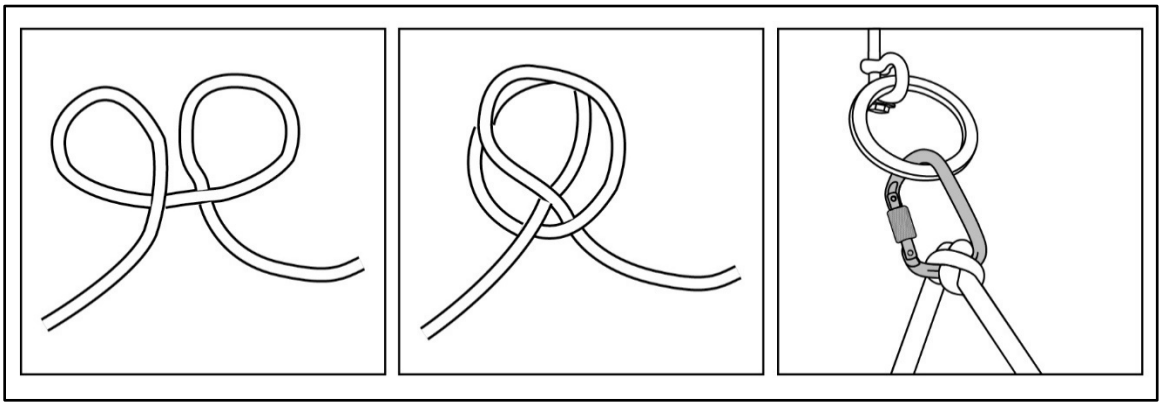


Figure 4-13. Middle-of-the-rope clove hitch

4-36. Follow these four checkpoints to ensure the knot is tied correctly:

- The knot has two round turns around the anchor with a diagonal locking bar.
- The locking bar is facing 90-degrees from the direction of pull.
- The ends exit 180-degrees from each other.
- The knot has more than a 4-inch pigtail remaining.

CLASS III: MIDDLE ROPE KNOTS

4-37. The middle of the rope knot can create a loop or anchor at a point in the rope that is not necessarily at the end. The following knots are commonly used in this manner.

WIREMAN'S KNOT

4-38. The wireman's knot forms a single, fixed loop in the middle of the rope (see figure 4-14). To tie a wireman's knot:

- Step 1. When tying this knot, face the anchor that the tie-off system will be tied to. Take up the slack from the anchor and wrap two turns around the left hand (palm up) from left to right.
- Step 2. A loop of 1 foot is taken up in the second-round turn to create the fixed loop of the knot.

- Step 3. Name the wraps from the palm to the fingertips: heel, palm, and fingertip.
- Step 4. Secure the palm wrap with the right thumb and forefinger and place it over the heel wrap.
- Step 5. Secure the heel wrap and place it over the fingertip wrap.
- Step 6. Secure the fingertip wrap and place it over the palm wrap.
- Step 7. Secure the palm wrap and pull up to form a fixed loop.
- Step 8. Dress the knot down by pulling on the fixed loop and the two working ends.
- Step 9. Pull the working ends apart to finish the knot.

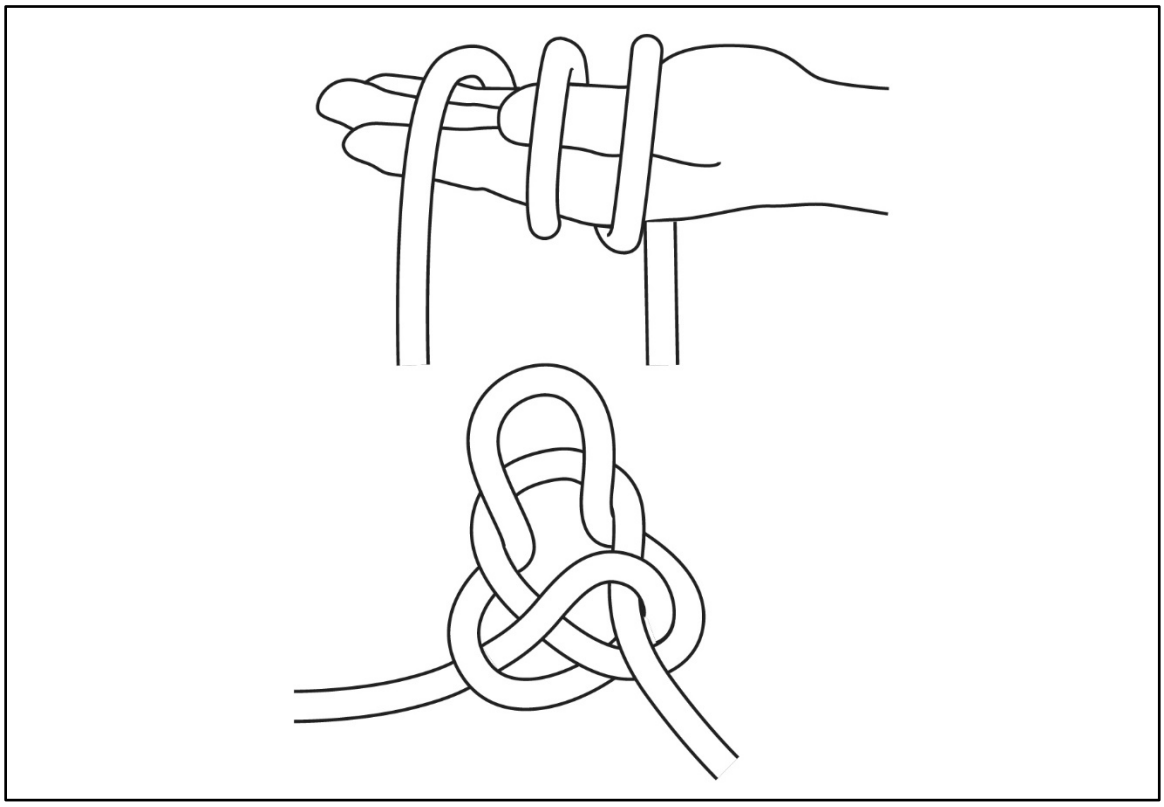


Figure 4-14. Wireman's knot

4-39. Follow these two checkpoints to ensure the knot is tied correctly:

- The completed knot should have four separate bights locking down on themselves with the fixed loop exiting from the top of the knot and laying toward the near side anchor point.
- Both ends should exit opposite each other without any bends.

BOWLINE ON A BIGHT

4-40. The bowline on a bight is used to form two fixed loops in the middle of a rope (see figure 4-15). To tie a bowline-on-a-bight knot:

- Step 1. Form a bight in the rope about twice as long as the finished loops will be.
- Step 2. Tie an overhand knot on a bight.
- Step 3. Hold the overhand knot in the left hand so the bight is running down and outward.
- Step 4. Grasp the bight with the right hand and fold it back over the overhand knot so the overhand knot goes through the bight.
- Step 5. From the end (apex) of the bight, follow the bight back to where it forms the cross in the overhand knot. Grasp the two ropes that run down and outward and pull up, forming two loops.
- Step 6. Pull the two ropes out of the overhand knot and dress the knot down.
- Step 7. A final dress is required. Grasp the ends of the two fixed loops and pull, spreading them apart to ensure the loops do not slip.

