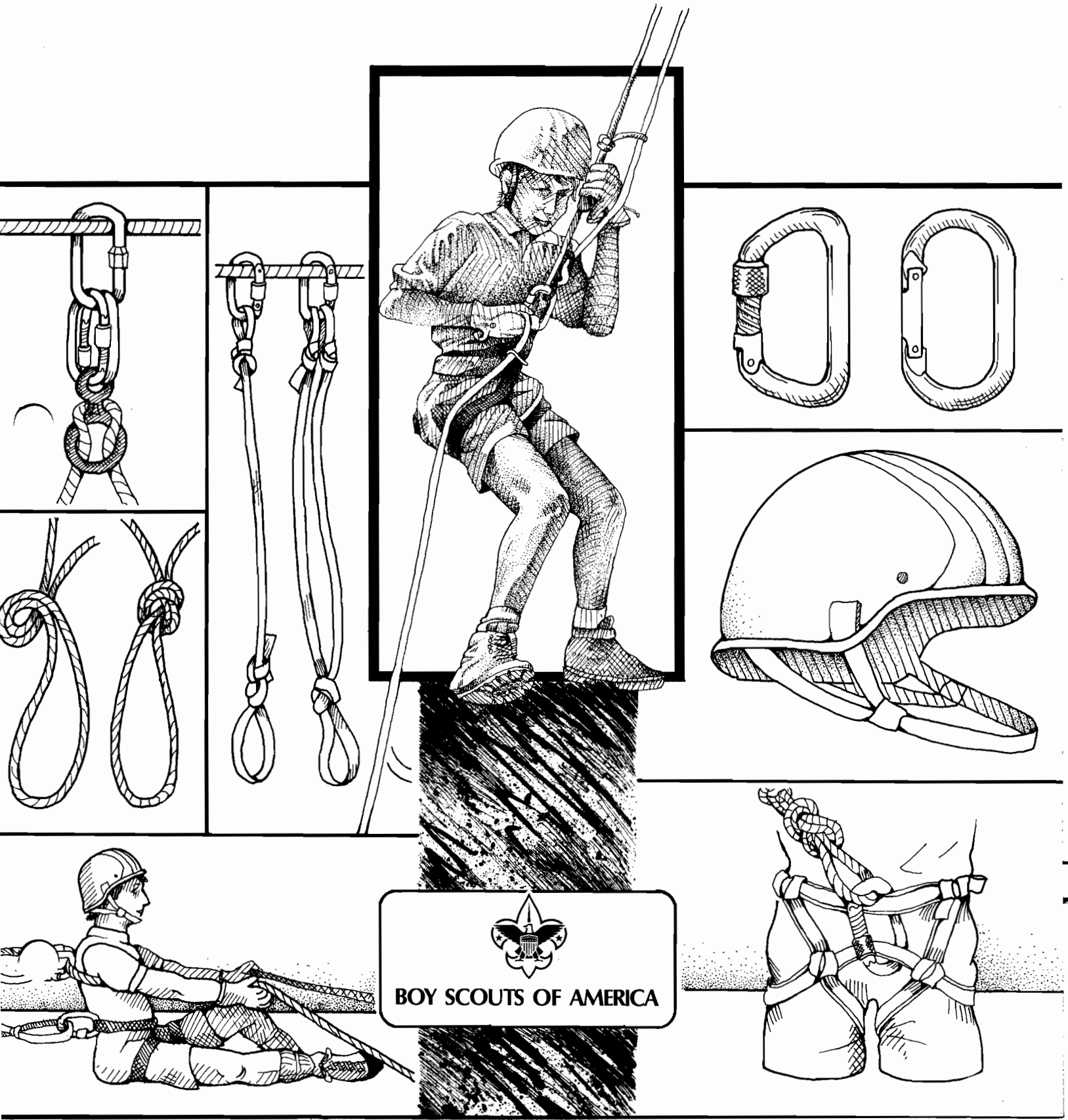
OUTDOOR SKILLS INSTRUCTION
CLIMBING/RAPPELLING



BOY SCOUTS OF AMERICA

OUTDOOR SKILLS INSTRUCTION
CLIMBING/RAPPELLING

Introduction

The Boy Scouts of America has centered many of its activities around the outdoors. Scouts and Scouters are seeking new ways to test their physical and mental abilities.

This manual is designed to help create an awareness of the proper use of equipment and needed skills to participate in these activities. It is important that participants in this course understand the necessity of proper training and equipment use.

Note to the user of this manual:

This manual is one in a series of skills manuals. Each manual may be used separately, or sessions may be mixed. Each manual covers a broad spectrum of topics. You will note that there are no time schedules listed. The training should be conducted according to the ability of the participants to complete the topics. These sessions may be conducted by any qualified Scouter. You are encouraged to recruit experts to assist in instructing. Use the outlines as guides to create a hands-on learning experience.

Outdoor Skills Instruction Manuals

Aquatics, No. 33026
Backpacking, No. 33035
Camping, No. 33003
Cooking, No. 33567
Rappelling/Rock Climbing, No. 33027
Survival, No. 33029
Team Building, No. 33004

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OVERVIEW

Why Begin a Rock-Climbing Program?

Rock climbing is one of the most rapidly growing outdoor sports. Many young people are now engaging in it with various degrees of knowledge and ability. Some people express the concern that rock-climbing is too risky. If improperly conducted, rock climbing can be an extremely hazardous activity for both participants and observers. However, by using a qualified rock-climbing authority, using quality equipment, and practicing sound techniques, rock climbing can be safer than driving a car or crossing a street.

Rock climbing supports Scouting's basic objectives. It clearly promotes physical fitness, being one of the most strenuous outdoor activities, and it also develops character. Young people are able to surmount seemingly impossible objectives—they do more than they thought possible prior to participating in this exhilarating outdoor sport. Rock climbing provides a worthy challenge. As their knowledge and skill increases, participants become more confident and develop more self-reliance.

Good leadership and self-discipline are essential in rock climbing. Young people have an opportunity to see superb examples of leadership. They learn leadership by example. As their proficiency grows, they, too, have an opportunity to exercise leadership. In rock climbing, as elsewhere, a participant needs to be a good follower before becoming a good leader.

Rock climbers work together as a team in pairs or in threes. Good teamwork is crucial. Rock climbers entrust their life and well-being to their "stout-hearted" belayer. The friendships that develop between rock climbing participants frequently are life-long.

Selecting a Suitable Site

In selecting a suitable site, look for the following:

1. Get the assistance of a local rock-climbing authority—someone with extensive, safe, rock-climbing experience. Contact several rock-climbing organizations and other qualified climbers to be sure of getting a bona fide authority. Some rock climbers will claim to be authorities without having a thorough knowledge of climbing and teaching techniques. A true authority will acknowledge his or her limitations. A true authority will also give meticulous attention to safety procedures and techniques, yet not overburden participants with nonessential rules. Getting a qualified rock-climbing authority to assist in setting up the program is imperative for a safe, successful experience.
2. The rock chosen should not be unduly fractured, brittle, loose, slippery, or crumbly. Soft sandstone is best avoided. Easily dislodged rock may present a hazard to observers at the base of a rock face as well as to climbers.
3. Specific sites should be sought and designated for climbing and rappelling—not just any area that "looks good." These sites should be designated by a rock-climbing authority rather than arbitrarily selected by staff.

4. Ideally, climbing and rappelling sites will be adjacent, where both can be observed by one instructor from the same location, even though more than one instructor should be present.
5. The incline for climbing should be a 60- to 80-degree slope, depending upon the rock and available holds; 60 to 70 degrees is usually best. The rappelling site should have a 60- to 85-degree slope; 70 to 80 degrees is generally best. Both the climb and the rappel should be challenging, yet within the capabilities of beginning climbers.
6. The rappelling site should have a reasonably constant slope from bottom to top, without any large ledges or benches, so that continuous tension will be on the rappel rope and so that participants can be readily observed throughout.
7. Both climbing and rappelling sites preferably face north or east, out of direct sunlight, in warm or arid regions. The sites should be readily accessible should any emergency arise.
8. The climb should be 30 to 60 vertical feet, depending upon the number of participants. The more climbers there are, the lower the climb should be. Two or three adjacent climbs of varying difficulty are preferable to only one. In an intermediate or advanced climb, offer Scouts or Explorers a smorgasbord of increasing challenges, provided that time is adequate. Point out both the easier and more difficult routes, and let the climbers choose which to try first.
9. The rappel should be a least 30 vertical feet; otherwise, the feeling of adventure and accomplishment is lost. A longer rappel requires little additional time, so it can be considerably longer than the climb—beginning climbers should attempt a maximum of one rope length. If you are using 120-foot ropes, the maximum rappel length will be about 90 feet using a single rappel rope with a figure-eight brake.
10. There must be sufficient level space above each climb and each rappel to accommodate at least three persons comfortably—a belayer (staff member) and two climbers.
11. The climbing site must have sufficient hand and foot holds, preferably a variety of cracks, ledges, protrusions, ribs, and so on. Extensive smooth surfaces are not suitable. Low-angle (40 to 50 degrees) slabs are generally good for friction-climbing practice, depending upon the experience and skill of the participants. Even lower slabs allow balance-climbing practice (without using the hands), using only boot soles and good balance to ascend.
12. Establish a safe path from the top of the climb to the rappelling site. The path should not run next to the edge of a cliff, but if it must, set up a safety rope for climbers to clip into as they walk along the path.
13. If any tree limbs or shrubs interfere with the climb or rappel, choose another site.
14. There must be a good place for a belayer to conduct a firm belay for climbers and rappellers—one where the belayer's feet can be braced against the direction of a possible fall, and one that is protected from the potential of falling rocks.

15. Both the climb and rappel must have good places for anchors, preferably large trees (that will not budge) or solid rock projections. If artificial protection must be placed, use ⅜-inch diameter expansion-type bolts (placed by your rock-climbing authority) with hangers. They should be driven into solid rock, not a flake or projection, at a 90-degree angle to the surface. The hangers should have some play; they should not be tight against the rock. The direction of pull on hangers should be parallel to the rock surface.
16. The site must permit the climbers to be observed throughout the climb from below, and preferably from above as well. Rappellers must be constantly observed throughout the rappel, preferably from the bottom. The staff observer and participants should be located far enough out from the base of the rock to be well removed from the line of fall of rocks or climbing equipment. The lower rappel observer must be prepared to grab the rappel rope to control descent speed.
17. All rock-climbing staff should be able to smoothly, efficiently, and safely negotiate all designated climbs and rappels. If they cannot, it is unrealistic to expect beginning participants to be able to gain anything from rock climbing except a terrifying experience.
18. Provide a secure place to store equipment, whether it be a building or a large box. The storage provision must be rodent-proof and watertight. Equipment should be hung and harnesses permitted to air dry.

Selecting Equipment

1. Consult your rock-climbing authority for your specific needs. The following recommendations are fairly standard. Used rock-climbing rope cannot be trusted. The history of its use is uncertain, and thus, its capability unknown. Once a rope is subjected to three hard falls, it should be retired from both climbing and rappelling. (Nylon webbing and rope must be new.) Used chocks, hammers, pitons, carabiners, helmets, and belay devices can be quite good, but a knowledgeable resource should check them carefully. If any doubt exists concerning the reliability or capability of equipment, you would be well advised to get new, quality gear. Quality equipment lasts longer as well as provides an extra margin of safety.
2. Use only high-quality Goldline (7/16-inch diameter) or Kernmantle (11-millimeter diameter). Blue Water III (a caving rope) is suitable for rappelling because it does not stretch or gnarl as much as Goldline or Kernmantle. Cut ropes to appropriate lengths for the climb and rappel so that they do not become needlessly snarled or spaghetti-like. Do not use Blue Water rope for climbing because it lacks the stretch (and hence the shock absorbency) to comfortably hold a fall. Seal the ends of climbing rope with heat to prevent fraying.
3. Steel carabiners last much longer than aluminum ones, but either will do. Beware of old-model steel carabiners, though, because some are weak. D-shaped locking carabiners are best for most situations. For rappelling, a locking D carabiner and a figure eight work especially well with a minimum possibility for mistakes. If purchasing standard carabiners, use them in tandem with gates reversed and opposed. Locking carabiners cut the total needed nearly in half because they may be used

singly without accidental failure. Beware of cheap hardware or special deals. Buy equipment only from reputable dealers. If using brake bars for the rappel, they must fit the carabiners being used.

4. The quantity of equipment needed fluctuates according to the number of participants and the available time. Extra helmets, harnesses, slings, and carabiners may make the program more efficient. Having the right quantity eliminates delay in retrieving gear from the last climber or rappeller. When the first participant is finished, the second can be equipped, ready to go. Be sure to have a supply sufficient for use in any foreseeable rescue situation. Also keep in mind that rock-climbing gear is in great demand and that it may be difficult to purchase additional equipment during the summer or to receive it when needed. If adequate equipment is not available, the program must cease.
5. Check new climbing equipment for defects or flaws in manufacturing. Never assume that a rope, carabiner, or any other item is sound.
6. Do not buy or use second-hand or military surplus climbing equipment, much of which is inadequate.
7. Keep a complete, current equipment inventory, and establish an effective system for issuing, checking in, and maintaining equipment. All equipment is kept in locked storage when not in use. It must be protected from animals, inclement weather, sunlight (rope and webbing), water, chemicals, gasoline, oil, unauthorized use, and theft.
8. Use rescue equipment only for rescue. It should be color-coded or otherwise designated so that it can be easily distinguished from standard equipment used in the program. Rescue gear and first-aid supplies are available at the program site whenever it is being used. Again, keep enough rescue equipment available to perform any foreseeable rescue in a safe manner.

Selecting Your Staff

1. Climbers possess a wide range of climbing abilities and knowledge and also profess a wide range of climbing abilities. A great disparity between real ability and knowledge and what the climber claims is often apparent. A truly competent climber will admit to his or her own limitations—be wary of overconfidence and ignorance. *Beware of hot-shot climbers who have great climbing ability but who lack patience or the ability to teach effectively and safely.*
2. Rock-climbing staff members must be dependable, must exercise good judgment, and must be mature enough to resist foolish attempts. All staff must be safety conscious. A minimum age of 21 is strongly recommended for the rock-climbing director.
3. Rock-climbing experience is difficult to assess. Although rock climbing is classified according to six classes of increasingly difficult climbing, no particular rating method exists for determining the qualifications of an individual as a rock-climbing instructor for Scout camp or for Scouting or Exploring activities. Generally speaking, the more experienced an individual is, the more knowledgeable the individual will be. Remember, though, that climbing prowess is no indication of teaching ability or of commitment to the ideals and objectives of the Boy Scouts of America. A personal interview is best in assessing a rock climber's skill, demeanor, and ability to teach.

4. Ideally, a head rock climber should have previously taught rock climbing or attended a nationally recognized rock-climbing school such as the National Outdoor Leadership School "Instructor Course." The individual selected as head rock climber need not necessarily be the most proficient climber. Leadership and judgment are more essential to success. The head rock climber should be resourceful, have initiative, and generate enthusiasm both for the program and toward participants.

   A positive attitude is essential for all rock-climbing staff. Every staff member should have great reserves of patience and understanding to effectively support frustrated beginning rock climbers throughout the camping season.
5. First-hand experience with a good rock-climbing program is also inherent to the leader's success.
6. Good physical condition is essential.
7. Applicants who have been instructed under supervision generally are the best qualified.
8. First aid, cardiopulmonary resuscitation (CPR), and rescue experience are essential for at least some of the instructors; ideally, for all of them.
9. Be aware that some very capable climbers are not in tune with the aims and objectives of the Boy Scouts of America—they are more interested in developing good climbers at the expense of BSA objectives.
10. Rock-climbing staff should be willing to wear the correct Boy Scout or Explorer uniform—Scout shorts are not flexible enough for climbing. Activity shorts or others are okay.
11. While a Scout or Explorer may be employed for his or her rock-climbing talents, he or she should express a willingness to do other camp chores that may be assigned.
12. The minimum number of rock-climbing staff is two for each climb and two for each rappel. For rappelling, the top staff climber checks knots and techniques, while the bottom one observes the participants' progress. For climbing, the bottom person guides participants through tying in and giving signals as well as in coaching their first moves on the rock. The top person either belays or closely supervises the belay. All belayers should demonstrate that they can successfully hold a fall by practicing with sandbags.
13. The head instructor must have previous experience in rescue techniques for the type of climbing or rappelling program being offered.