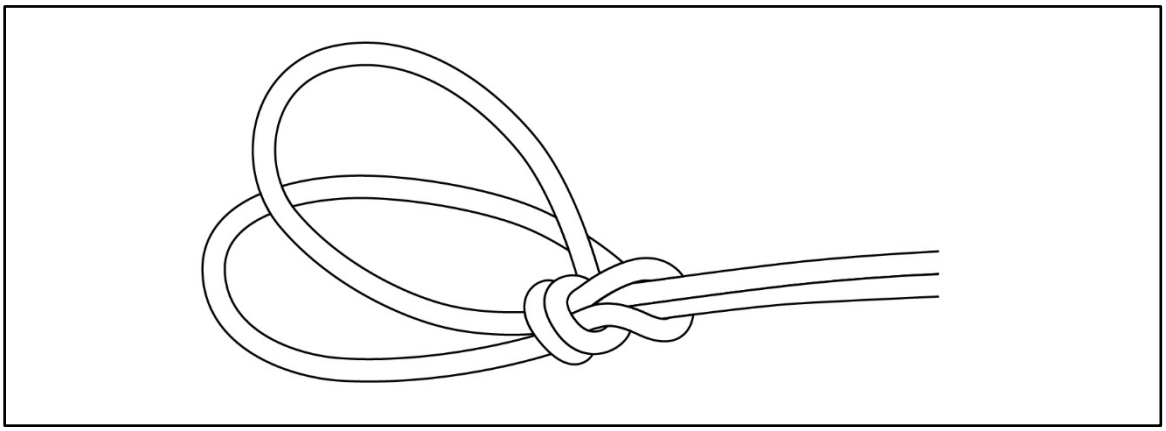


Figure 4-15. Bowline on a bight

4-41. Follow these three checkpoints to ensure the knot is tied correctly:

- There are two fixed loops that do not slip.
- There are no twists in the knot.
- A double loop is held in place by a bight.

TWO-LOOP FIGURE EIGHT

4-42. The two-loop figure eight is used to form two fixed loops in the middle of a rope (see figure 4-16). To tie a two-loop figure eight knot:

- Step 1. Using a doubled rope, form an 18-inch bight in the left hand with the running end facing to the left.
- Step 2. Grasp the bight with the right hand and make a 360-degree turn around the standing end in a counterclockwise direction.
- Step 3. With the working end, form another bight and place that bight through the loop just formed in the left hand.
- Step 4. Hold the bight with the left hand and place the original bight (moving toward the left hand) over the knot.
- Step 5. Dress the knot down.

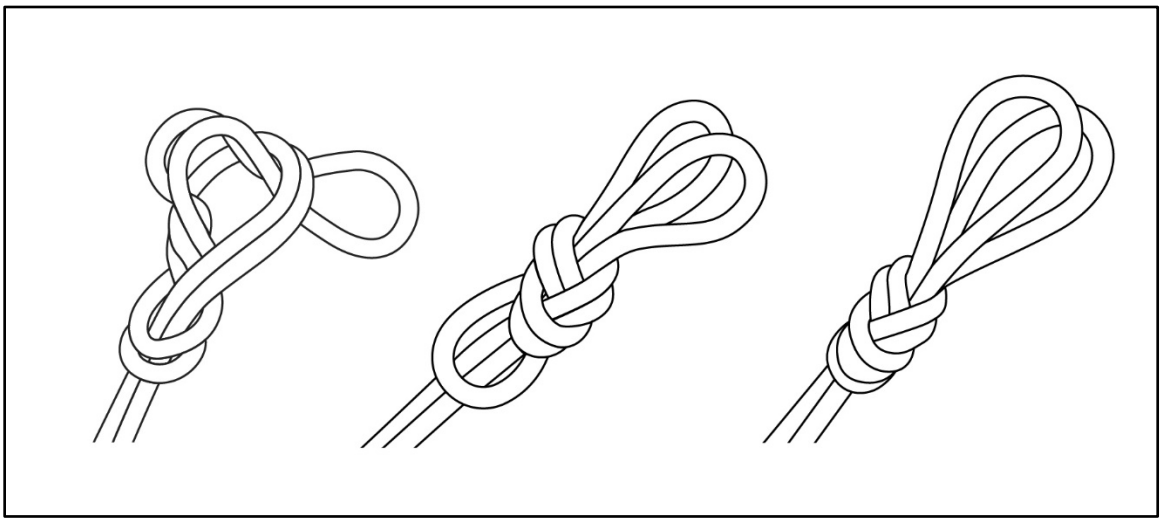


Figure 4-16. Two-loop figure eight

4-43. Follow these three checkpoints to ensure the knot is tied correctly:

- There is a double figure-eight knot with two loops that share a common locking bar.
- The two loops must be adjustable by means of a common locking bar.
- The common locking bar is on the bottom of the double figure-eight knot.

FIGURE-EIGHT ON A BIGHT (FIGURE-EIGHT LOOP)

4-44. The figure-eight on a bight is used to form a fixed loop in a rope (see figure 4-17). To tie a figure-eight on a bight knot:

- Step 1. Form a bight in the rope about as large as the diameter of the desired loop.
- Step 2. With the bight as the working end, form a loop in rope (standing part).
- Step 3. Wrap the working end around the standing part 360-degrees and feed the working
- end through the loop.
- Step 4. Dress the knot tightly.

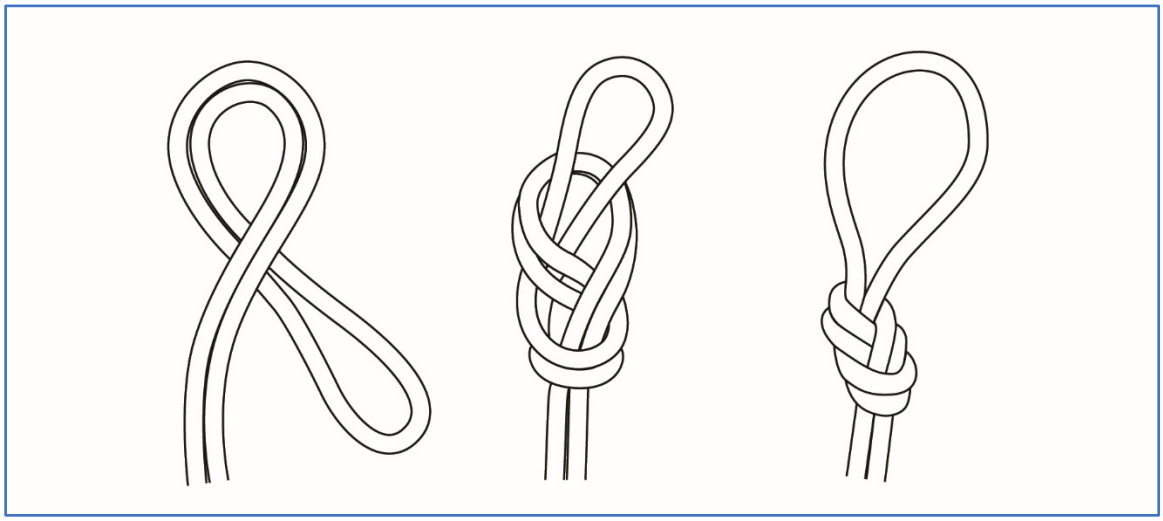


Figure 4-17. Figure-eight on a bight

4-45. Follow these three checkpoints to ensure the knot is tied correctly:

- Two ropes running side by side in the shape of a figure eight.
- The knot forms a fixed loop.
- At least a 4-inch pigtail remains when tied at the end of the rope.

CLASS IV: SPECIAL KNOTS

4-46. Special knots are used for special purposes and are very useful to know in specific situations. The following knots are commonly used special knots.

PRUSIK KNOT

4-47. The Prusik knot is used to put a moveable rope on a fixed rope such as a Prusik ascent or a tightening system. This knot can be tied as a middle or end of the rope knot. To tie a Prusik knot:

- Middle of the rope Prusik knot. The middle-of-the-rope Prusik knot can be tied with a short rope to a long rope as follows (see figure 4-18):

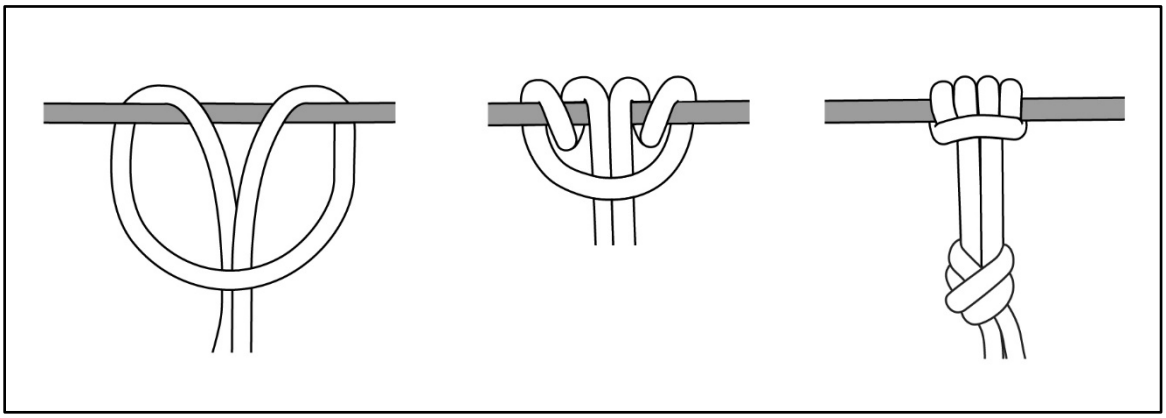


Figure 4-18. Middle of the rope Prusik knot

- End of the rope Prusik knot (see figure 4-19).
  - Step 1. Using an arm's length of rope, place it over the long rope.
  - Step 2. Form a complete round turn in the rope.
  - Step 3. Cross over the standing part of the short rope with the working end of the short rope.
  - Step 4. Lay the working end under the long rope.
  - Step 5. Form a complete round turn in the rope, working back toward the middle of the knot.
  - Step 6. There are four wraps and a locking bar running across them on the long rope. Dress the wraps and locking bar down. Ensure they are tight, parallel, and not twisted.
  - Step 7. Finish the knot with a bowline to ensure that the Prusik knot will not slip out during periods of varying tension.

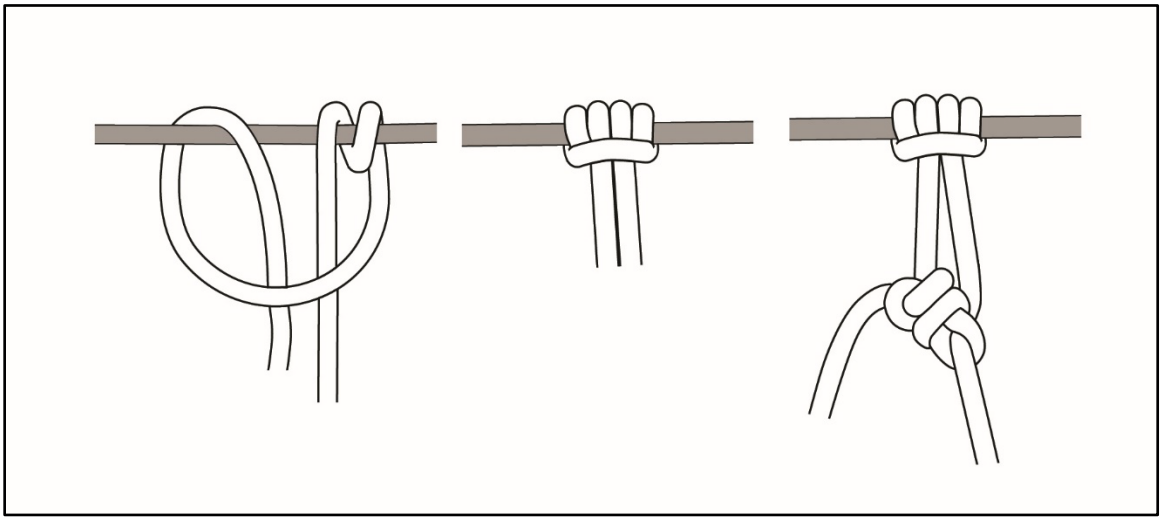


Figure 4-19. End of the rope Prusik knot

4-48. Follow these four checkpoints to ensure the knot is tied correctly:

- There are four wraps with a locking bar.
- The locking bar faces the climber.
- The knot is tight and dressed down with no ropes twisted or crossed.
- The knot should be finished with an overhand or bowline.

THREE-LOOP BOWLINE

4-49. The three-loop bowline is a bowline tied using two strands of rope. A third loop is formed when tying the knot when one rope is folded, forming a bight (see figure 4-20). To tie a three-loop bowline knot:

- Step 1. Form an approximate 24-inch bight or grasp two strands of rope.
- Step 2. With the right thumb facing toward the body, form a doubled loop in the standing part by turning the wrist clockwise. Lay the loops to the right.
- Step 3. With the right hand, reach down through the loops and pull up a doubled bight from the standing part of the rope.
- Step 4. Place the running end (bight) of the rope (on the left) through the doubled bight from left to right and bring it back on itself. Hold the running end loosely and dress the knot down by pulling on the standing parts.
- Step 5. Safety it off with an overhand safety knot.