Mountaineers (Free Climbers) Climbing Classifications

Class 1 **Cross-country hiking.** Hands not needed.

Class 2 **Scrambling.** Hands helpful, rope not needed but probably carried to assure party safety.

Class 3 **Easy Climbing.** Scrambling with use of hands, elementary climbing technique helpful. Rope should be available and may be desired by an inexperienced climber.

Class 4 **Roped climbing with belay.** Belays may be anchored using either natural anchors or climbing hardware. Some moves might be

difficult and could be designated as Class 5 except for the security of short pitches or natural protection such as trees, shrubs, and rock horns.

Class 5 **Roped climbing requiring protection.** This includes the use of runners, artificial chocks and pitons, and belays.

Class 6 **Roped climbing with artificial assist.** This could include stepping on a piton or climbing a chain of slings or pretied stirrups.

Staff Training

1. Stress that safety is our first and foremost concern. All should understand the basic essentials before proceeding further.
2. Familiarize everyone with the equipment by having them inspect each item or piece.
3. Practice knot tying (overhand figure eight, figure-eight loop, ring bend, water knot, bowline, bowline on a coil).
4. Explain that this is the way "we" do it—one way for all climbers. Point out, however, that there are other ways that can be used.
5. Outline policies and procedures. Relate those included here as well as any from the camp's rock-climbing authority.
   a. Rock rescue plan—have one devised for all foreseeable mishaps, including rescuing an unconscious climber or rappeller who is halfway up the pitch. Rehearse this plan on a regular basis throughout the summer. The rehearsal can also be used as a demonstration to Scouts of how rescues are performed. If a real rescue is required, a prior rehearsal will help keep it low key. If both campers and staff have already been through a rescue exercise, the real one becomes S.O.P. (standard operating procedure) rather than a state of panic. Any plan must ensure that the camp director and the Scout executive are promptly notified of any serious mishap. Good communications are essential.
   b. A Stokes litter and a backboard should be rigged and located at the rock-climbing site when it is being used.
   c. Involve staff in a comprehensive run-through of the rigging for climbs and rappels as well as signals and techniques to ensure common understanding by all staff. Staff should be thoroughly knowledgeable of the climbing and rappelling routes.
6. Conduct the program.
   a. Become familiar with the site, set up a demonstration, and practice with the local rock-climbing authority.
   b. Stress "hands-on" experience for Scouts and Explorers.
   c. Ensure that everyone has something to do.
   d. Stress action rather than sitting, standing, or waiting. Teach the fundamentals of bouldering to those waiting to climb and/or rappel.
   e. Have experienced rock-climbing staff do some role playing for situations that are inevitably encountered: panic, overconfidence, overenthusiasm, the nonlistener, and the individual who refuses to climb.

7. Teach effectively, using guided discovery, teaching/learning, application, and evaluation. However, never jeopardize the benefits of a rock-climbing experience by using a guided discovery alone. Emphasize to staff that they are to do more than only demonstrations, tying in climbers, and belaying. They are teachers and coaches. Staff must constantly be alert, watching each new climbing participant, giving ideas, and "helping" the climber over the rough spots. Staff should be a positive, reassuring influence.
8. The rationale for each safety procedure is explained during the orientation so that Scouts and Explorers understand why we do it *this way*.
9. Avoid prolonged exposure to sun.
10. Establish policies for camp staff on time off.
    a. Inexperienced or beginning rock-climbing staff are to climb only in designated areas under the supervision of experienced climbers.
    b. On camp property, rock-climbing staff may be permitted to climb in nondesignated areas only if:
        1. The camp's rock-climbing authority indicates that the area of the proposed climb is reasonably safe.
        2. The authority, the camp administration, and the camp's head rock-climber agree that the climber(s) is qualified to successfully undertake the climb.
        3. A qualified rock-rescue team is on hand with all appropriate rescue equipment, preferably within camp.
        4. All climbers are members of the camp staff. Off camp property, the camp administration should require written parental approval for nonadult rock-climbing staff or a waiver of all responsibility for those who are adults.
    c. A plan for rotating other interested camp staff into the rock-climbing program, after they have received adequate training, is a good way to develop potential rock-climbing staff members.
    d. Staff should be permitted some free time to climb and practice outside the regular program, but firm guidelines should be established:
        1. No climbing or bouldering alone is permitted.
        2. On camp property, all staff climbing is accomplished in groups of two or more with a qualified rock-rescue team available.
        3. No climbing in dark or twilight is permitted.
        4. No climbing is permitted when a thunderstorm is imminent.
        5. Staff should not be permitted to use camp rock-climbing equipment off camp property.
        6. Sitting or standing on the rock day after day with large numbers of participants can become extremely boring and distract staff from being alert to safety and problems encountered by participants. During staff training, discuss this with the staff to find remedies.
        7. Establish a plan so that if one staff member becomes upset with a participant, another rock-climbing staff member is available to assume responsibility. Only one staff member talks to a climber or rappeller at one time.

CONDUCTING THE PROGRAM

The following is a suggested format to follow in conducting a climbing/rappelling activity.

I. Welcome to "Steamboat Rock."

   A. Introduce staff.

   B. Ask the following questions. How many have rock-climbed before? What did you do? Where did you climb? Find out how much or how little experience the group has before beginning instruction. It may be prudent to divide participants into ability groups if a wide range of experience is apparent.

   C. Discuss rock climbing, rappelling, and belaying. Beginners will need to learn the nomenclature of rock climbing.

   D. Stress the need for safety and strict adherence to all established procedures. Horseplay will not be tolerated.

   E. Stress that participants will learn only a few of the basics of rock climbing and rappelling and will not be ready to start climbing on their own after this brief program. Know your limitations for rock climbing and rappelling; even expert climbers have limitations. Point out reputable organizations or individuals to whom they can go for further instruction and practice. Stress for beginners that this experience in no way prepares them to go out on their own.

II. Orientation.

   A. Good physical condition is a prerequisite for participating in rock climbing or rappelling. Scouts or leaders with serious medical problems must have approval from a physician licensed to practice medicine and have had a medical examination within one year. Staff must be informed (privately) of the physical or mental limitations of any participant.

   B. Review clothing for climbing—it depends on the weather, terrain, and elevation.

      1. Shorts and short-sleeve shirts are suitable.

      2. Footwear—boots with narrow welt are best. Tennis shoes are adequate for friction climbing.

      3. Headgear—helmet (with stocking cap worn under it in cold weather) protects against falling rock and against the head striking a rock in a fall. Each climber and rappeller must wear a climbing helmet with the chin strap secured when engaged in these activities.

      4. Do not wear loose-fitting trousers and tops. Do not wear skirts, as they may get caught in the braking system.

      5. Long hair and any loose items must be secured so that they will not become entangled in the braking system.

      6. Glasses are acceptable, but remove necklaces, bracelets, earrings, and finger rings. All these could become caught, possibly mangling parts of the body.

      7. Put your watch in your pocket. Better yet, leave it with a responsible friend.

      8. Belayers must wear gloves. Even though a belayer may be able to hold a fall without gloves, using them will prevent blisters. Gloves should also be used for rappelling.

      9. Dark glasses may be worn.

10. Sunburn ointment is advised for those with fair complexions.

C. Review equipment.

1. Explain and show how each of the following is used: rope, sling, carabiners, helmets, brake bars, figure-eight rings or other belay or rappelling devices, climbing harness, bolts, pitons, chocks, bongs, rack, and gloves.
2. Stress the dangers of inadequate equipment—manila, clothesline, or hemp rope should never be used for climbing.
3. Review rope and sling.
   a. Show types—clothesline, manila, Goldline laid, Kernmantle, everdry, and sling.
   b. Discuss characteristic qualities—strength, shock absorbency, weight, resistance to abrasion, tendency to kink, good grip, life expectancy, dynamic versus static.
   c. Review size—diameter and length.
4. Discuss the care of rope.
   a. Avoid getting it dirty or wet.
   b. Never step on the rope. This forces grit into the fibers and will cause the rope to wear rapidly. Stress that the rope is everyone's lifeline.
   c. The history of every rope is important. Retire Kernmantle or Goldline after three hard falls. Use UIAA fall ratings.
   d. Avoid contact with sharp edges or abrasive rocks. Pad sharp edges with burlap or old canvas.
   e. Remove all unnecessary knots. Knots weaken the strength of the rope.
   f. Avoid knots in the center of the rope. Tie knots at rope ends.
   g. Never put rope near flame, heat, chemicals, gasoline, or oil, which deteriorate nylon. A fast rappel or crossing two moving ropes can also generate damaging heat. Do not allow smoking around a rope.
   h. Store rope out of the sun's rays. Ultraviolet rays cause deterioration with extended exposure.
   i. Fuse or whip rope ends to prevent unraveling.
   j. Keep ropes coiled in a simple manner for easy use.
   k. When ropes become dirty, wash them with a mild detergent and hang them to dry thoroughly before storing.

D. Practice climbing knots. Those knots that participants should know are marked with an asterisk. The rest are ones staff need to know and may be taught to Scouts or Explorers if time permits. See "Climbing Knots" in Appendix D for more on knots.

*Overhand
*Bowline
*Figure eight
Sheet bend
Ring bend or water knot (overhand follow-through water knot)
Figure eight on a bight
Water knot
Flemish bend (figure-eight follow-through)
Fisherman's knot

*For staff training only

Double sheet bend
*Bowline on a coil
Grapevine
Double bowline
Prusik and girth hitch
Clove hitch
Coils—mountaineers and skein

E. Explain belaying techniques.
   1. Discuss purpose—to reduce the length of a fall and minimize its consequences.
   2. Secure anchor.
   3. There should be no slack between the belayer and his or her anchor point(s).
   4. The anchor must be placed in line with both the belayer and the direction of pull. The anchor should keep the belayer from being pulled out of position.
   5. The belaying rope must never run tautly across the anchor rope or sling. This can cause a nylon rope or sling to melt from the intense heat generated by the moving rope.
   6. Each point of anchor is rigged independently so that failure at one point will not cause a total collapse of the entire system.
   7. Climbing rope, as well as the belayer, is tied into at least one of the anchor points.
   8. The top belayer uses a sitting hip or stitch belay with feet firmly braced; the bottom belayer uses a standing hip belay or stitch belay plate.
   9. Rope must be kept on the muscle/fat/hipbone parts of the body and not be allowed to ride up over the spine. Use a keeper carabiner.
   10. Explain the feeling hand and the braking hand. The hand of the belayer holding the rope going to the climber is referred to as the *feeling hand.* It feels the progress of the climber. The hand grasping the rope after it passes around the hips is known as the ***braking hand.***
   11. *Never* remove the braking hand from the rope until the climber says, "Off belay."
   12. Holding a fall is entirely up to the belayer. The belayer needs to know how the climber is progressing and anticipate potential problems. The belayer must know precisely how to react to hold a fall. There is no second chance after a mistake.
   13. No one is permitted to talk with the belayer except a rock-climbing instructor and the person being belayed. This will avoid confusing and/or flustering the belayer and thus enable him or her to devote full attention to what needs to be done.
   14. Demonstrate and practice on a tower. See design standard No. 68 in Appendix W.

F. Explain the need for signals and re-emphasize the need for signals throughout the program.
   1. Belayers and climbers must work together in harmony.
   2. This requires distinct, clear communications.
   3. Signals are used for both safety and efficiency.

**For staff training only*

G. Review climbing techniques.

1. All movement should be controlled and deliberate, not jerky or lunging. Once a move is begun, finish it; do not hesitate or stop midway, which may result in "sewing machine" legs.
2. It is more efficient to push the body upward with the leg muscles than pull it up with the arms.
3. Hands should be kept between waist and shoulder to maintain a good stance and conserve arm strength. Hands should be used primarily for balance. If your hands become tired, shake them vigorously, one at a time, to get the blood pumping into them.
4. Climb with the eyes first, seeking a route. Look ahead!
5. Explain that three-point contact (two legs and one arm or two arms and one leg) is a must for security and stability.
6. Knee or elbow holds or stances are not to be used (they tend to get blood on the rock and do not permit adequate visibility or upward movement). Better contact with the rock is gained by turning the foot sideways and flexing the ankle for increased sole support.
7. Explain handholds, downpressure, slab climbing, mantelshelving, counterforce, laybacking, undercling, and jams.
8. Signals are used throughout.
9. † Staff tie Scouts or Explorers into climbing rope with a diaper slip of 1-inch tubular webbing secured with a locking D carabiner. A figure eight knot is tied in the end of the climbing rope to tie into the carabiner. Double-check the tie-ons of all participants before they start climbing.
10. Never use vegetable holds (brushes, small or loose roots, saplings, dead limbs, etc.).
11. † Staff should belay climbers unless the participants have benefitted from a the belayer's orientation and demonstration. If this is the case, participants may be permitted to belay with close staff supervision. Use a buddy system in which one Scout belays while another watches. The staff instructor should always check, too.

H. Explain rappelling techniques while demonstrating.

1. Brake rappel is the only type used — it is comfortable and easy to control.
2. A sit harness is best, but a diaper sling-rappel seat tied with 1 inch of tubular nylon webbing or seat harness may also be used.
3. A single Goldline with a figure eight and belay, as well as an independent safety line tied around the participant's waist with a bowline on a coil and belayed separately (in case the rappeller lets go of the rope) are used for all rappelling (preferably different-colored ropes).
4. A braking system may be established with carabiners and brake bars, carabiner brakes, figure eight ring, belay plate, and so on. The figure eight ring is by far the safest and should be used in camp. Whatever system is used should create enough friction on the rope to prevent the rappeller from descending too quickly. A slow descent enables the rappeller to develop proper technique, be observed for any problem that may develop, and gain confidence. It also saves the rope from being melted.

† *For staff training only*

5. Rappelling participants are encouraged to maintain a shoulder-wide stance, to keep their knees flexed, to keep feet 24 to 36 inches apart for balance, to lean back, to become perpendicular to the rock, and to walk backward, avoiding a speedy or bouncing descent that may place a sudden strain on the anchor(s).
6. Rappellers often need generous quantities of reassurance and encouragement on their first attempt.
7. The braking system is attached to the harness or diaper sling with one locking or nonlocking carabiner. The gates of nonlocking carabiners must be both reversed and opposed to prevent an accidental failure of the system. The belay rope is tied around the waist of the rappeller with a bowline on two to three coils.
8. New slings are always used on the rappel anchor.
9. All loose clothing, equipment, and long hair is secured so they do not become caught in the braking system or the chin straps of helmets.
10. All beginning rappellers should use leather palmed and knuckled gloves. More advanced rappellers can be permitted to descend bare-handed, as this will encourage them to slow down.
11. A rappeller should grip only with the braking hand; the guiding hand is used only to maintain balance. The rappeller must never release his or her grip on the rope with the braking hand. (This should be *stressed.*)
12. Onlookers should be kept away from the immediate area below the rappel so that they will not be struck by a falling rock or by equipment.

III. Explore additional program possibilities.

Evaluate which of these programs can be safely conducted during inclement weather when rock climbing and rappelling must be suspended.

A. Practice tying knots: water knot, figure eight, bowline.
B. Demonstrate and discuss equipment that climbers use, the history of climbing, how climbers lead without a top belay, climbing schools, and so on.
C. Present a slide show that demonstrates the proper use of equipment and techniques. (It needs to be well organized and narrated to hold the interest of viewers.)
D. Use a rock-climbing practice tower. (See Appendix W, Design Standard No. 68.)
E. Practice belaying on a tower with weight.
F. Practice using mechanical ascenders on a rope secured to a stout overhead tree limb. Keep in mind that ascenders are tough on rope and can become accidentally unclipped from it if not used properly.
G. Try belaying a litter. If any real hazard exists, use burlap bags lined with plastic bags and filled with sand or dirt for a "dummy."
H. Teach basic techniques of bouldering (always with a rock-climbing staff member present). Try using a long traverse across a crack or fault that runs a few feet above the ground near the base of a cliff.
I. Demonstrate how a rock-climbing team ascends. Do a full-pitch demonstration with the leader using and explaining proper technique and placing protection as he or she ascends. The follower belays the leader and then seconds the pitch and cleans it of protection while being belayed by the leader above.
J. Engage in free rappelling after participants have demonstrated a high degree of competence in performing a standard rappel.