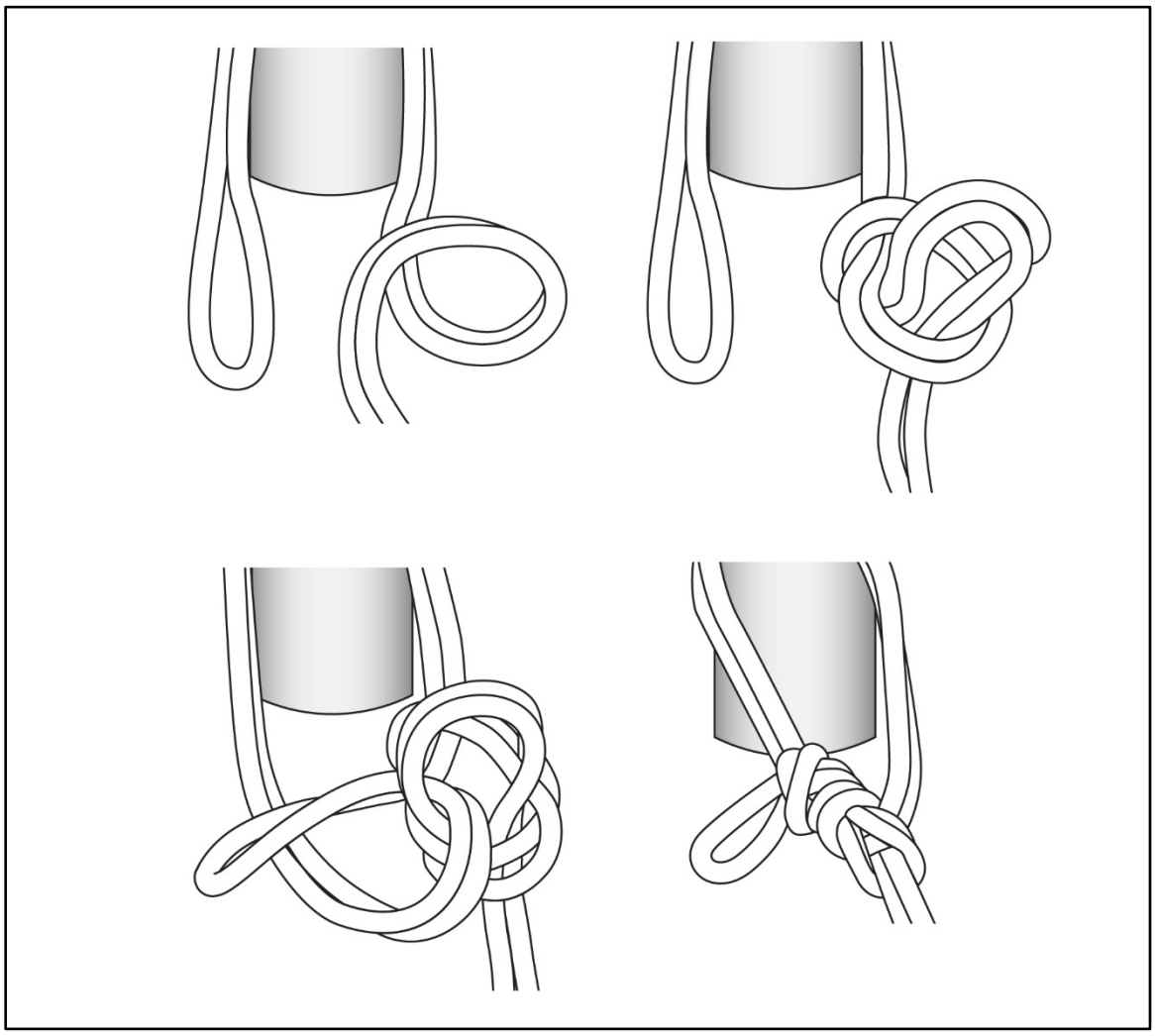


Figure 4-20. Three-loop bowline

4-50. Follow these four checkpoints to ensure the knot is tied correctly:

- There are two bights held in place by two loops.
- The bights form locking bars around the standing parts.
- The running end (bight) is on the inside of the fixed loops.
- There is a minimum 4-inch pigtail after the overhand safety knot is tied.

TRANSPORT KNOT (OVERHAND SLIP KNOT/MULE KNOT)

4-51. The transport knot is used to secure the transport tightening system (see figure 4-21). To tie a transport knot:

- Step 1. Pass the running end of the rope around the anchor point passing it back under the standing portion leading to the far side anchor, forming a loop.
- Step 2. Form a bight with the running end of the rope. Pass over the standing portion down through the loop and dress it down toward the anchor point.
- Step 3. Secure the knot by tying a half hitch around the standing portion with the bight.

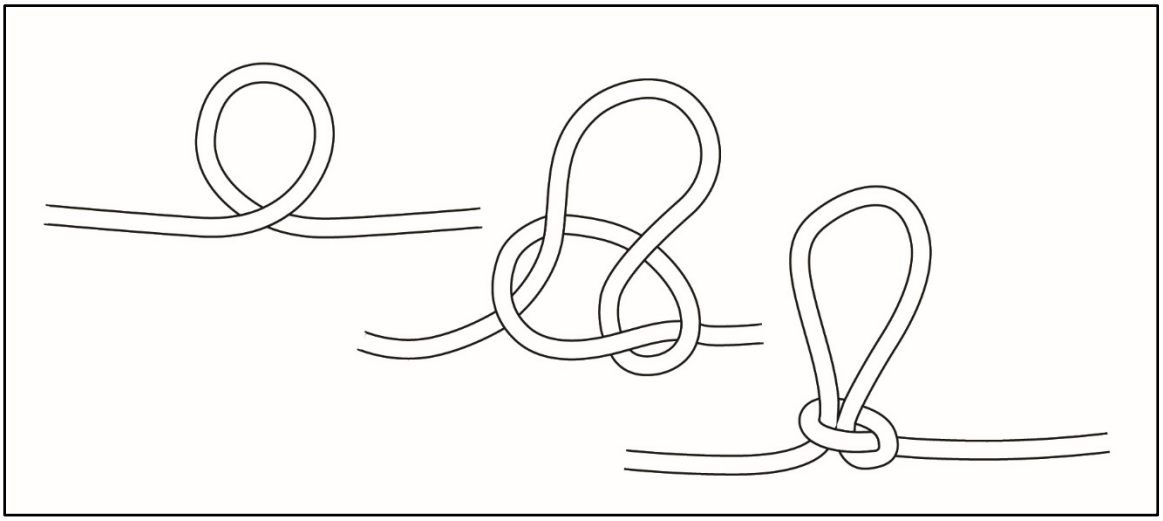


Figure 4-21. Transport knot (overhand slip knot/mule knot)

KLEMHEIST KNOT

4-52. The Klemheist knot provides a moveable, easily adjustable, high-tension knot capable of holding extremely heavy loads while being pulled tight (see figure 4-22). To tie a Klemheist knot:

- Step 1. Using a utility rope or webbing, offset the ends by 12 inches. With the ends offset, find the center of the rope, and form a bight. Lay the bight over a horizontal rope.
- Step 2. Wrap the tails of the utility rope around the horizontal rope back toward the direction of pull. Wrap at least four complete turns.
- Step 3. With the remaining tails of the utility rope, pass them through the bight (see step 1).
- Step 4. Join the two ends of the tail with a joining knot.
- Step 5. Dress the knot down tightly so all wraps are touching.

Note. Ultra-high molecular weight polyethylene spectra fiber is an example of a type of rope which should not be used for the Klemheist knot. It has a low melting point and tends to slip. Other types of rope with similar properties can also lead to failure in a system.

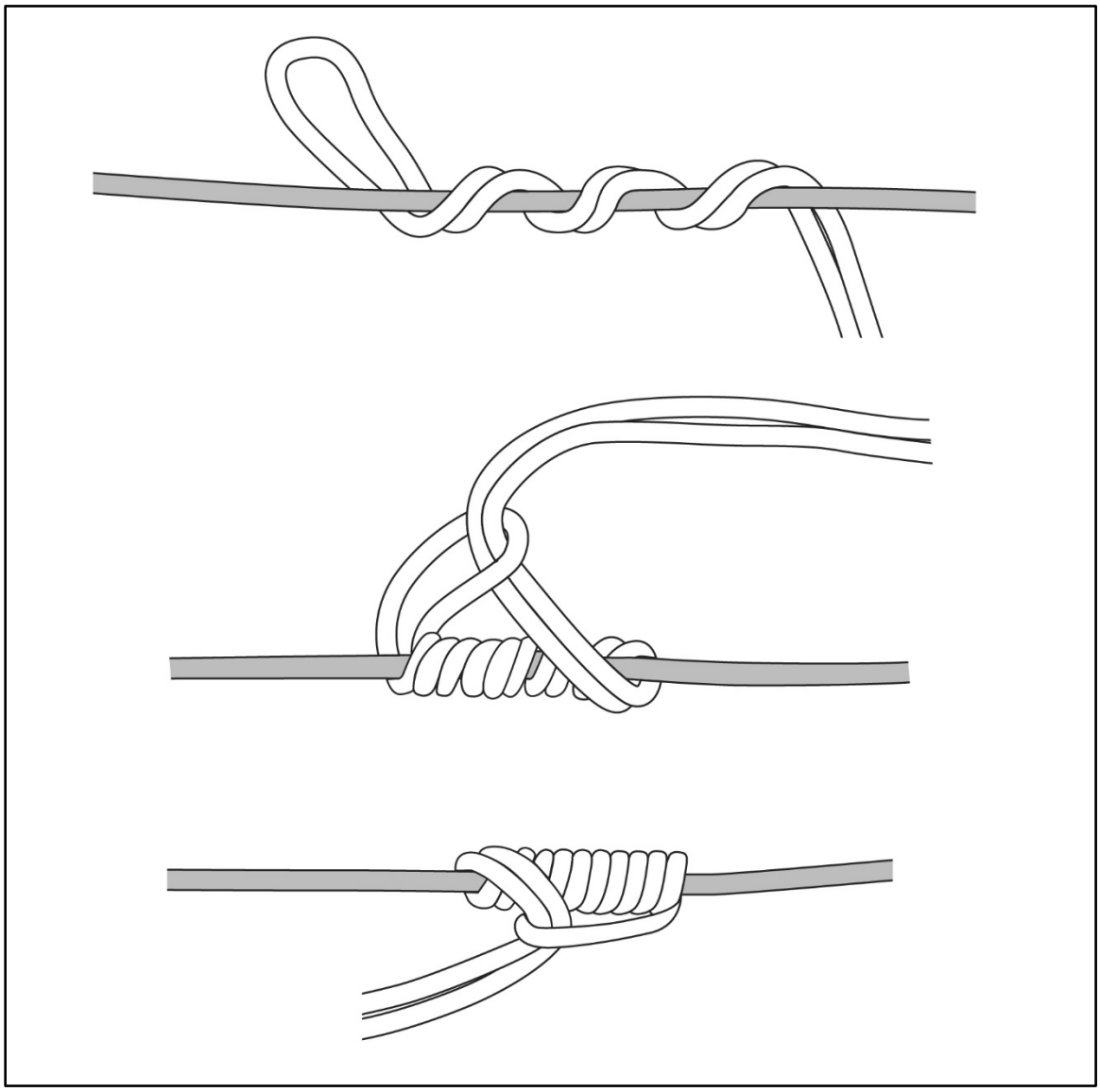


Figure 4-22. Klemheist knot

4-53. Follow these three checkpoints to ensure the knot is tied correctly:

- The bight is opposite the direction of pull.
- All wraps are tight and touching.
- The ends of the utility rope are properly secured with a joining knot.

GIRTH HITCH

4-54. The girth hitch is used to attach a runner to an anchor or piece of equipment (see figure 4-23). To tie a girth hitch:

- Step 1. Form a bight.
- Step 2. Bring the runner back through the bight.
- Step 3. Cinch the knot tightly.

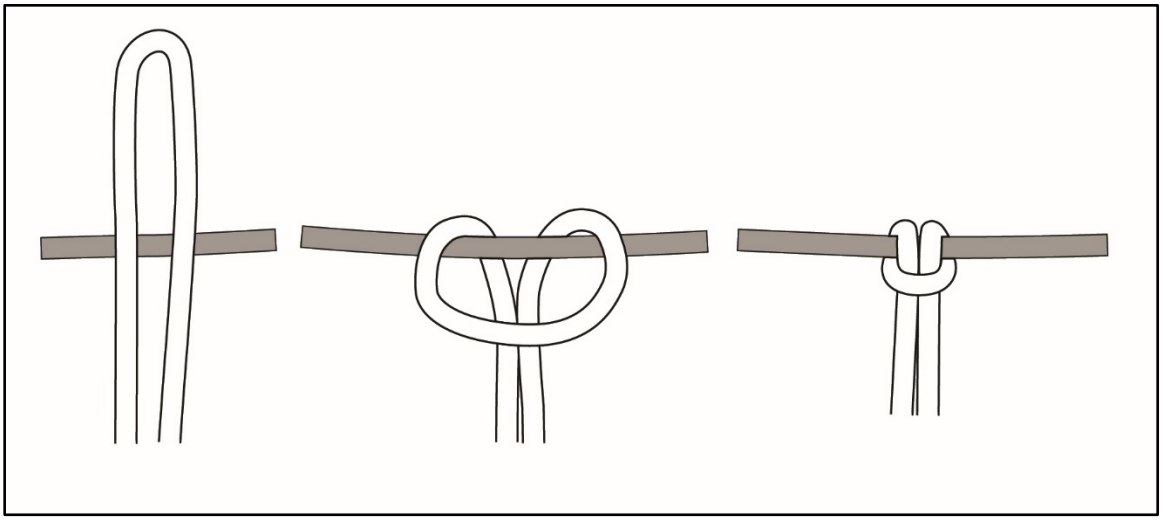


Figure 4-23. Girth hitch

4-55. Follow these two checkpoints to ensure the knot is tied correctly:

- Two wraps exist with a locking bar running across the wraps.
- The knot is dressed tightly.

MUNTER HITCH

4-56. When used in conjunction with a pear-shaped locking carabiner, the Munter hitch is used to form a mechanical belay (see figure 4-24). To tie a Munter hitch:

- Step 1. Hold the rope in both hands, palms down about 12 inches apart.
- Step 2. With the right hand, form a loop away from the body toward the left hand. Hold the loop with the left hand.
- Step 3. With the right hand, place the rope that comes from the bottom of the loop over the top of the loop.
- Step 4. Place the bight that has just been formed around the rope into the pear-shaped carabiner. Lock the locking mechanism.

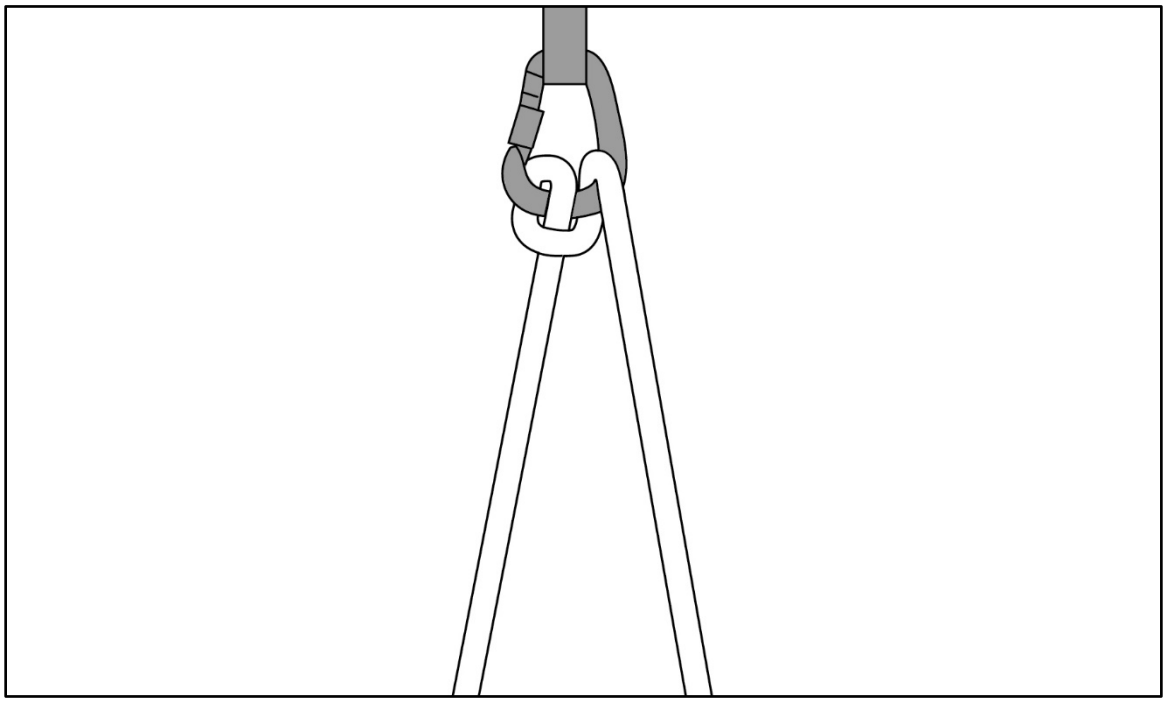


Figure 4-24. Munter hitch

4-57. Follow these two checkpoints to ensure the knot is tied correctly:

- A bight passes through the carabiner, with the closed end around the standing or running
- part of the rope.
- The carabiner is locked.