Standards for Rappelling from a Tower

Explorers and older Scouts in today's world are seeking greater challenges to their physical and mental abilities. We, the Boy Scouts of America, have an obligation to our youth to provide activities, such as rappelling, that require higher levels of knowledge and skill.

At the same time, many of these activities involve a degree of risk when conducted improperly. Safety must be paramount in providing for adequate supervision, equipment, facilities, and location. The local councils and the National Council of the Boy Scouts of America are accountable to parents, leaders, and youth, as well as to Scouting's public, for conducting programs and maintaining equipment and facilities so that participants are not exposed to unreasonable risk. Rappelling and rock climbing require a number of special considerations to be conducted in a safe manner. These standards need to be carefully considered *before* deciding to conduct such an activity.

The standards have been prepared with the able assistance of highly qualified rock-climbing authorities (see the list that follows the text). It is important to distinguish between rock climbing (ascending or traversing a steep rock face) and rappelling (descending with a controlled slide down a rope). These standards apply only to rappelling.

Rappelling can be used to descend a cliff, to descend from a helicopter (which is known as a free rappel because there is no contact with a rock face or anything else), or to descend a constructed rock-climbing tower. Although these standards apply specifically to rappelling from a tower, the first two sections on supervision and equipment apply to any type of rappelling, whether done on a rock face or from a tower.

I. Supervision
   - A. The head instructor must be at least 21 years of age and must give direct supervision to the activity. Assistant instructor(s) should be approved by the head instructor. At least one instructor or assistant should be certified in Red Cross first aid and CPR.
   - B. Rappelling requires supervision by at least one qualified instructor and one qualified assistant, one on the tower and one below.
   - C. The head instructor must have previous experience in rappelling and rescue techniques to retrieve an errant or stuck rappeller. The head instructor must also have previous experience in teaching rock climbing to young people or have actively participated in a nationally recognized rock-climbing school, club, or course.
   - D. Only one participant is permitted to rappel from the tower at a time. Each rappeller must be observed throughout the entire descent by at least one instructor or one assistant.
   - E. A safety line must be used for each rappel in addition to the rappel rope. The safety line must be tied around the participant's waist and not to the harness. This provides double protection.
   - F. Every person must wear a rock-climbing helmet (not a construction or bicycling helmet) when rappelling or belaying. Chin straps for helmets must be secured when in use.
   - G. Onlookers must be kept 25 feet away from the immediate area at the base of the tower.

H. Free rappelling is allowed only after a participant has demonstrated a high degree of competence in doing a wall rappel. Arm rappelling should not be taught or used.

I. Stress safety throughout all instruction and participation. Horseplay should never be encouraged, permitted, or tolerated while the program is being conducted.

J. No rappelling is conducted when a thunderstorm is imminent, when the tower is wet, or when visibility is restricted.

K. Teach rappelling participants to maintain a shoulder-width stance, to flex the knees slightly, to lean back, and to walk backward, avoiding a speedy or bouncing descent that places a strain on the anchors, the rope, and the belayer.

L. Participants are not to wear rings, watches, necklaces, neckerchiefs, bracelets, earrings, or loose clothing. Long hair must be tied up. Glasses may be worn, but a strap is recommended for holding glasses in place.

M. Brief everyone as to what is to be accomplished, and review proper voice commands before entering the rappelling area.

N. Good physical condition is a prerequisite to participation in a rappelling activity. Persons with serious medical problems should have approval from a physician to participate in rappelling. Information about these medical problems must be shared with the head instructor.

II. Equipment

A. All rope and nylon webbing used in the activity must be new when procured. Only high-quality (UIAA-approved) Goldline ($^{7}/_{16}$-inch diameter) or Kernmantle (11-millimeter rope) or an equivalent high-quality rock-climbing rope should be used. Goldline is more easily checked for damage.

B. Keep a written log regarding the history of each rope used in the program. The record for each rope should indicate:

1. Date the rope was purchased
2. The number of sessions of use
3. Any severe stresses that were placed on the rope
4. The number of days of exposure to sunlight

Each rope should be numbered by pushing a heated metal punch into the end of the rope. Ropes are retired when the strands of a laid rope cannot be felt or when the outer sheath of a Kernmantle rope is worn or cut through. Because of a gradual loss of strength, any climbing rope four years old or older should be retired.

C. All equipment, including hardware and anchor points, must be inspected before and after each use for excessive wear or defects.

D. When not being used, keep equipment in locked storage where it will not be exposed to sunlight, water, chemicals, gasoline, or oil.

E. Be sure that enough rescue equipment is on hand to quickly perform any foreseeable rescue. Do not use rescue equipment for conducting the activity.

F. All rappellers should wear gloves with leather palms.

G. A commercially manufactured seat harness (Whillans harnesses are particularly good) is preferred to a diaper sling made from tubular webbing. Any type of rappelling harness must fit snugly around the hips and crotch of each participant.

H. A figure eight ring is preferred to using carabiners to control the rate of descent. Do not use brake bars.

III. Structure

A. Engineering Service has a plan drawing for a rappelling tower. It is design standard No. 68 and can be found in Appendix W.

IV. Location

A. A rappelling tower must be located in an area where access to it can be monitored around the clock. Access to the top of the tower should be by a ladder or stairway with an entrance that can be locked.

B. A telephone or two-way radio should be accessible near the site.

C. If a rappelling tower is constructed, it should be located on camp property where access can be controlled, where proper supervision is provided, and where it will be available to older Scouts and Explorers throughout the council.

D. The framework for securing the anchor must be capable of withstanding a force of 2,650 pounds (a 175-pound weight dropped a distance of 15 feet) and should be tested prior to each session of use. In addition, the entire tower and all supports must be securely anchored to withstand the same force as well as high winds.

E. Locate towers well away from power lines, radio transmitting stations, heavy vehicle traffic, and other potentially dangerous hazards.

Safety Procedures or "Hazard Prevention" for Climbing and Rappelling

I. All participants climb and rappel in an area established by qualified rock-climbing authorities and approved by the council camping committee and camp administration.

Establish an effective evacuation system should someone become injured on the rock. All staff should know how to implement the system. Establish leadership roles in advance so that there is no question about who is in charge.

II. Have a checklist.

A. Always stress safety. Procedures and equipment must have a backup if the primary system fails.

B. Nothing is taken for granted. Every item of equipment and all procedures are checked and rechecked. Use the buddy system; two staff members check everything.

C. Onlookers are kept away from the base of the climb and rappel, where they could be struck by falling rock or ropes.

D. All anchor points are checked daily, especially at the beginning of the summer when they may be weakened from freezing and thawing over the winter.

Check bolts by tapping them with a carabiner (a high pitch indicates firm placement). If any doubt exists, put in a new bolt.

E. All rock-climbing equipment is checked daily for flaws (e.g., badly worn rope, cracked helmets, loose carabiner pins, sticky carabiner gates, holes in gloves, frayed chin straps, etc.). Check carabiners for cracks, loose pins, excessive wear, and so on.

F. The rocks atop the climb and rappel are periodically swept clean of loose rock and debris. Keep a broom handy for this.

G. Participants are constantly supervised. Stress that this program does not make them climbers. They are not ready to go out on their own but should seek help from other qualified rock-climbing schools or teachers if they wish to engage in more rock climbing.

H. Climbing routes are periodically checked by staff to remove loose rocks or other hazards.

I. No climbing is conducted when a thunderstorm is imminent or when the rocks are slippery wet. Have an alternate program in a safe area, such as a slide show, equipment display, belay practice, rock-climbing tower, and so on. By being well organized in advance, you will be ready should inclement weather occur.

J. A written log should be kept regarding the history of each rope used in the program. The record for each rope should indicate (1) the date the rope was purchased, (2) the number of sessions of use, (3) any severe stresses that were placed on the rope, and (4) the number of days of exposure to sunlight. Number each rope by pushing a heated metal punch into one end of the rope.

   A rope is overdue for retirement when the separate strands of a laid rope cannot be felt or when the outer sheath of a Kernmantle rope is worn or cut through anywhere. Because of a gradual loss of strength, any climbing rope four years old or older should be retired.

K. Any rope subjected to three severe falls of any length should be retired immediately.

L. No climbing is conducted at night or on a rock that is slick from rain.

M. Have a sharp knife on hand to cut anything (hair, clothing, gear) that becomes hopelessly caught in the rappelling braking system.

Inspecting Equipment—What to Look For

Here are some potential problems to look for when periodically inspecting equipment. Exercise good judgment in determining when to retire rope or hardware because of excessive wear. If any doubt exists, retire the item until a rock-climbing authority can inspect it more closely.

Keep some worn items on hand to show when various pieces of equipment should be retired. Designate each item with a piece of tape that indicates the item's problem in writing. Retired samples must be vividly marked so that no chance exists of confusing them with serviceable equipment.

Item	Signs of Wear
Brake bars	Must snugly fit the type of carabiners used; grooves formed with excessive wear.
Carabiners	Gates that do not close, unresponsive gates (fail to snap back into place), loose pins, wear around pin heads, cracks; grooves formed with excessive wear.
Figure eight	Grooves formed with excessive wear.
Goldline	Cuts, history of three falls, knots in middle of rope, serious abrading, excessive exposure to sun.
Helmets	Chin strap unserviceable; cracks; thin spots with excessive wear; suspension inadequate, assortment of sizes for different size heads (small, medium, large, extra large); holes.
Kernmantle	Damaged sheath cause for closer inspection; dents or irregularities in feel of rope, excessive exposure to sun, history of three falls.
Webbing	Cuts, history of three falls, excessive exposure to sun, serious abrading, knots in middle.

Climb On!

Climbing/Rappelling Schedule

Day	Time	Activity
Friday	6:00 p.m.	People arrive/registration
	7:30 p.m.	Review training schedule
		Terms used in climbing/rappelling
		Types of rope
		Equipment used in climbing/rappelling
	9:30 p.m.	Adjourn
Saturday	6:30 a.m.	Rise
	7:00 a.m.	Breakfast
	8:00 a.m.	Knots used in climbing/rappelling:
		Square knot
		Overhand knot
		Figure eight
		Bowline
		Bowline on a coil
		Double loop bowline
		Bights:
		Overhand on a bight
		Figure eight on a bight
		Bowline on a bight

Day	Time	Activity
		Bends: Water knot Figure-eight bend Double fisherman's knot
		Hitches: Half hitch Girth hitch Clove hitch Prusik knot Lark's head
	11:00 a.m.	Tie-ins: For cables Trees Boulders
	Noon	Lunch
	1:00 p.m.	Rules for climbing/rappelling
		Tying a knotted leg-loop-seat sling
		Tying a Swiss-seat sling
	4:00 p.m.	Anchor points: Top anchor belay rappel system Bottom anchor belay rappel system
	6:00 p.m.	Dinner
	7:00 p.m.	Practice knots
		Seats
		Belaying techniques
		Climbing/rappelling signals
Sunday	6:30 a.m.	Rise
	7:00 a.m.	Breakfast
	8:00 a.m.	Climbing/rappelling: Demonstration Practice
	Noon	Lunch
	1:00 p.m.	Continue practice
	4:00 p.m.	Wrap-up
	5:00 p.m.	Depart

APPENDIX A—TERMS USED IN ROPEWORK, CLIMBING, AND RAPPELLING; EQUIPMENT NEEDED

Anchoring. Attaching oneself to a fixed point, generally a tree or rock that is independent of the other ropes.

Belaying. Protecting or supporting by means of rope-friction arrangement.

Bend. Tying two ropes or two pieces of webbing together by running the working ends of the ropes/webbings in reverse direction of each other to form the knot (examples are Flemish bend, overhand bend [water knot], etc.).

Bight. A simple turn of a rope that does not cross itself.

Brake bars. Round aluminum rods approximately 4 inches long with a hole drilled through one side to fit a carabiner. The other end of the brake bar has a slot machined across it to allow it to lock into the other side of the carabiner. It is used as a braking device during rappels.

Carabiner. A convenient mechanical device that replaces a knot. It looks like a gigantic safety-pin. (See "Explanation of Equipment.")

Dynamic belay. A belaying technique that is used by stopping a falling climber in a gradual deceleration rather than in a sudden, complete stop. Too rapid a stop endangers not only the climber but also the equipment.

Dynamic rope. A rope that tends to absorb energy in a slower fashion, possesses higher stretch and elasticity, and has an increased ability to absorb the shock from a fall.

Elasticity. A springy, flexible, rubber band-like quality found in rope.

Figure-eight descending bar. A braking device made from aluminum, resembling an 8, used for descending a rope. (See "Explanation of Equipment.")

Knot. A configuration in ropes to join two lines together; to fasten a rope into a loop or onto some other object.

Lashing. To *bind* with a rope. The two basic types of lashings used in rope course construction are *square lashing* and *diagonal lashing*.

Loop. A simple turn or bend of the rope or webbing that crosses itself.

Noose. A circle of rope that will slip and tighten.

Pendulum action. In climbing, if the climber is at an angle from the top anchor point when he or she falls, a pendulum action will take place. The climber will swing toward the top anchor point, back and forth, until stopping in a vertical position below the anchor point.

Rack. A circular nylon sling used for holding and transporting hardware (carabiners, figure eights, etc.) and webbing (seat-slings).

Rapid link/lock link. Steel oval links with a screw opening and no hinged gate like a carabiner. They are extremely strong when the opening is screwed closed (supporting 10,000 pounds) but support less than 1,100 pounds when opened. They are useful for rigging varied applications where high strength is desirable. They are also commonly used as hookups on cabled activities.

Rappel. To descend with ropes from a cliff or wall, controlling your own speed of descent by means of rope friction.

Round turn. In knot tying, passing the running end (working end) of the rope one full turn around the support before tying a finishing knot.

Running end. The free rope end being used for tying in, knot tying, pulley use, and so on. It is commonly called the *end* (opposite end from the standing end).

Safety knot. An *overhand knot* used for backing up a major knot by tying off the loose end.

Slash rope. A rope that has been *retired* from rappelling, belaying, and climbing and that is used only for lashings.

SRT (single rope technique). The use of a *single* rope (nylon) in rappelling, climbing, and belaying. Synthetic fiber ropes made this technique possible because of the rope's strength.

Stacking the rope. The process of overlapping the rope, back and forth, instead of coiling the rope. This will prevent the rope from becoming knotted and tangled. This process is used mostly in belaying.

Standing end. The end of the rope that is fastened, that is, tied to a tree, anchor point, belay point, and so on, or not being used to tie a knot. This is the whole rope and may be called the *line* or simply the *rope*.

Static belay. The opposite of *dynamic belay.*

Static rope. The opposite of *dynamic rope.*

Tensionless rigging. An arrangement in which the rope itself holds the load and the knot experiences no stress. (An example is the *coil wrap* anchoring.)

Tie-in. Usually a piece of tubular webbing used for the purpose of fastening a person to an anchor point in order to prevent the person from falling or being pulled away from that anchor point. Tie-ins are used mostly in belaying and in setting up a climb, rappel, or activity.

Whipping. Binding the end of a rope with twine or thread, preferably waxed. The binding must be tight and start away from the end of the rope and work toward it.

Working end. The same as *running end.*

EQUIPMENT NEEDED

Demonstration	Climbing	Rappelling
Chocks (assorted sizes and types)	X	
Rock hammer	X	
Pitons	X	
Bongs	X	
Sling rope	X	
Pack (to carry gear to rock-climbing site)	X	
Carabiners	X	X
Rope	X	X
Rock and set harness	X	
Whillans sit harness	X	
One-inch tubular webbing	X	X
Helmets (for every participant and staff member)	X	X
Broom (to sweep areas free of small stones)	X	
Figure-eight ring		X
Stitch plates		X
Descending ring (CMI rings recommended)		X
Sharp knife (to cut hair or clothing that may become caught in brake system)		X
First-aid kit	X	X
bandaids	three-inch elastic bandages	
butterfly bandages	wire-mesh splints	
moleskin	water	
antibacterial soap	pencil and paper	
roller gauze	advanced first-aid book	
salt tablets	Red Cross rescue plan	
gauze pads	Stokes litter (rigged for use)	
adhesive tape	backboard	
triangular bandages		

APPENDIX B — ROPE INFORMATION AND SELECTION

When selecting a rope on which your life is going to depend, strength must be the first and foremost consideration. Strength, or tensile strength, is defined as the maximum weight the rope will hold before breaking. As a rule of thumb, it is wise to consider the strength of a rope to be approximately half the total strength because of the fact that a rope can easily be weakened up to 50 percent through abrasion, knots, and similar factors. Another important point to consider before purchasing a rope is what the rope will be used for. By knowing this, you will know whether to select a rope that has dynamic qualities or static qualities.