HIP-RAPPEL SEAT

4-58. While technically listed as a specialty knot, the hip-rappel seat is a rappelling harness constructed out of a length of rope. It is constructed as follows (see figures 4-25 through 4-29 on pages 63 through 67):

- Step 1. Place the midpoint (center) of the length of the sling rope on the hip opposite the brake hand (the brake hand is the dominant hand). (See figure 4-25 A, B, C on page 63).
- Step 2. With the dominant hand, reach around the back and bring the sling rope around the waist above the hip bone. (See figure 4-25 D on page 63.) Tie two overhand lays creating five peaks at the navel (figure 4-25 E, F, G, H on page 64).
- Step 3. Let the two free ends of the sling rope fall to the ground in front (see figure 4-25 I on page 64).
- Step 4. Bring the two free ends of the sling rope down between the legs and up over the buttocks. Ensure that the two free ends do not cross (see figure 25 J on page 65).
- Step 5. Pass the ends of the ropes over the rope that is tied around the waist at the two points above the center of the two rear seat pockets and toward the spine (see figure 4-25 K on page 65).
- Step 6. Grab the free end of the rope that is on the left side of the body with the left hand, and the free end of the rope that is on the right side of the body with the right hand.
- Step 7. Squat down and simultaneously pull on both running ends of the ropes and stand up. This will tighten the seat (see figure 4-25 L on page 65).
- Step 8. Take the rope in the dominant hand and bring around the front of the waist and meet the rope in the nondominant hand on the hip of the non-dominant side of the body (see figure 4-25 M on page 66).
- Step 9. Tie the two running ends with a square knot and two overhand safety knots (see figure 4-25 N on page 66).

- Step 10. Place any excess rope in the trouser pocket near the square knot (see figure 4-25 O, P on page 66).
- Step 11. With the gate down and the hooked end of the carabiner against the navel, move the carabiner to encase all three ropes, the single waist rope and the two ropes forming the overhand lays (see figure 4-25 Q on page 67).
- Step 12. Rotate the carabiner a half turn so the gate is facing up and will open away from the body (see figure 4-25 R, S, T on page 67).

Note. The recommended length of a hip-rappel seat rope is a minimum of 15 feet.



Figure 4-25. Construction of the hip-rappel seat

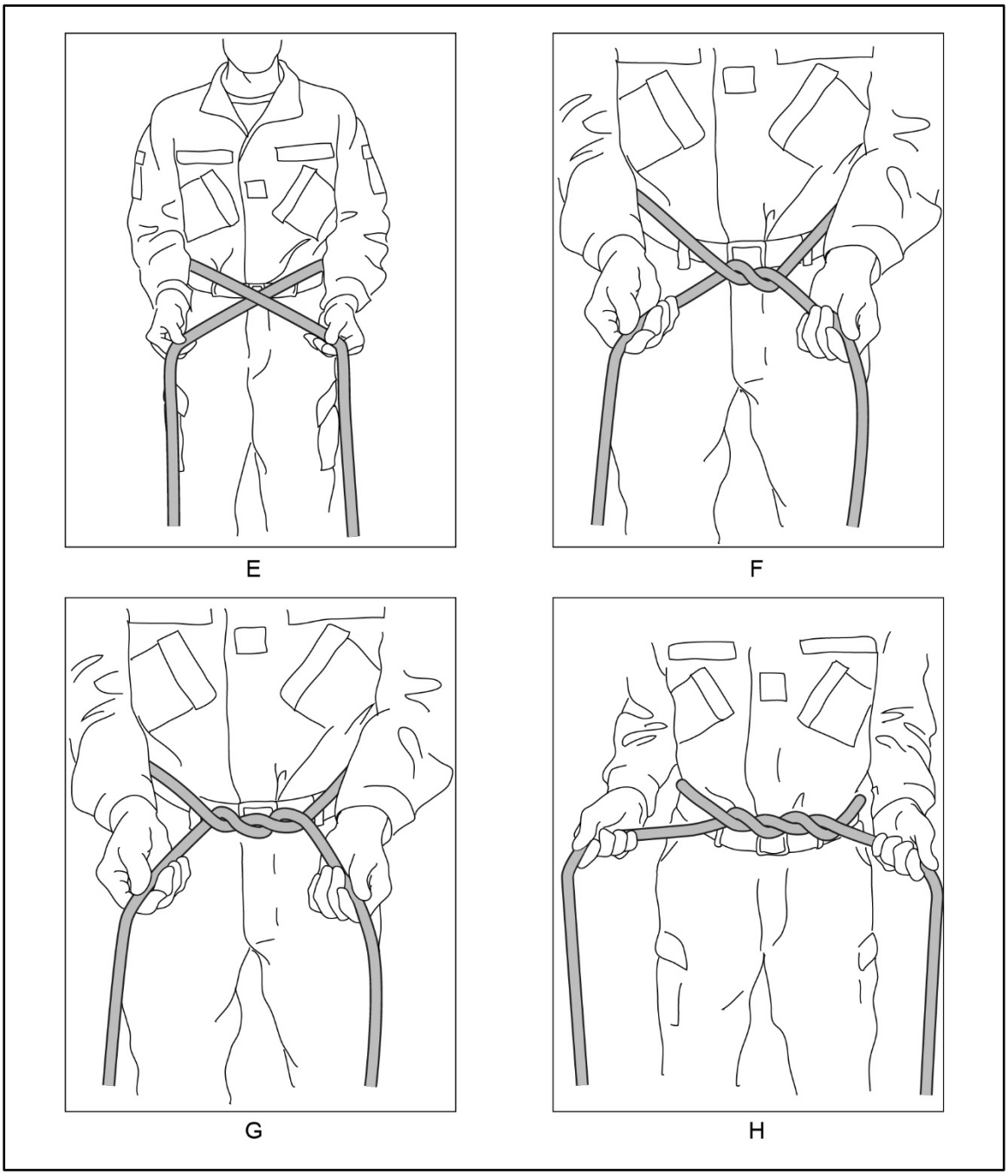


Figure 4-25. Construction of the hip-rappel seat (continued)