The more dynamic qualities the rope has, the more the rope tends to absorb energy in a slower fashion, possesses higher stretch and elasticity, and has an increased ability to absorb the shock from a fall. In rock climbing, belaying, and mountaineering, where falls are commonplace, a dynamic rope is the best choice because it will absorb the shock of a fall in a rubber band-like effect.

The more static qualities the rope has, the quicker it will absorb the energy, as it does not possess the stretching qualities of the dynamic rope. Most static ropes have approximately 2 percent stretch under body weight. Never use a static rope as a belay rope because in case of a fall, the body will absorb all the shock due to the lack of elasticity in the rope. This could cause great injury to the body and damage to the rope. The static rope is a popular choice for vertical caving because of the use of prusiks and ascenders for climbing up the rope. It is also a good rope for rappelling. Never use a dynamic rope with ascenders or prusiking because with the dynamic rope's elasticity, a climber could climb up several feet of the rope before ever leaving the ground.

Many other qualities should be considered when selecting a rope, as you will see, but the above qualities should always be considered first.

Natural Fiber Rope

Natural fiber ropes are dangerously affected by household chemicals, have poor handling qualities, and have very little elasticity. Natural fiber ropes are very water absorbent, which will increase the friction of the rope over carabiners, rocks, and clothing when the rope is wet. This water absorbency is the reason that most natural fiber ropes are "oil spun," treated with a special lubricant during their manufacture to soften the fibers. It is necessary to first spin the fibers into yarn. Then they are twisted more tightly to form strings, twines, and strands. These are then woven into groups of strands to form ropes in such a way that the twists are equalized and make the rope stable but flexible.

Natural fiber ropes do not compare with synthetic ropes. Synthetic ropes are far superior in qualities such as tensile strength, energy absorption, resistance to abrasion, lightness of weight, water resistance, weather resistance, and handling characteristics. About the only advantage a natural fiber rope has over a synthetic fiber rope is that it is much less expensive. *Do not use natural fiber ropes for climbing.* Some examples of natural fiber ropes and their qualities are as follows:

Manila. Manila makes a strong, smooth, hard fiber rope that is never tarred, as it does not rot when wet, although water makes it swell. To make a more stable and easier-to-handle rope, manila ropes are treated with oily compounds during their manufacture. Manila rope is highly resistant to weathering but has only about a two-year life expectancy. It should be checked regularly for signs of decay. Under load, it stretches up to 30 percent and has a tensile strength of approximately 2,500 pounds for $^{7}/_{16}$-inch ropes. Manila rope has a *laid* construction, which means that multiple strands are twisted about one another to form a single rope.

Hemp. Once the most common material for ropemaking, hemp is now hardly used at all. Hemp rope lasts well, is easy to handle, does not swell when wet, and loses little, if any, strength. It has very little stretch and is more vulnerable to rot and mildew than is manila. It is also a *laid* rope.

Sisal. Sisal is a hard fiber rope. It has a tensile strength of approximately 2,000 pounds for $^{7}/_{16}$-inch rope. Sisal is very serviceable and stands up well to sea water but swells when wet and is liable to be slippery. The sisal fiber is also shorter than manila fiber. It is white in color and is also of *laid* construction.

Flax. Flax is used, sometimes mixed with hemp, for high-quality, smaller cords such as smooth, strong twines and plaited log-lines. It also makes strong, durable ropes, which are expensive and usually made on special order.

Cotton. Cotton rope is smooth, soft, and pliable, which makes it very suitable for fancy work and for running over blocks. It is not as strong as manila, and once wet, it rapidly becomes hard, dirty, and weak.

Synthetic Fiber Rope

The development of single rope technique (SRT) was possible only after the development of these safe, strong, and lightweight ropes because the main component in the SRT system is the rope and the importance of its not failing. When compared with earlier ropes made of natural fibers, synthetic fiber ropes are far superior in qualities such as strength; energy absorption; resistance to abrasion, water, rot, and mildew; weathering; and handling qualities. Synthetic fiber is a general name given to a group of chemically similar substances called *polyamides.*

Although these synthetics resemble one another in chemical makeup, their physical properties differ. They are still being manufactured for use where a rougher-surfaced rope is required and are known as *spun* cordage. Recently, manufacturers have designed rope in which individual fibers each run the entire length of the rope. This is known as *filament* rope and produces approximately 50 percent greater strength than spun cordage. Some examples of synthetic fiber ropes and their qualities are as follows:

Nylon. Basically, two types of nylon are used in climbing ropes. Perlon has a greater resistance to abrasion and sunlight, generally greater strength, and increased elastic properties. Perlon is used to manufacture mountaineering rope because it is light and a bit more supple. Here, a core provides extra strength, and a special outside sheath protects it from minor abrasions. Nylon is smooth, has a tensile strength of 4,500–5,500 pounds, and will stretch up to 17 percent. It retains almost all its strength even when wet, and when dry has better abrasion resistance than *terylene,* another well-known synthetic.

Terylene. Terylene is a polyester synthetic fiber that is widely used and does have some advantages over nylon. Terylene is stable at higher temperatures and is not affected by moisture, as is nylon. When nylon is wet, the water is absorbed both between and directly into the nylon fibers. Nylon's tensile strength exceeds that of terylene, but when a nylon rope becomes water saturated, it may lose more than 10 percent of its tensile strength and has a much greater tendency to rupture. Terylene may be a superior rope for wet caves, whereas nylon may be better for dry conditions.

Courlene and Tenstron. These brand names of synthetics are made from synthetic fibers known as polyethylene (Courlene) and polypropylene (Tenstron and Ulstron), with Tenstron being more popular. Polyethylene and polypropylene ropes are inexpensive and lightweight. They float in water, are fairly strong, and hence, are frequently used for waterskiing. These ropes are usually dyed a bright yellow and are manufactured from much coarser filaments. They have very low melting points and are extremely susceptible to abrasion. They appear to be quite slippery to the touch but actually have rather high friction. *Their use as a main rope is not recommended.* They do have their place in climbing as ascending sling material. The tensile strength for a $^{7}/_{16}$-inch rope is approximately 2,700 pounds.

Dacron. Although not quite as strong as nylon, dacron is, however, resistant to acids, not alkalis, and has less elasticity, which makes it more suitable for static purposes. Because its elongation under load is much less than that of nylon or Perlon, dacron has been rejected by Alpinists, who consider the ability of a line to absorb the shock of a falling climber to be a very important factor. In this aspect, dacron is approximately the same as manila. The tensile strength of dacron is about 75 percent that of nylon or Perlon.

Rayon. Some of the first synthetic fibers used, such as rayon, proved unsuccessful, having a low tensile strength and deteriorating rapidly with age and exposure.

Laid versus Braid

Abrasion resistance partially depends upon the rope's construction. Two basic types of physical construction are used for ropes available today, *laid ropes* and *braided ropes.* In laid ropes, long fibers are bunched into yarns and combined into three or more larger strands, which are twisted around themselves to form rope. Laid ropes have excellent abrasion-resistant properties and are less expensive than braided rope, but when weight is placed

on the end of a laid rope, it has a tendency to begin unwinding, which in turn spins the climber around if he or she is located away from a wall.

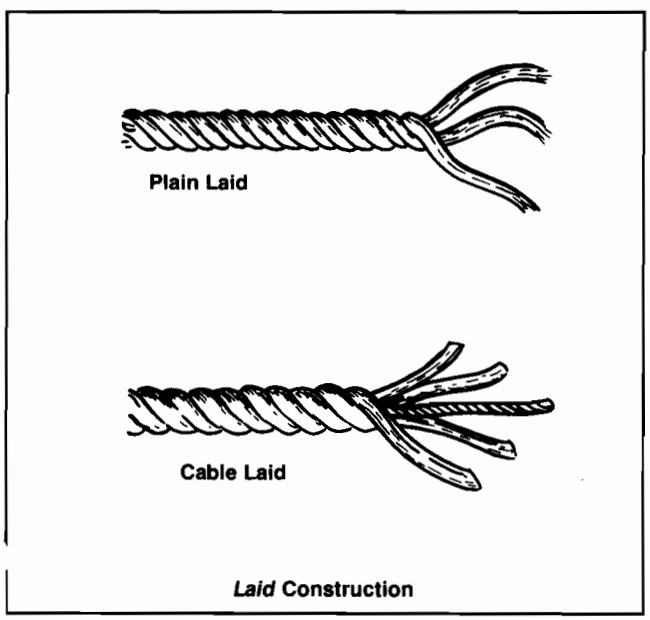
Laid ropes tend to be dynamic and begin to untwist and stretch as weight is placed upon them. They are stiffer, have a tendency to kink, and are quite difficult to work with. A laid rope's outermost fibers will break down, and the surface will take on a fuzzy feeling. This breakdown does weaken the rope slightly, but the fuzz helps protect the interior rope from further abrasion.

Goldline rope is probably the best and most popular choice in laid rope. It is used mainly for climbing and belaying purposes because of its considerable stretch and elasticity. Note that $^{7}/_{16}$-inch Goldline has a tensile strength of approximately 4,500–5,500 pounds. As a rule of thumb, Goldline should be retired after about 200 hours of hang-time or if a serious fall occurs. If the rope is ever cut into lengths, heat the ends of the rope to melt the strands together and prevent unravelling. Back each melted end with a piece of tape.

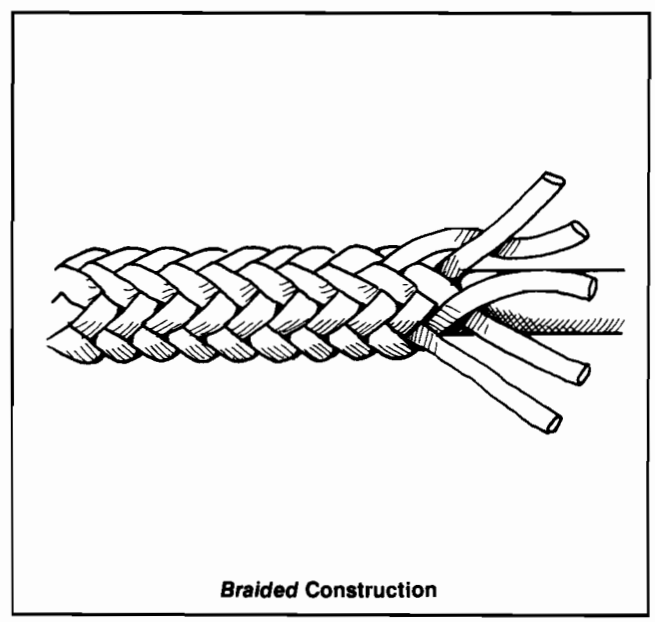
Nylon rope is another good example of laid rope, but its tensile strength is only approximately 3,800 pounds. *Manila* is a popular natural fiber rope. Laid rope is not a good choice for rappelling or rope climbing (for example, vertical caving) because of its dynamic quality. It is less expensive than braided rope.

In braided ropes, the yarns are plaited and braided around an inner core, forming an outerwoven jacket or sheath. Braided ropes do not initiate spinning, and they tend to have a more static quality, making them excellent for rappelling and rope climbing. Their tensile strength is approximately 5,500–6,000 pounds. The core is responsible for approximately 70 percent of the rope's tensile strength. The sheath is important in abrasion resistance. The tighter the sheath, the more abrasion resistant the rope will be. The tight sheath also reduces the chances of the sheath's slipping a great distance up or down the core should it be worn or cut through. Sheathed rope is far superior to laid rope with regard to handling, flexibility, nonkinking, limberness, coiling ease, carrying, and storage. It has the great advantage of sliding with less friction through carabiners and figure eights and over rock surfaces, eliminating rope drag and aiding climbing efficiency. It is preferred by nearly all climbers doing long, serious climbs on rocks. The most commonly used width in braided ropes is 11 millimeters.

Kernmantle and *Blue Water* are two good examples of braided rope. Blue Water offers several types of braided rope: *Blue Water II, Blue Water III,* and *Super Blue Water III.* Blue Water II was developed by cavers and features a tightly woven sheath to help prevent mud and water from penetrating the core. It is composed of type 66 nylon, variety 707, and has a tensile strength of approximately 6,000 pounds. Even if the sheath were to wear through, the core would still have a tensile strength of approximately 4,000 pounds. Blue Water III is composed of type 66 nylon, variety super 707, which claims a bit more abrasion resistance but which is also a bit more dynamic. Super Blue Water III supposedly has no problems with the sheath slipping.



***Laid* Construction**



***Braided* Construction**

APPENDIX C — EXPLANATION OF EQUIPMENT USED IN ROPEWORK

Webbing

Webbing is woven from continuous strands of nylon and is subject to the same damage as nylon rope, so avoid stepping on webbing. If webbing is cut, ensure that the ends are melted together. No tape is necessary because webbing resists ravelling. Double the webbing two or three times and tie with an overhand knot, or daisy-chain the webbing before storing. The two basic types of webbing are *flat* and *tubular.*

Flat webbing has limited uses and a breaking strength of about 3,000 pounds. In rock climbing, it is used for short rope ladders in direct-aid climbing because it holds its shape better. Tubular webbing is shaped like a tube and is commonly used for slings, harnesses, and tie-ins. One-inch tubular webbing is the most commonly used webbing in rappelling and rock climbing and has an approximate breaking strength of 4,500 pounds. Webbing stretches, but not as much as dynamic rope.

Carabiners

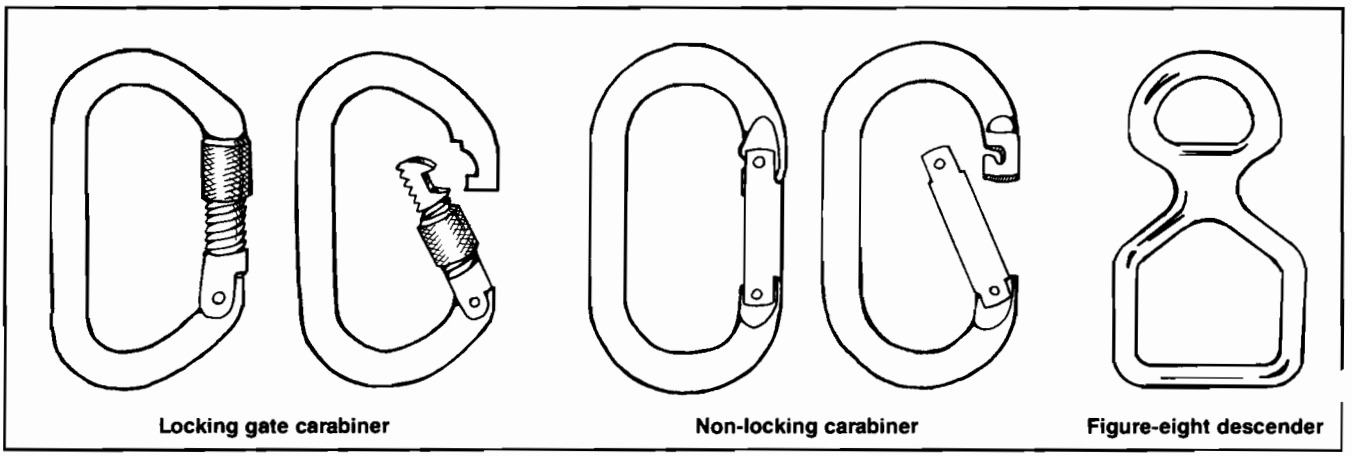
Carabiners, sometimes nicknamed "crab," " 'biner," or "snap link," are metal clips made of aluminum alloy. A carabiner is a convenient mechanical device that replaces a knot and is used extensively on the COPE course, on rappels, during climbs, and so on. Although carabiners are available in various shapes and styles, professionals and students generally use only two basic types.

Non-locking gate carabiner. This type of carabiner does not have a locking gate and is usually used with another carabiner as a backup. Military and professional rock climbers use this type of carabiner for fast hookups, but it can be dangerous because it does not have a locking screw gate to keep it from accidentally opening. Beginners and students should not use this type.