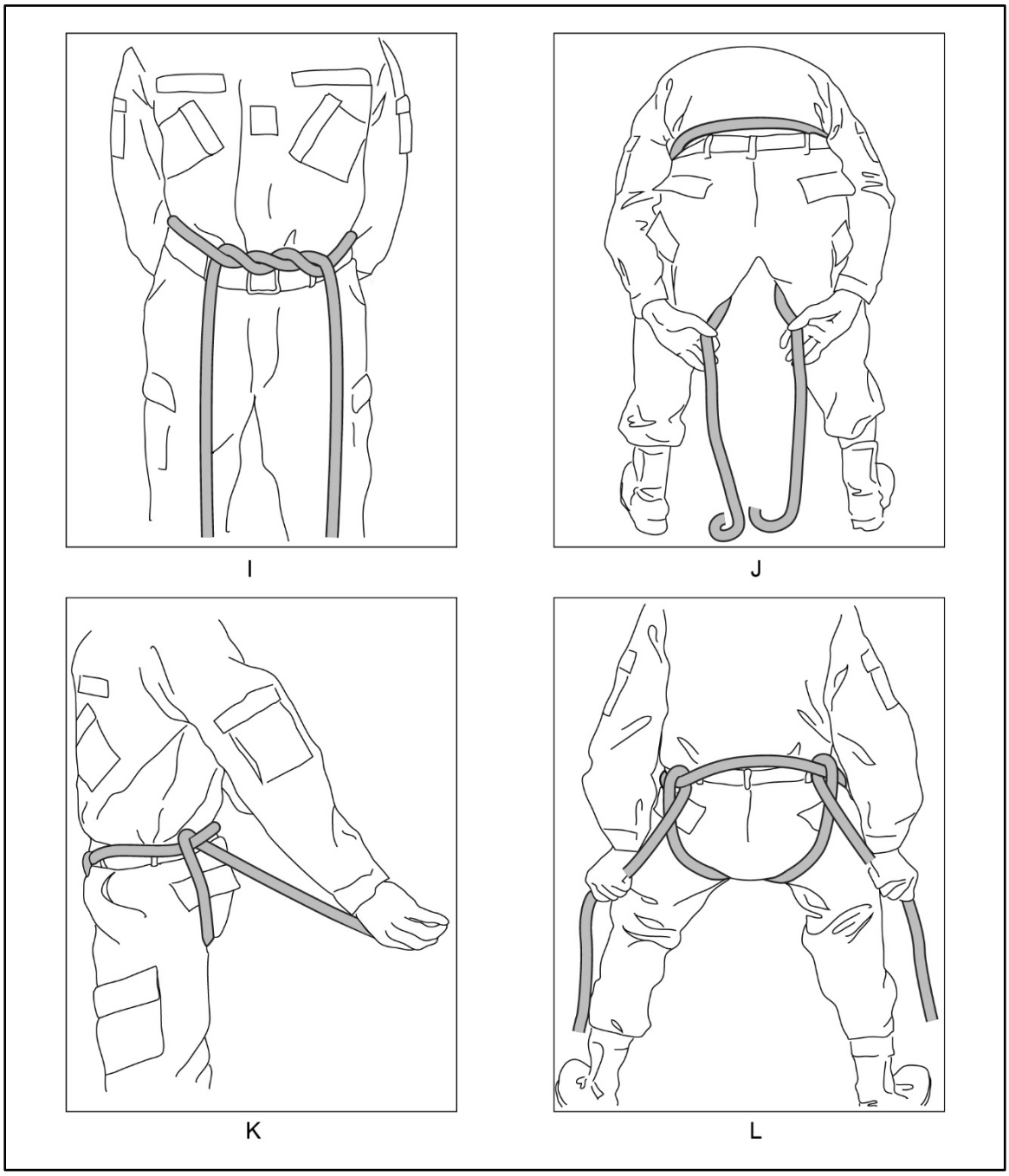


Figure 4-25. Construction of the hip-rappel seat (continued)

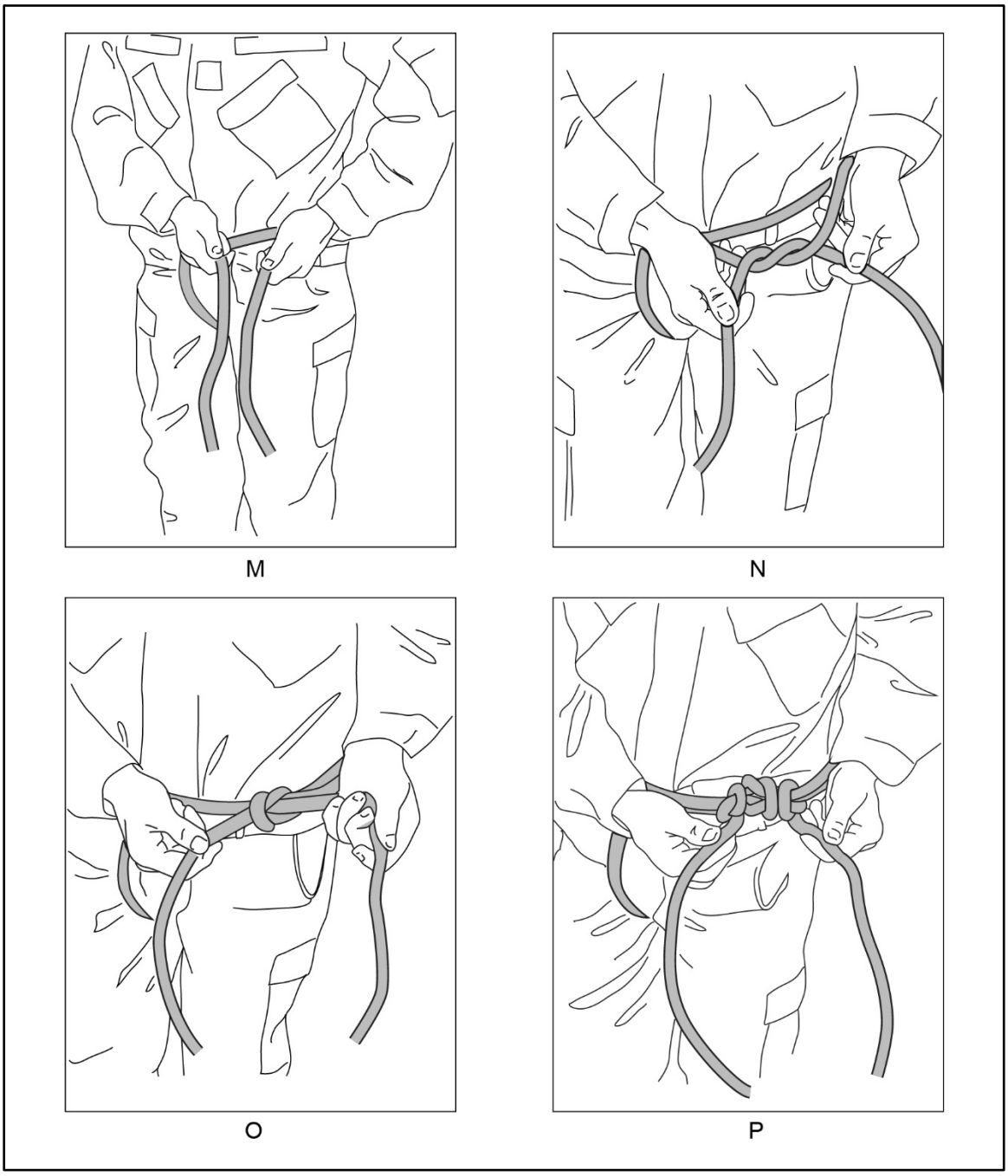


Figure 4-25. Construction of the hip-rappel seat (continued)