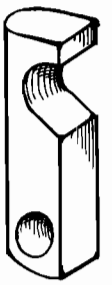
Locking-gate carabiner. There are two types of locking-gate carabiners, half-gate and full-gate. A locking-gate carabiner can be used by itself, with no other carabiner to back it up. It costs more but is safer because of the locking gate. There is no chance of its opening if checked properly before an activity. This is the best choice for student use. All carabiners have a breaking strength of between 2,000 and 3,000 pounds, depending on the manufacturer and the design.

The Figure Eight

The figure eight is a braking device used for descending a rope. It is made of aluminum alloy and comes in several sizes. Because its soft metal can be grooved out by friction from the rope, the figure eight needs to be checked after each use. The figure eight has no moving parts to open or close, so braking strength can range from 9,000 to 15,000 pounds. Dropping or banging the figure eight or carabiners against hard surfaces can create hairline fractures on the inside that the eye cannot detect.



Locking gate carabiner | Non-locking carabiner | Figure-eight descender



Braker bar

One drawback of the figure eight is that it tends to twist the rope with repeated rappels. Many times, the more experienced climber/rappeller uses a device called a *braker bar* in combination with a non-locking carabiner. The braker bar is connected to the non-locking carabiner along with ascending rings. For the very long rappel (over 100 feet), braker bars are superior, for they offer greater flexibility in varying the amount of friction. However, if not hooked up properly, the braker bar can come loose. Therefore, for student use and all practical purposes, the figure eight is superior to the braker bar because of the simplicity of hookup, the smaller chance for mistake; the ease of rappel; and the economy.

Helmets

Helmets should be lightweight and comfortable. Probably the best construction materials for helmets are plastic or fiberglass. They should always be adjustable and have a suspension system that will protect the head from injuries due to falling or being hit by falling rocks. Caving helmets with a bill are poorly suited for climbing. They should have chin straps and protect the top of head, the back of head, and the temple area.

Gloves

Gloves should be worn during a rappel or a belay to keep from getting a rope burn from the friction generated by the rope's passing through the hands. Leather gloves are probably the best type. Nylon gloves should never be used because of the friction generated and the melting degree of nylon (rope) rubbing against nylon (gloves). Cloth gloves don't hold up to the friction of the rope and are easily worn out. The brake hand *must* be gloved on rappels and belays.

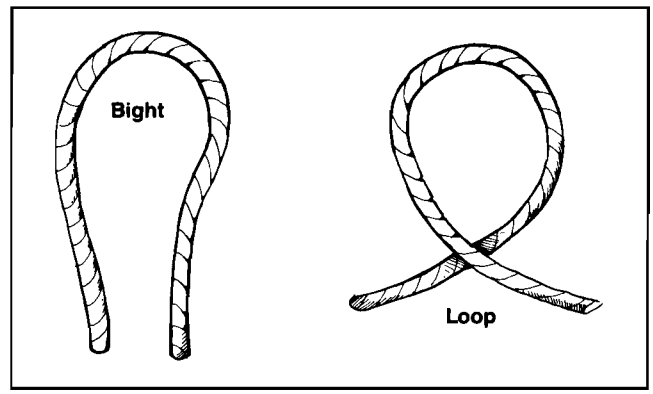
APPENDIX D — UNDERSTANDING THE ROPE AND ITS PARTS

The *standing end* is the end of a rope which is fastened, i.e., tied to a tree, anchor point, belay point, etc., or not being used to tie a knot. This is the whole rope and may be called the *line* or simply the *rope.*

The *working end* or *running end* is the free rope end which is being used for tying in, knot tying, pulley use, etc. It is commonly called the *end* (opposite end from the standing end).

Two terms of importance should be introduced at this point. A *bight* is a simple turn or bend of the rope or webbing which does not cross itself.

A *loop* is a simple turn or bend of the rope or webbing that *does* cross itself.

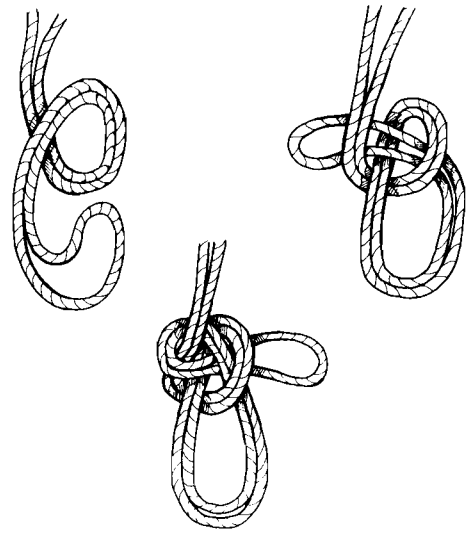


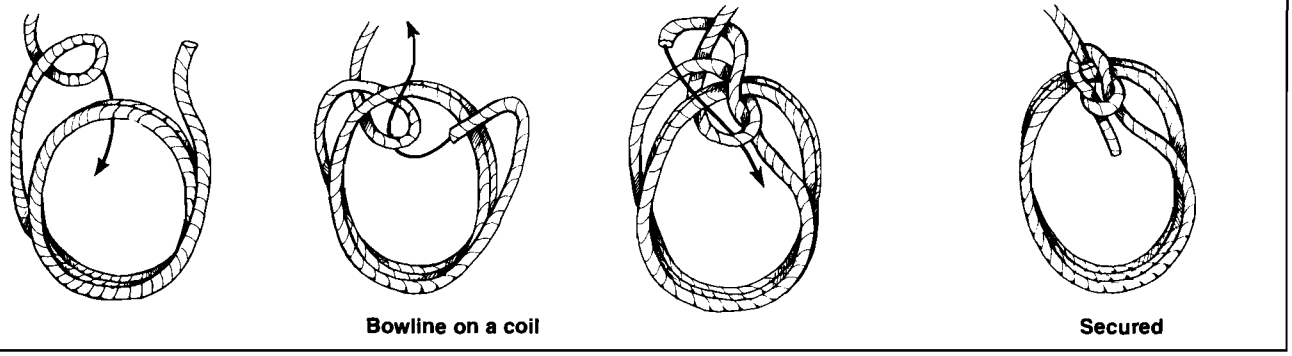
Knots

Basically, a knot is a configuration in ropes to join two lines together or to fasten a rope into a loop or onto some other object.

Bowline on a coil. The bowline on a coil is often used by the end man to take up slack in a climbing rope. By using this to tie a man to the end of a belay rope, it provides a much wider bearing surface around the tender middle. It is also used in fastening the belay rope and rappel rope to a fixed object, and used in tying a seat-sling. It may also be used to provide extra loops for lash-ups and slings where more points of connection are desired. When so used, it tends to equalize the tensions. A double bowline on a coil can be used for attaching rappel rope to an anchor point when there is a large excess of rope.

Double-loop bowline. This knot holds better than the bowline and is sixty-nine percent efficient.


Double-loop bowline


Bowline on a coil

Secured

Climbing Knots

Knot	Purpose	Dependability	Ease of Untying	Stress on Rope
Overhand	Safeguard to prevent other knots from slipping	Secure	Extremely difficult	Extreme
Figure 8	Prevents climbers from going off the end of a rappel rope	Secure	Difficult	Heavy
Figure 8 on a bight	To tie into middle of rope, to clip rope to an anchor	Extra secure	Average	Moderate
Flemish bend (figure 8 follow-through)	To join two ends of rope or sling	Secure	Fairly easy	Moderate
Ring bend (overhand follow-through)	To join two ropes or the ends of one rope	Good—may loosen with use	Difficult	Heavy
*Water knot (double overhand to form a bight)	To secure climbing rope to waist or harness	Extra secure	Difficult	Heavy
Fisherman's knot	To join two small-diameter ropes or two ends of one rope	Good	Difficult	Moderate
Grapevine knot	To tie runners and closed loops, especially with small-diameter ropes or webbing	Extra secure	Extremely difficult	Moderate
Prusik	For ascending a rope, usually for an emergency or to secure a running line	Slips when loose, holds when tightened	Easy	Light when kept in place; heavy when allowed to slip
Sheet bend	To join two different diameter ropes	Good if pull is steady	Difficult	Moderate
Double sheet bend	To be used only for joining two rappel ropes	Secure	Difficult	Moderate
Bowline	To secure an end man, to provide a nonslipping loop	Good, but may loosen with use	Average	Moderate
Bowline on a coil	To tie directly into the end of a climbing rope	Secure	Easy	Light
Double bowline	To secure end of rope to tree or large boulder	Secure	Average	Light
Clove hitch	To tie climbing rope to a belay anchor	May fail—requires load on both ends to hold	Easy	Moderate
Coils—mountaineers or skein	To prevent rope from becoming tangled while carrying or storing it	Good	Easy	Very light
Square	To join two ropes	Prone to fail	Easy	Extreme
Butterfly	Middleman's knot	Secure	Difficult—can jam	Moderate
Bowline on a bight	Middleman's knot	Minor error makes this a slip knot	Average	Moderate

Bights

A bight is a simple turn of a rope which does not cross itself. After this has been done, a knot can be tied onto the bight.

Overhand on a bight. This knot may be used to construct loops by simply tying them in bights. This is used quite often on webbing to construct *tie-ins*.

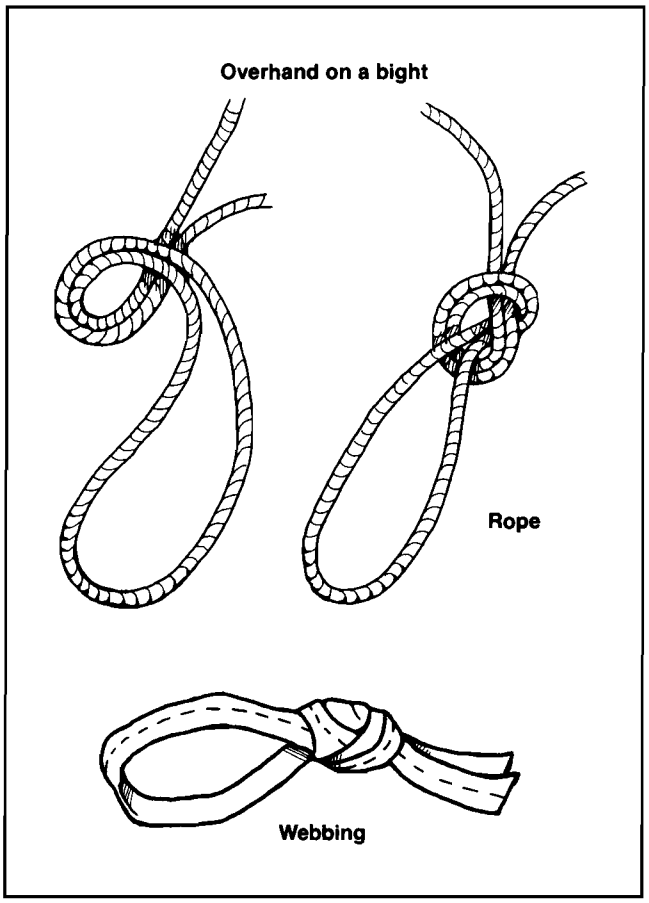
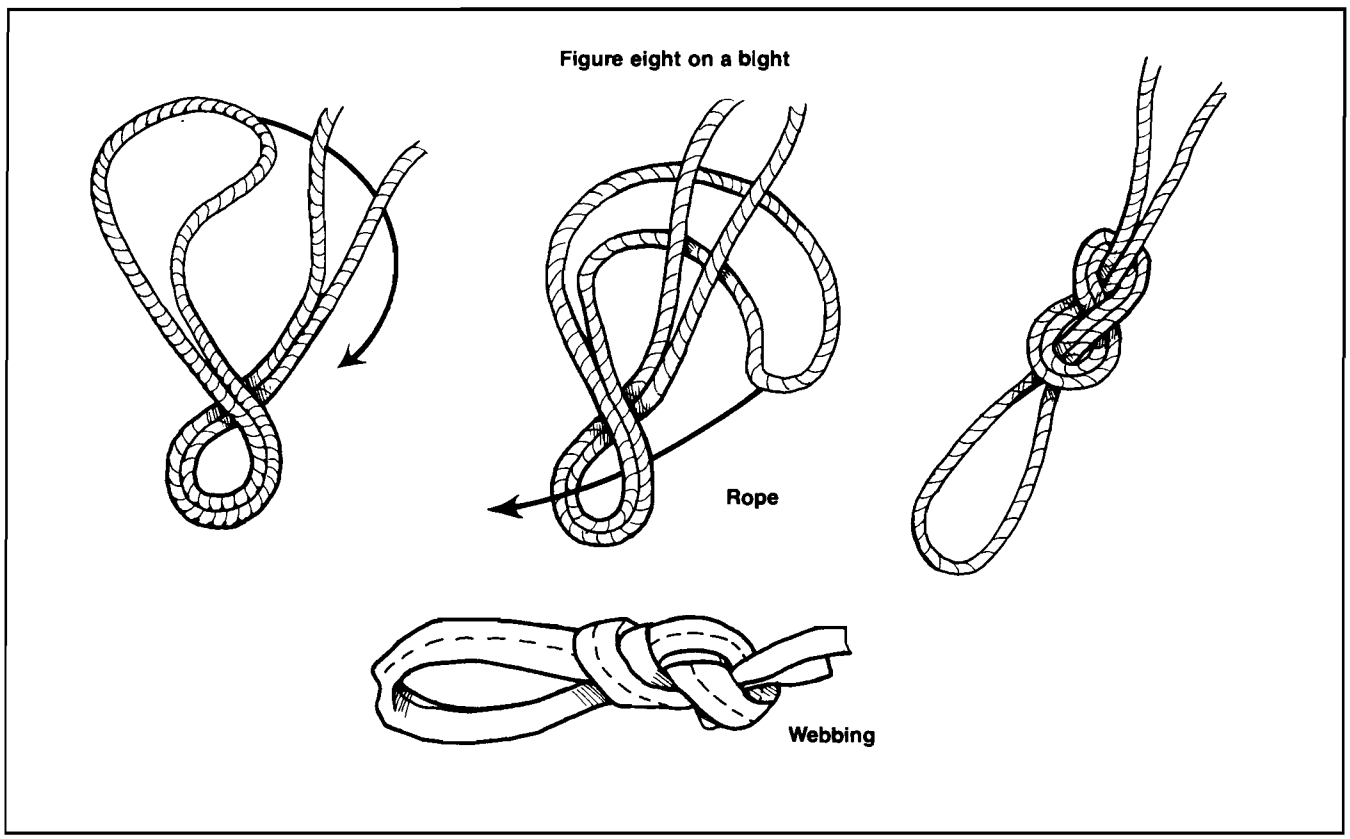
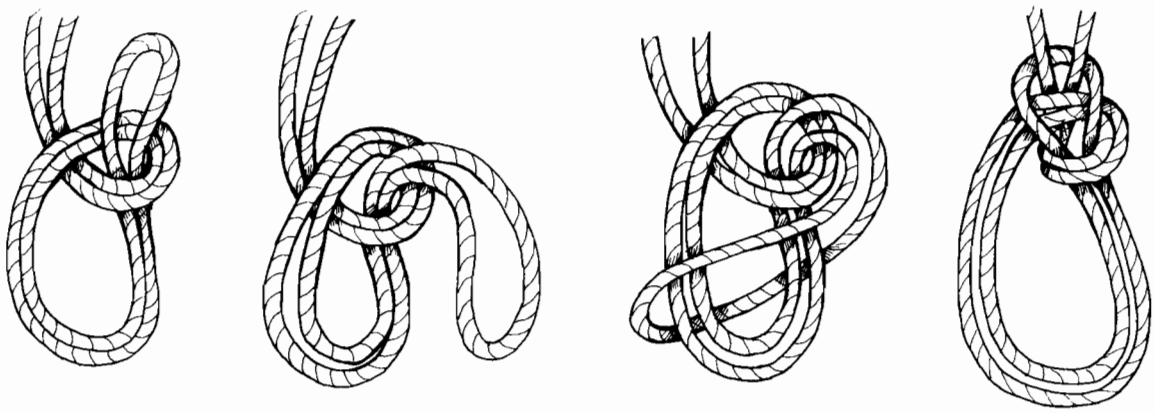


Figure eight on a bight. This knot also may be used to construct loops, by simply tying them in bights. It, too, is used quite often on webbing to construct tie-ins, and is easier to untie, once subjected to strain, than the overhand on a bight. It is also used, along with carabiners, to hook a rappel rope to a cable or a belay rope to a seat-sling.





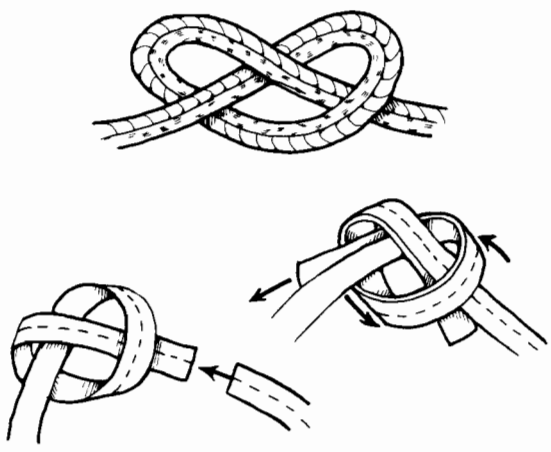
Bowline on a bight

Bowline on a bight. This knot is often used in climbing for the lead man for a more comfortable and safer knot, if a fall must be suffered. It can also be used as a double-loop arrangement (seat-sling) for hoisting a person up or down in an emergency situation where there is little time allowed.

Bends

A bend is used when tying two ropes together.

Overhand bend, water knot, or sling knot, and ring bend. This is a very secure knot and is tied by first tying an overhand knot in one rope, then leading the second rope end along the first until the knot is formed. This knot works well when tied in webbing and is used quite often in tying seat-slings.



Overhand bend

Figure-eight bend or Flemish bend. The Flemish bend is a bit more complicated than the overhand bend and is probably not much stronger. However, the extra loop can provide a little more peace of mind. It makes for a more symmetrical knot and is much easier to untie.

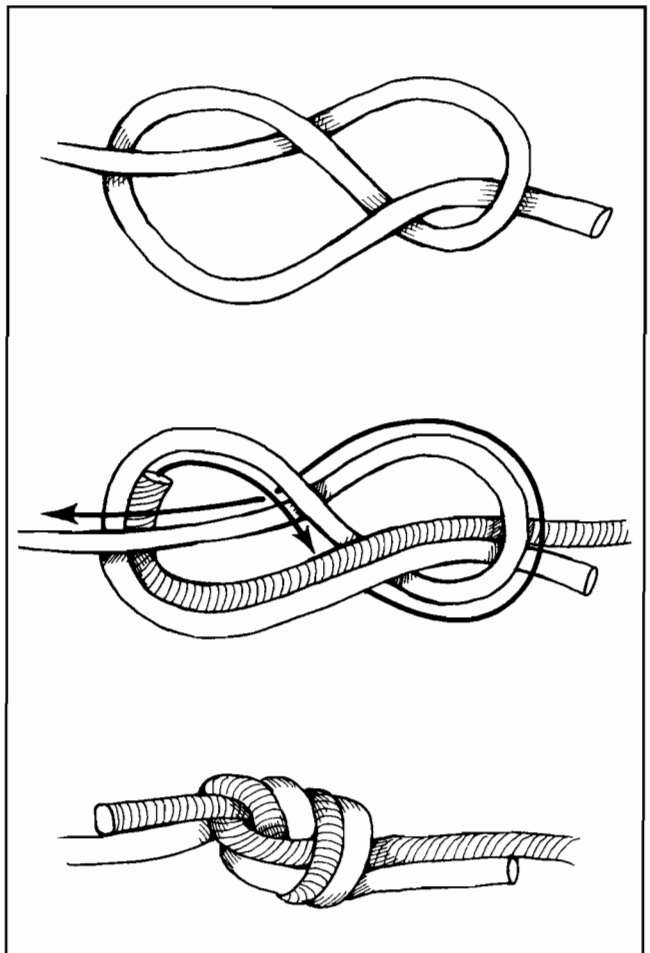
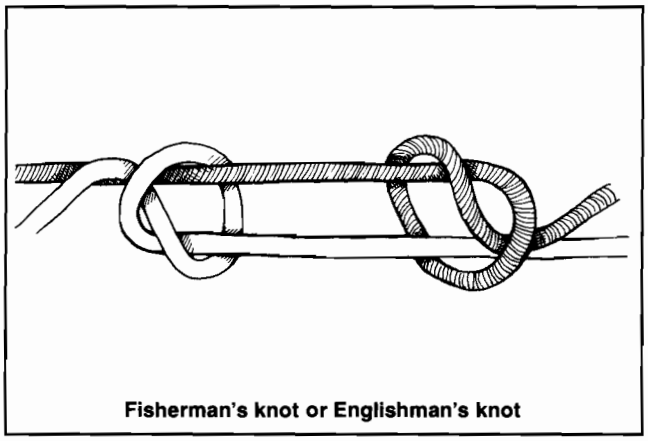


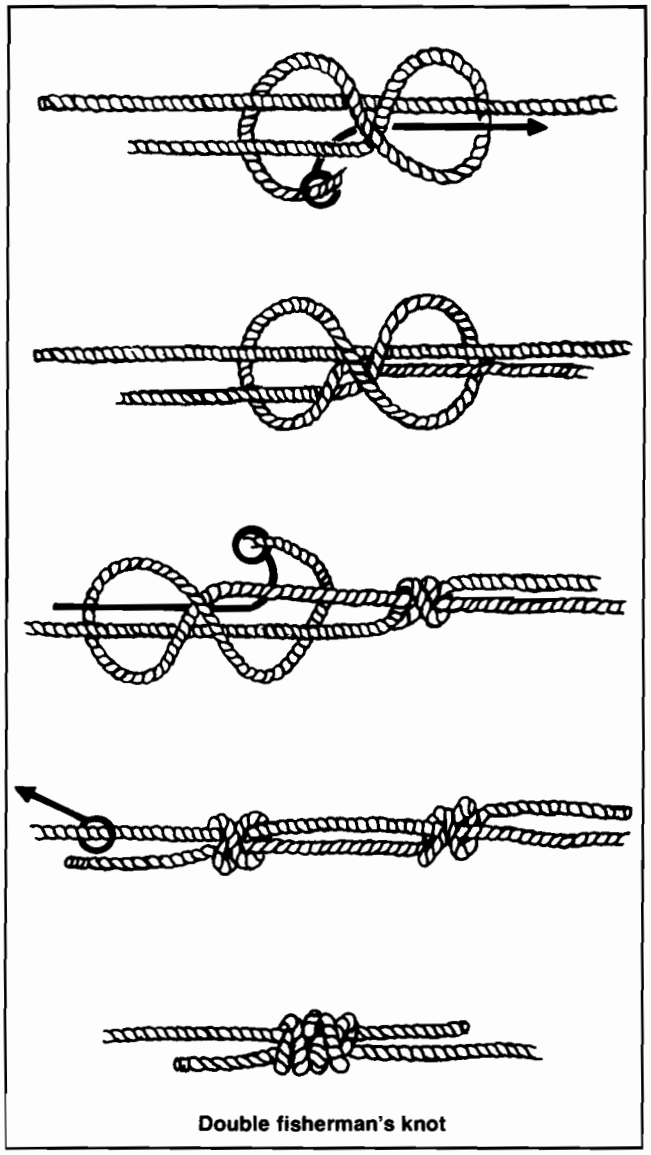
Figure-eight bend or Flemish bend

Double fisherman's knot. This knot is used for joining together two ropes of similar and dissimilar materials. It is also used in making a loop to be used for a lark's head (see diagram). This is a much stronger knot than the single fisherman's knot. Much like the single fisherman's knot, this knot should also slide together so that the flat sides are parallel. Always, after tying this knot or any other knot, tie off all loose ends with safety knots.

Fisherman's knot or Englishman's knot. This knot may be used to tie together two ropes of quite dissimilar materials, such as a braided rope and a woven rope. It is made by tying an overhand knot in one end of a rope, then passing the end of another rope through this knot and tying a second overhand knot around the standing part. The two overhand knots should be slid together so that the flat sides are parallel.



Fisherman's knot or Englishman's knot



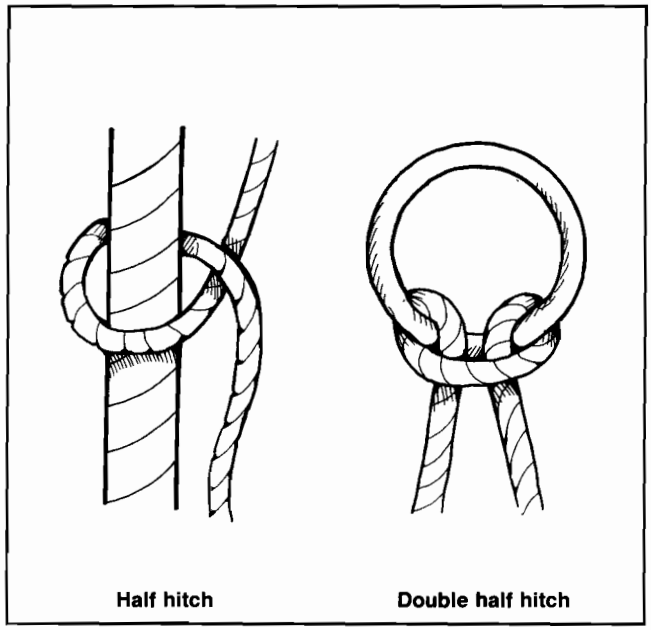
Double fisherman's knot

Hitches

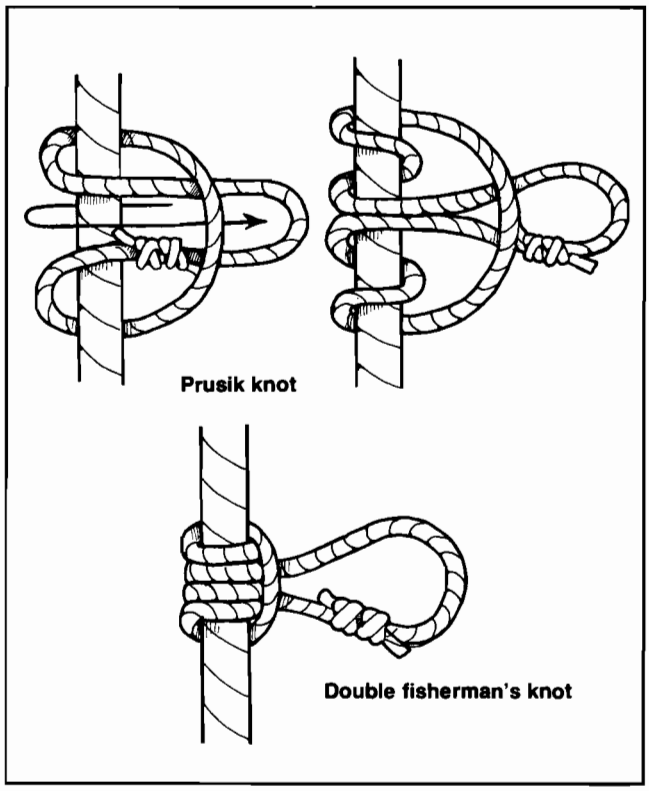
Hitches are knots that grip a shaft or another rope.

Half hitch. This is a loop that runs around a shaft, or a piece of rope, so as to lock itself.

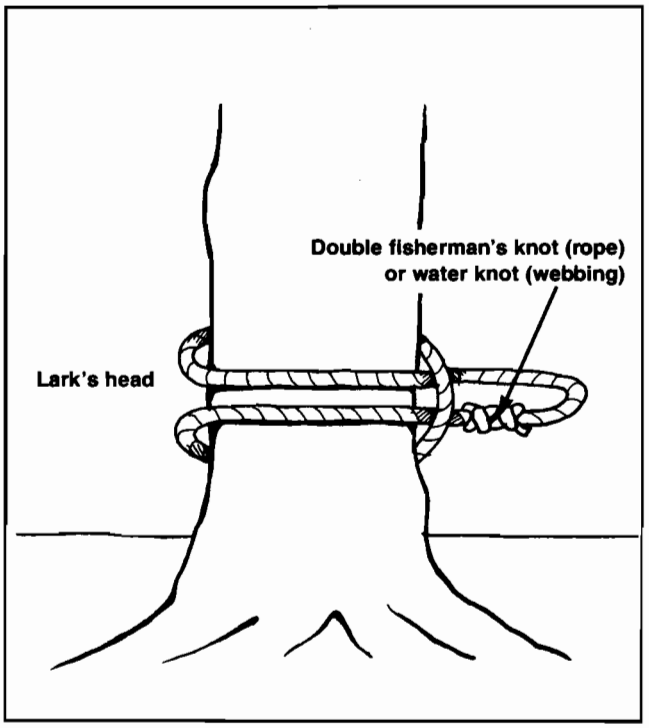
Double half hitch, girth hitch, or ring knot. This knot is the most satisfactory hitch to tie onto a shaft cinch ring or another rope. If tied in a doubled rope, there is absolutely no way in which it can loosen. If a post has a convenient open end, the knot may be formed about the fingers and dropped over the post. If it is to be tied through a ring, one end is fed through, around, across and back through, so that the two ends lie parallel and adjacent. It was from this knot that the prusik knot was developed.



Half hitch Double half hitch

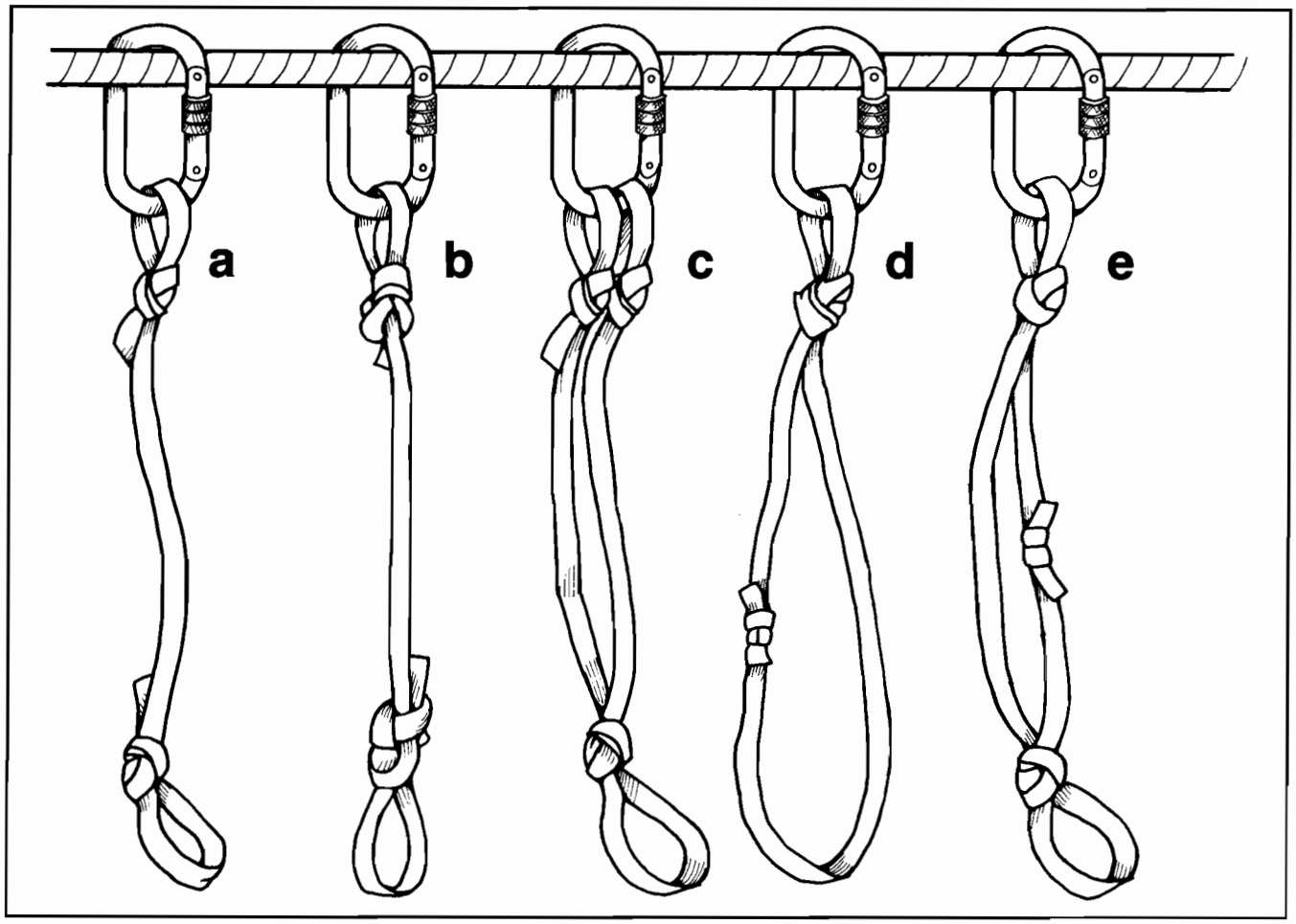


Prusik knot. This hitch is commonly used for climbing a rope or prusik up a rope. In normal practice, it is used to tie a smaller rope, usually in the form of a loop or a sling, onto a larger rope. It grips the main line very securely if under tension, but is easily slipped along the line, if the pressure is released. This is considered a *friction knot.*



Lark's head. A lark's head is a loop made from a piece of rope (tied with a double fisherman's knot) or a piece of webbing (tied with a water knot) for the purpose of setting up a *bottom belay system.* The lark's head loop is fastened around an anchor point, such as a tree, in the same manner as half of a prusik knot. This forms the lark's head (see diagram). Carabiners are fastened to the lark's head for the belay rope to run through. (See bottom belay system diagram.)