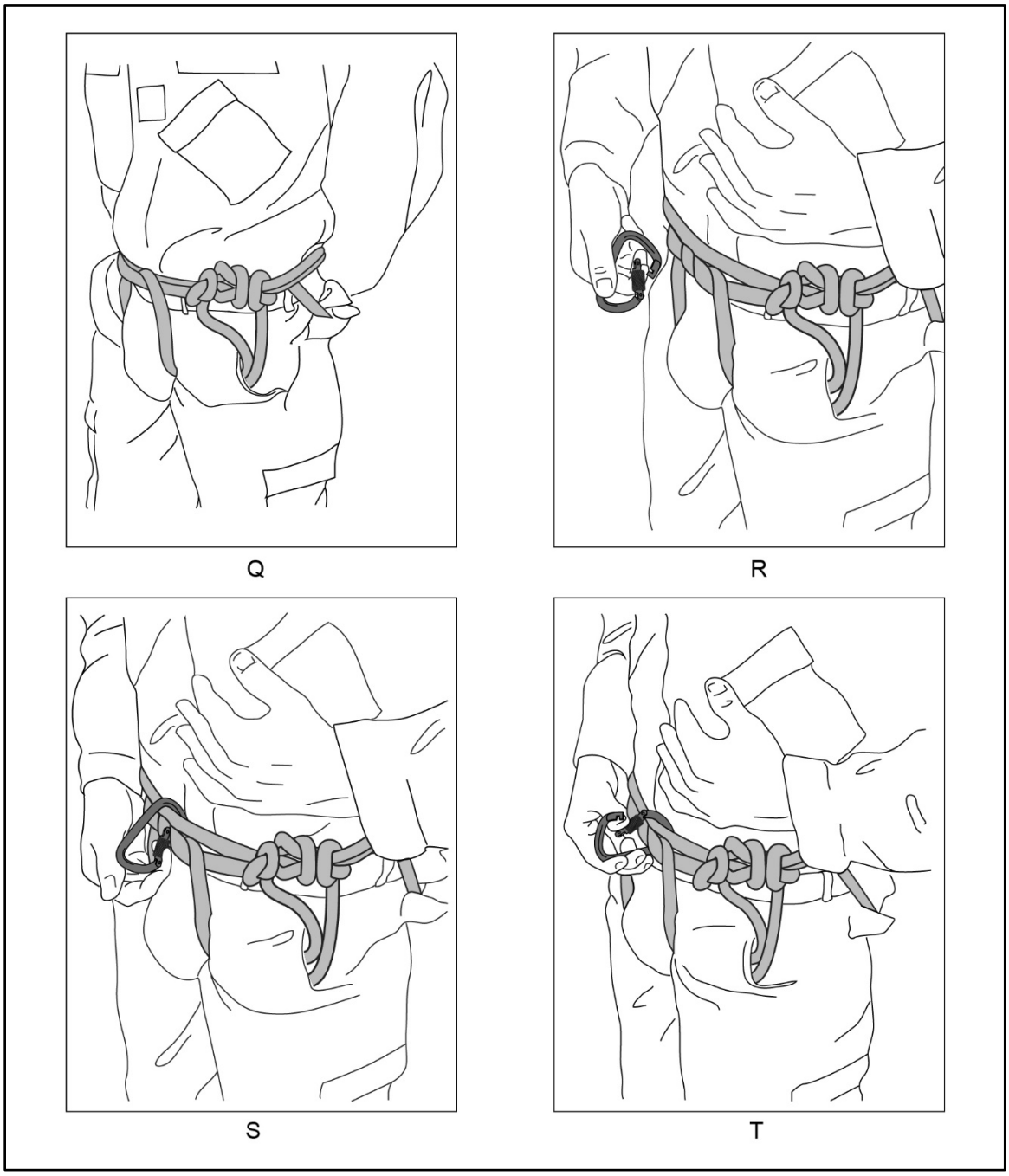


Figure 4-25. Construction of the hip-rappel seat (continued)

4-59. Follow these four checkpoints to ensure the hip-rappel seat is tied correctly:

- There are two overhand lays creating five peaks in the front.
- The ropes are not crossed between the legs.
- A half hitch is formed on each hip.
- Seat is secured with a square knot with overhand safeties on the non-brake hand side.

This page intentionally left blank.

Appendix A

Basic Equipment for Rappel Operations

The equipment listed in this appendix comprise the standard basic items required to conduct ground and air rappelling operations.

TOWER RAPPELLING

A-1. For tower rappelling, the following equipment is needed:

- Static kernmantle ropes.
- Locking carabiners.
- Heavy duty leather gloves with friction pads.
- Rope coiling log or standard deployment bag.
- Hip-rappel seat ropes or manufactured harnesses.

AIRCRAFT RAPPELLING

A-2. For aircraft rappelling, the following equipment is needed:

- All items in paragraph A-1.
- Radio for communication with aircraft.
- High performance, waterproof, pressure sensitive tape.
- Army approved personal gear:
  - Ear protection.
  - Eye protection.
  - Helmet.
  - Long-sleeved shirt.

This page intentionally left blank.

Glossary

The glossary lists acronyms and terms with Army or Joint definitions. Where Army and Joint definitions differ, Army precedes the definition. Terms for which TC 21-24 is the proponent are marked with an asterisk (*). The proponent publication for other terms is listed in parenthesis after the definition.

ACRONYMS AND ABBREVIATIONS

Acronym	Definition
DA	Department of the Army
FM	field manual OR frequency modulation
NCO	noncommissioned officer
PIC	pilot-in-command
RAPSO	rappel safety officer
RM	rappel master
TC	training circular
U.S.	United States

This page intentionally left blank.

References

URLs for this publication were accessed on 7 February 2025.

REQUIRED PUBLICATIONS

These documents must be available to intended users of this publication.

DOD Dictionary of Military and Associated Terms. December 2024.

FM 1-02.1. *Operational Terms*. 28 February 2024.

RELATED PUBLICATIONS

These documents are cited in this publication.

ARMY PUBLICATIONS

Most Army publications are available online: https://armypubs.army.mil.

FM 6-27/MCTP 11-10C. *The Commander's Handbook on the Law of Land Warfare.* 7 August 2019.

TM 3-34.86/MCRP 3-17.7J. *Rigging Techniques, Procedures, and Applications.* 16 July 2012.

PRESCRIBED FORMS

This section contains no entries.

REFERENCED FORMS

Unless otherwise indicated, DA Forms are available online: https://armypubs.army.mil.

DA Form 2028. *Recommended Changes to Publications and Blank Forms.*

DA Form 5752-R. *Rope Log (Usage and History).*

This page intentionally left blank.

Index

Entries are by paragraph number.

A

adverse weather. ***2-13***

air traffic controller. *3-14*

anchor knots
- bowline. 4-30
- clove hitch. 4-35
- figure-eight retrace. 4-34
- round turn and two half hitches. 4-32

C

carabiners. 3-3, 3-9

CH-47 helicopter. 2-29
- anchor points, primary. 2-33
- anchor points, secondary. 2-32
- rigging. 2-31
- seating. 2-37
- third rappel station. 2-34

communications. *2-10*

D

DA Form 5752-R. ***4-5.***

deployment bag. 2-17

G

gloves. 3-10

H

helicopter
- hand and arm signals. 2-27
- rappelling. 2-1, 2-7, A-2
- rappelling commands. 2-26
- rappelling safety. 2-28

helmet. 3-11

hip-rappel seat. *1-17*, *1-21*, 2-9, 2-15, 2-24, 2-25, 3-13, 4-59
- hookup. *1-22*

J

joining knots
- double fisherman's knot. 4-23
- figure-eight bend. 4-25
- fisherman's knot. 4-21
- square knot. 4-19
- water knot. 4-27

L

lock-in procedure. 1-29

M

main, 22

medical. 2-10

middle rope knots
- bowline on a bight. 4-40
- figure-eight on a bight. 4-44
- two-loop figure eight. 4-42
- wireman's knot. 4-38

N

night operations. 2-14

R

rope. 4-1
- coiling
  - butterfly. 4-13
  - mountain. *4-10*
  - small diameter. 4-14
- inspection. 4-5
- packaged. 4-3
- securing ends. 4-4
- throwing. 4-16
- types
  - kernmantle. 3-2, 4-4
  - laid. 3-2, 4-4

S

safety briefing
- helicopter. 2-15
- medical. 2-11
- tower. *1-16*, *1-16*

special knots
- girth hitch. 4-54
- hip-rappel seat. *4-58*.
- Klemheist knot. 4-52
- Munter hitch. 4-56
- Prusik knot. 4-47
- three-loop bowline. 4-49
- transport knot. 4-51

T

tower
- hand and arm signals. 1-24
- procedures. 1-23
- rappelling, 1, *1-17*, 1-18, 1-18, A-1

U

UH-60 helicopter. 2-20
- anchor points, primary. 2-23
- anchor points, secondary. 2-22
- rigging. 2-21
- seating. 2-24

This page intentionally left blank.

TC 21-24

25 February 2025

By Order of the Secretary of the Army:

RANDY A. GEORGE
General, United States Army
Chief of Staff

Official:

MARK F. AVERILL
Administrative Assistant
to the Secretary of the Army
2505207

DISTRIBUTION:
Active Army, Army National Guard, and United States Army Reserve. To be distributed in accordance with the initial distribution number IDN 115059, requirements for TC 21-24.

This page intentionally left blank.

This page intentionally left blank.

This page intentionally left blank.

PIN: 068597-000