APPENDIX E—WEBBING TIE-INS



Webbing Tie-ins for Cable

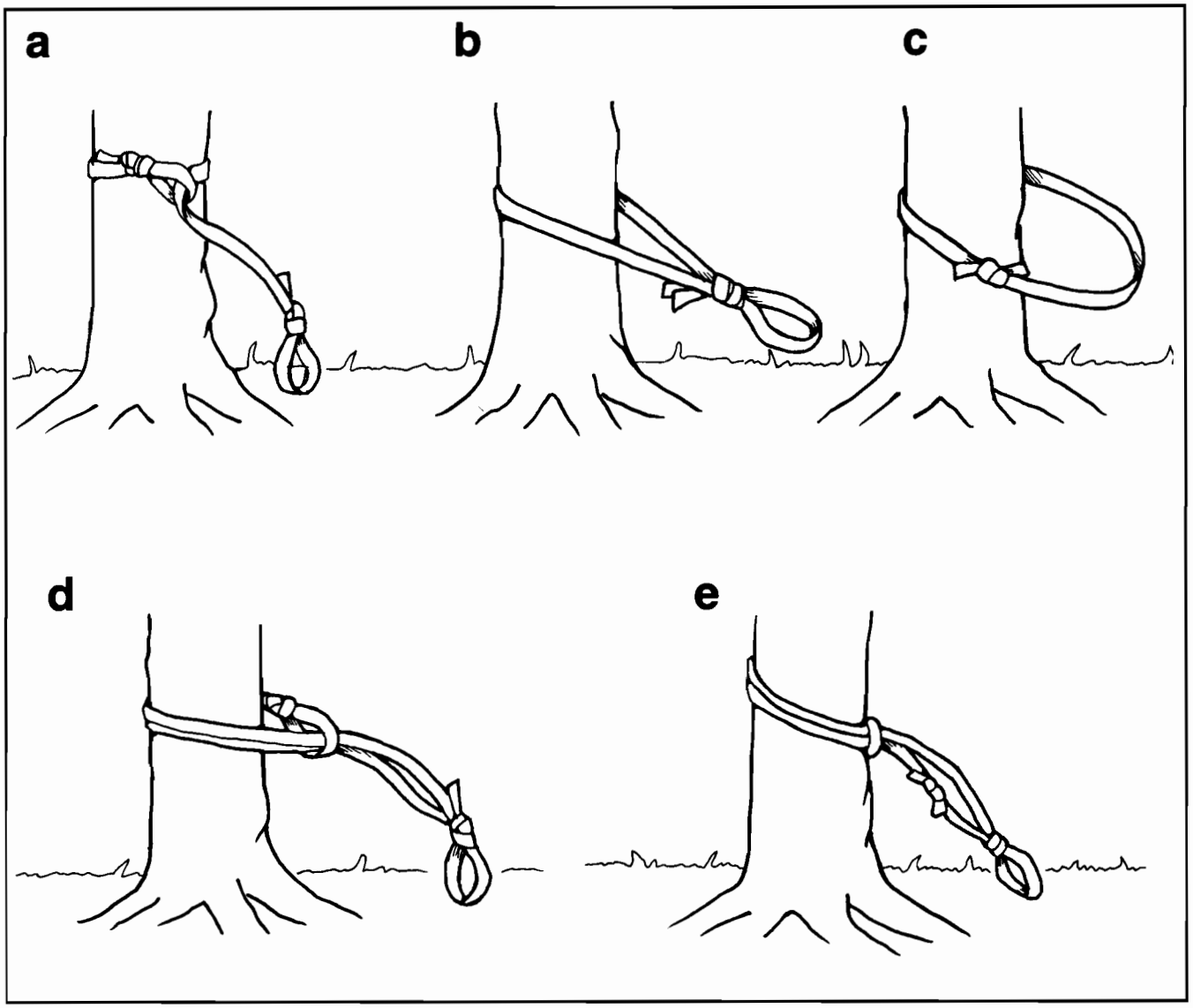
a. This tie-in is made with an overhand on a bight put on each end of a single piece of one-inch tubular webbing. One end is hooked into a carabiner attached to the cable (see diagram), and the other end is hooked into a carabiner attached to the seat-sling.

b. This tie-in is made with a figure eight on a bight and operates exactly as figure "a."

c. This tie-in is a piece of one-inch tubular webbing doubled by using an overhand-loop attached to a person's seat-sling, and having the two loose ends tied with an overhand on a bight and hooked into the carabiner attached to the cable (see figure "c"). The same tie-in can be made by using a figure eight loop in the middle and a figure eight on a bight for each of the loose ends.

d. This tie-in is a piece of one-inch tubular webbing doubled by using either an overhand-loop or a figure eight loop hooked into the carabiner attached to the cable, with the two loose ends tied together with a water knot hooked into the carabiner attached to the person's seat-sling.

e. This tie-in is a piece of one-inch tubular webbing doubled and fastened together with a water knot. The water knot is positioned in the center of the tie-in with an overhand loop or a figure eight loop on each end. These are fastened into the cable carabiner and the person's seat-sling carabiner. This is probably the most popular cable tie-in used.



Webbing Tie-ins for Trees

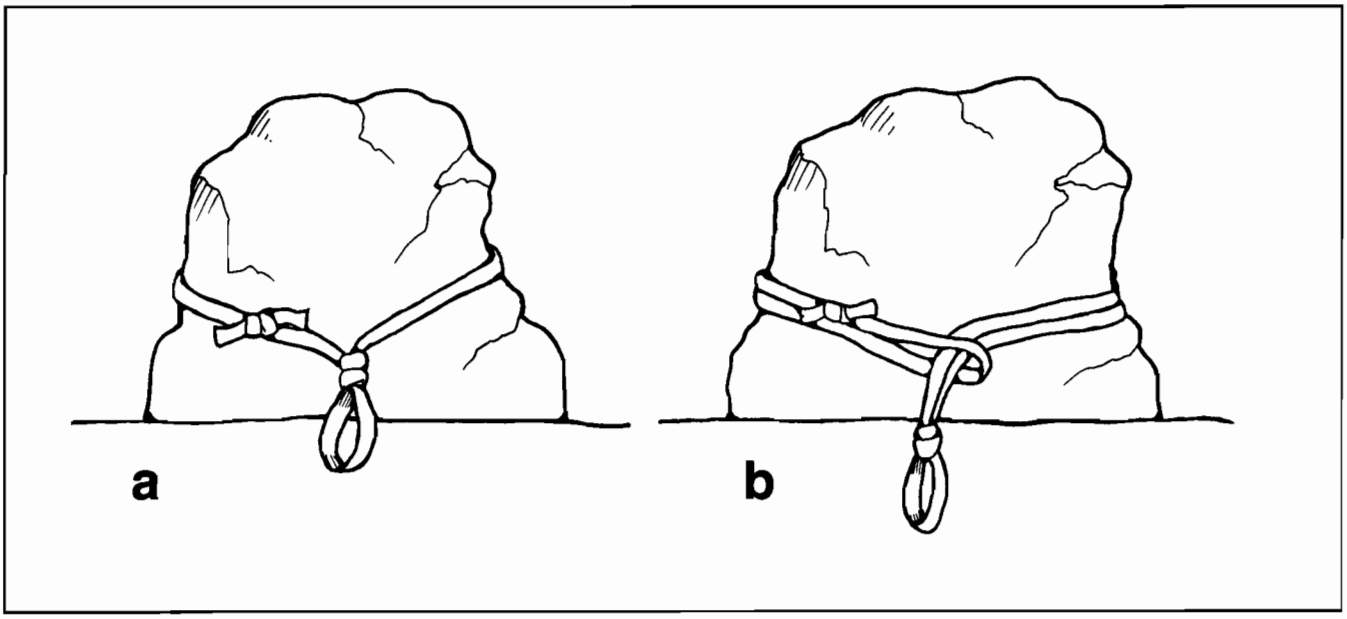
a. This tie-in is made with an overhand on a bight or a figure eight on a bight put on each end of a single piece of one-inch tubular webbing. The webbing is then wrapped around the tree, and one looped end is fed through the other looped end and pulled tight.

b. This tie-in is a piece of one-inch tubular webbing wrapped around the tree with the two loose ends tied together, making a loop, with either an overhand on a bight or a figure eight on a bight.

c. This tie-in is a piece of one-inch tubular webbing wrapped around the tree with the two loose ends tied together with a water knot.

d. This tie-in is a piece of one-inch tubular webbing, doubled, by using an overhand-loop or a figure eight loop. The two loose ends are tied together, making a loop, with either an overhand on a bight or a figure eight on a bight. The webbing is then wrapped around the tree and the end's loop is fed through the overhand loop or figure eight loop and pulled tight.

e. This tie-in is a piece of tubular webbing tied together with a water knot and wrapped around the tree in a lark's head or a prusik fashion. An overhand loop or figure eight loop is placed at the end for fastening into the person's seat-sling carabiner (the belayer). This is probably the most popular tree tie-in used.



Webbing Tie-ins for Boulders

(Also see Appendix I, "Selection of Anchor Points for the Top Anchor Belay System, Top Anchor Rappel System, and the Bottom Belay System.")

a. This tie-in is a continuous loop of webbing, tied off with a water knot. An overhand-on-a-bight or figure eight on a bight makes the loop to clip the carabiner into.

b. Same type tie-in as used in "e" of "Webbing Tie-ins for Trees."

APPENDIX F—RULES USED IN ROPED CLIMBING AND RAPPELLING

1. *Never* walk on a rope. Stepping on a rope with crampons or triconis is a "cardinal sin."
2. Do not drag the rope or webbing along the ground.
3. Do not allow the rope to run over sharp edges if it can be avoided, especially if the rope is under a heavy load. A canvas shield laid over the edge is good for protecting the rope from rubbing against the rough edges.
4. Do not store rope near radiators or other sources of heat, or in a dirty car trunk.
5. Do not hang rope over sharp nails.
6. Keep the rope reasonably dry if possible. Dry before storing.
7. Do not leave a rope stretched or under tension for any extended period of time.
8. Remove all tight knots after using and before storing.
9. Do not use a climbing rope as a car-towing rope. Once so used, it is then and forever a tow rope and never again a climbing rope.
10. Completely examine a rope immediately after it has held a fall.
11. Examine the rope at regular intervals. If puffs of fibers are observed at any point along the line, *retire* the rope. On a climb, a butterfly knot can be tied to isolate the damaged section in its loop.
12. Examine the rope immediately after it has been hit by a falling rock, no matter how small. If a sudden strain has been placed upon the rope while passing over a sharp edge, examine.
13. Keep oils, spirits, gasoline, and lacquer thinners away from synthetic ropes. Lacquer or lacquer thinner will destroy a nylon rope in minutes.
14. Keep rope away from cigarettes, open flames, and (when stored) direct sunlight.
15. Keep rope coiled when not in use.
16. Keep ends of rope and webbing burnt to prevent fraying.
17. Dry wet ropes uncoiled.
18. Periodically wash dirty slings and ropes with a mild detergent and lukewarm water.
19. Inspect ropes and slings for damage after each use.
20. Do not allow one nylon rope (or any nylon equipment) to run or rub over another piece of nylon rope (or any nylon equipment). With the weight being placed on the ropes, it is only a matter of seconds before one rope will melt through the other due to friction heat.
21. Do not allow nylon webbing or rope to remain for unnecessarily long periods of time in direct sunlight. Ultraviolet rays can break down the strength of the rope or webbing. Webbing is the most critical because of its large amount of surface area.
22. Carabiners, figure eights, brake bars, ascending rings, helmets, and so on, can all become weakened when dropped or thrown against a rock surface. Pulling them back up on a rope subjects them to a great deal of banging against the rock face. Often, these items can suffer internal cracks not visible from the outside. Treat them with care even though they are made out of metal.
23. In knot tying, secure all loose ends with a safety knot, and position each safety knot directly next to the major knot being used.
24. No one should climb or rappel alone.
25. No one should climb or rappel at any site without top-rope-anchored belays.
26. Helmets must be worn within 20 feet of the cliff base and always while climbing or rappelling.
27. No one should be within 5 feet of cliff top unless on belay or tied in to an anchor.
28. The brake hand must be gloved on rappels and belays.
29. The sitting-hip belay is usually the safest and most used belaying system in rock climbing and rappelling. In this type of belay, cliff-top belayers must be seated and anchored.
30. Bottom and top supervision is necessary for all rappelling of noncertified students.
31. No ropes should ever be left hanging unsupervised.

32. The bowline knot and double fisherman's knot are used for rope; the water knot is used for webbing. The safest practice is not to interchange a webbing knot for a rope knot or vice versa.

33. Always use a separate anchor for the belay rope than you use for the rappel rope.

34. The rappel rope anchor should be in direct line with the rappel spot, and the belay rope should be at a slight angle from the rappel rope to prevent the two ropes from becoming tangled or rubbing against each other.

35. An extra rope should always be anchored and out of the way at the rappel sight in case an emergency situation arises.

36. *Never* wear loose clothing, hanging straps, or strings, and keep long hair up and out of the way of the figure eight. These can become lodged in the figure eight during a rappel, requiring rescue operations.

37. Any rope not being used should be coiled and whipped and then put away in a safe place.

38. Use double carabiners on running belays from top anchors.

Appendix G—Techniques Used in Tying a Knotted Leg-loop Seat-sling

The knotted leg-loop seat-sling is the seat-sling most accepted and used by rappelling/rock-climbing facilitators and instructors because of its greater safety features (over the Swiss seat-sling method).

Note: Learning to tie the knotted leg-loop seat-sling from these instructions and diagrams may be difficult and confusing without firsthand experience and assistance from a rappelling/rock-climbing facilitator or instructor.

Step 1: Take one end of the webbing (seat-sling) and measure off approximately one arm's length of webbing (with arm stretched out to side, measure webbing to nose). See diagram. This section of webbing will be used in step 3 for tying the final knots. Be sure you keep this short measured length for that purpose.

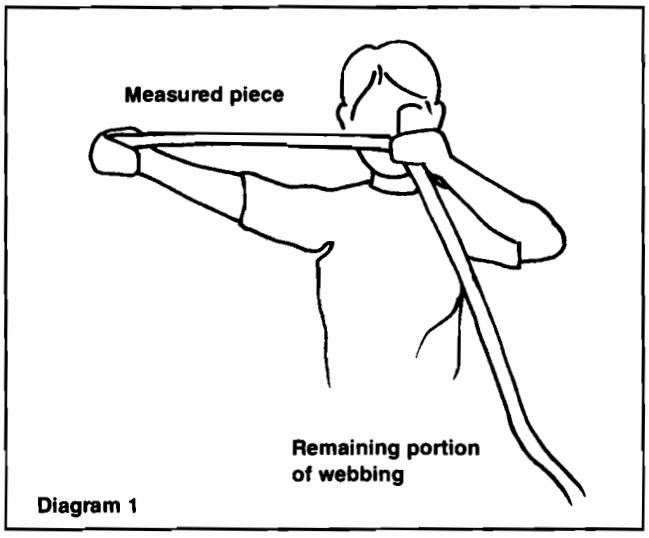


Diagram 1

Step 2: Keeping the short measured piece of webbing marked with your finger, and using webbing only from the long portion, wrap webbing around one leg in order to get your leg size. Add approximately 4 to 6 inches more webbing to this measurement to allow for the knot.

Step 3: Hold the leg loop together in a *bight* and tie an *overhand-on-a-bight* knot. This will make your first leg loop. Adjustments may have to be made to get a comfortable fit. See diagram.

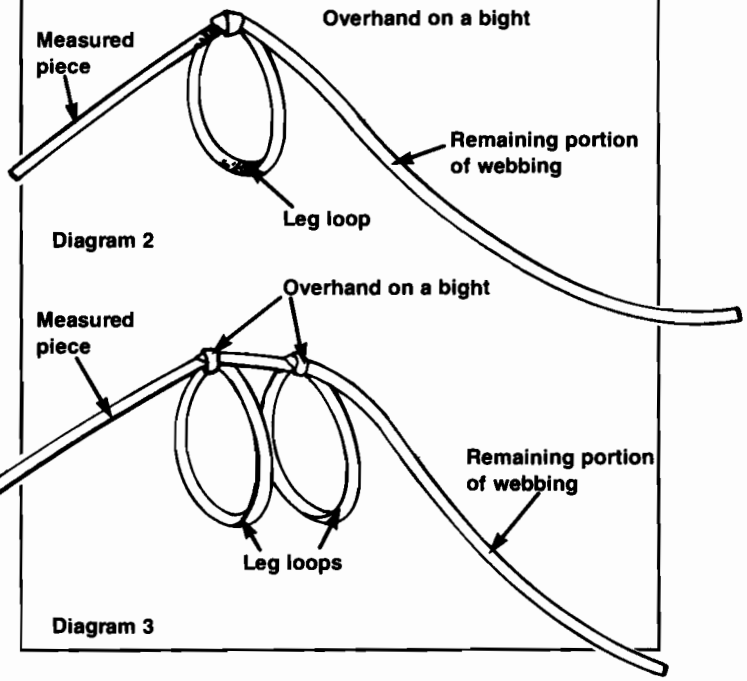


Diagram 2

Diagram 3

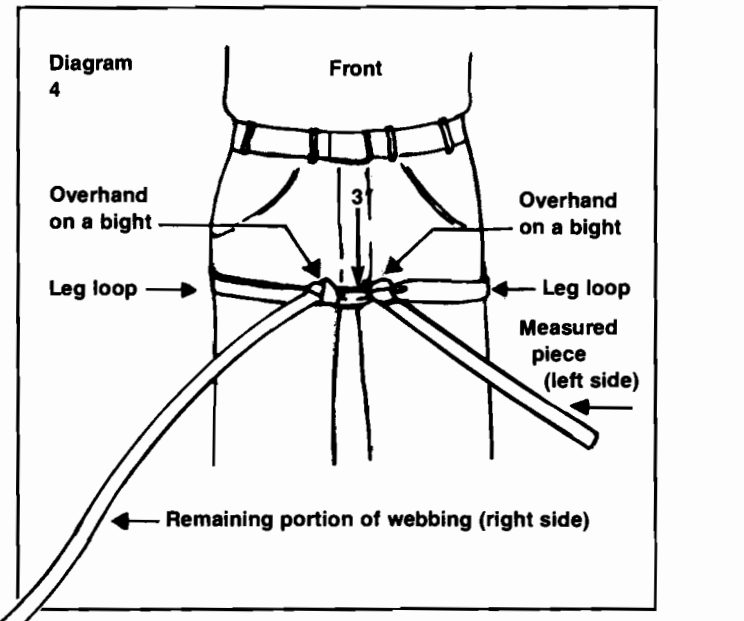


Diagram 4

Step 4: After the first leg loop has been made and fitted comfortably, move down the remaining portion of webbing, approximately 3 inches from the first leg loop's knot, and make another leg loop in the same manner as you did the first leg loop. Adjust to fit comfortably. See diagram. (See note below.)

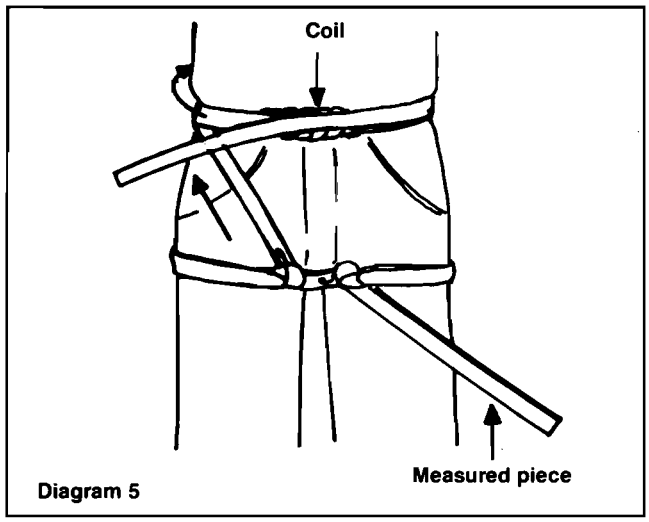


Diagram 5

Step 5: With the short measured piece on your left-hand side, put on the leg loops like putting on a pair of pants. Pull the leg loops all the way to the crotch area, and pull knots toward the front. For comfort, be sure there are no twists in the leg loops. They must fit smoothly and snugly around the legs. See diagram. (See note below.)

Note: Don't make the leg loops so tight that they cut off circulation, and don't make them so loose that they are constantly sagging or having to be pulled up. *Rule of thumb:* If you can slip *two* fingers comfortably between the leg loop and the leg, then the leg loop is tight enough.

Step 6: Letting the short, measured piece of webbing hang, take the long, remaining portion of webbing up toward the right side and start coiling it neatly and smoothly around your waist until all webbing is used up. See diagram. (See note below.)

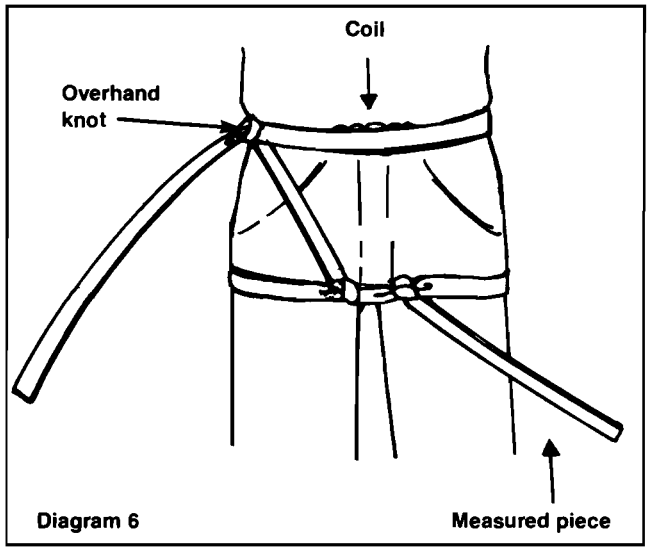


Diagram 6

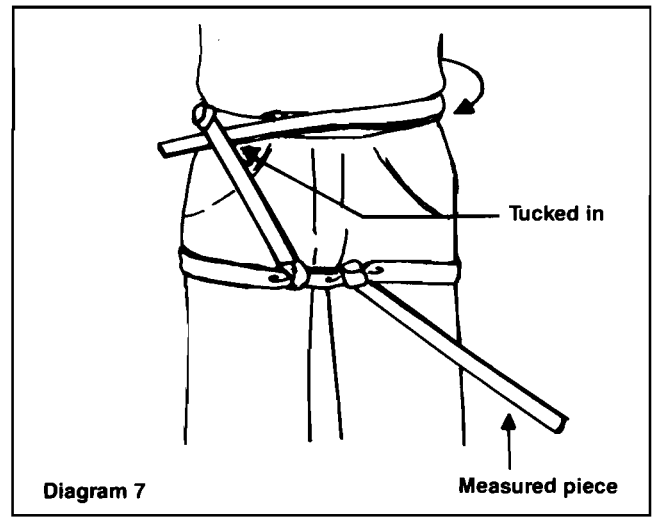


Diagram 7

Step 7: Back off the webbing one or two complete coils (see note below) and tie an overhand knot around all coils on the right side (see diagram above).

Step 8: Take the remaining webbing around the back side to the front, and tuck in for later tying of a water knot. See diagram.

Step 9: Take the short, measured piece of webbing to the left side up and over all coils. Tie a loose overhand knot (one-and-a-half of the water knot). See diagram above.

Step 10: Take the tucked-in portion of the webbing and complete the water knot on the left-hand side.

Step 11: Finish off the water knot with a safety knot (overhand knot).

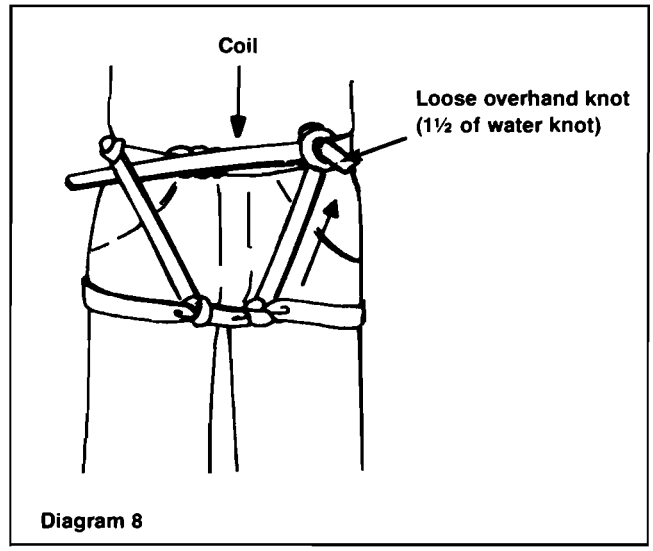


Diagram 8

Tying a Seat-Sling Using a Water Knot

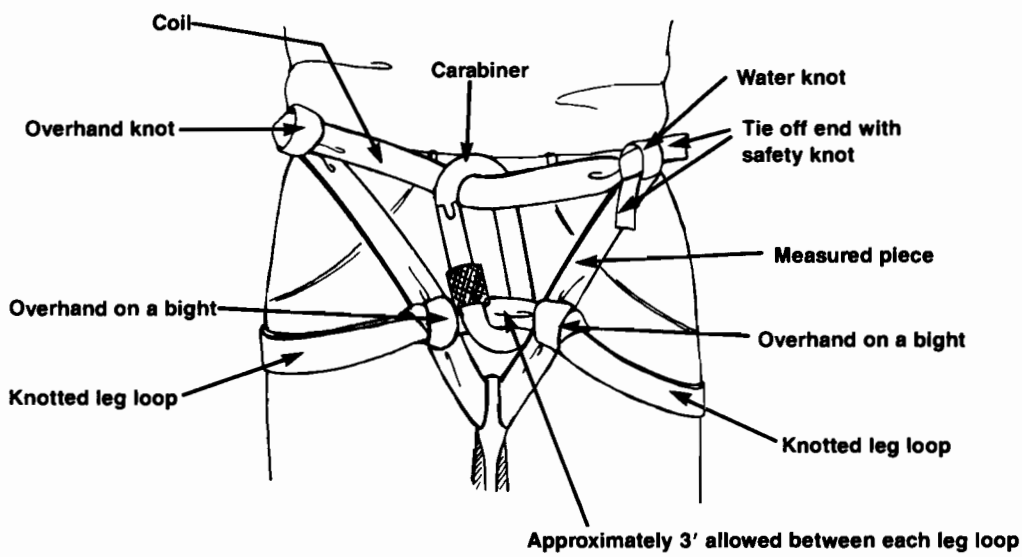


Diagram 9 Knotted leg loop seat-sling

Note: Once the webbing has been used up in the coiling process, and if the webbing end passes the diagonal portion running up the right side, then back off the coil (webbing) *once* before tying the overhand knot (see diagrams under step 6). If the webbing end does not pass the diagonal portion once it is used up in the coiling process, then back off the coil (webbing) *twice* before tying the overhand knot.

Note: When putting the carabiner onto the sling, be sure that the gate opens at the bottom for convenience in hookup and unhooking.

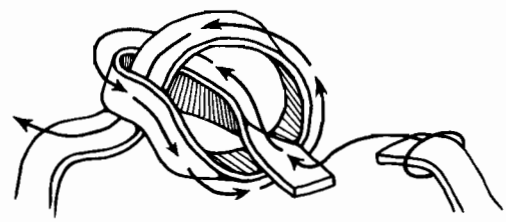


Diagram 10 Webbing water knot

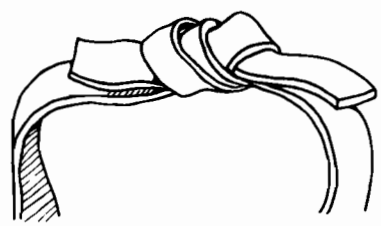


Diagram 11

Note: The above knot is used in the belayer's waistband and the climber's seat-sling, in which case it includes all coils around the waist.

APPENDIX H—TECHNIQUES USED IN TYING A SWISS SEAT-SLING

1. Find the middle of the sling, and hold onto it.

2. Throw the remainder of the sling (webbing) behind you, and step over it with one leg, or throw the remainder of the sling (webbing) between your legs, behind you.

3. The webbing is now folded in half between your legs.

4. Take the left, loose half of the webbing and wrap it around your left leg and the right, loose half of the webbing around your right leg.

5. Be sure the sling is not crossed between the legs (the crotch area), and be sure the webbing is not twisted. A smooth sling (webbing) makes a more comfortable sling.

6. Now, pass the left and right pieces of webbing through the folded middle of the sling (webbing) from the bottom up, and pull all the way through.

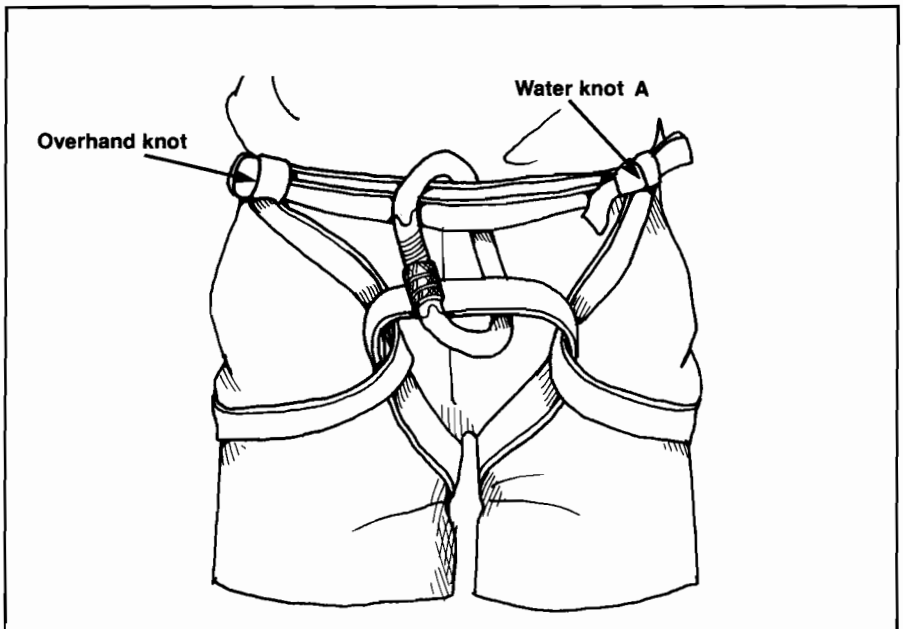
7. Wrap the left half around toward the left and the right half around toward the right, making a coil around the upper hips until enough webbing remains for securing with a water knot.

8. Secure the sling with a water knot and safety knots (overhands). Tie the water knot on the left if the rappeller is right-handed or on the right if the rappeller is left-handed.

9. The water knot will encompass the upper crosspieces of the seat-sling and encircle all the coils around the upper hips (waistband).

10. Use a carabiner to hold the upper (coils) and lower crosspiece. This will prevent the leg loops of the seat sling from sliding down. A tight, neat sling will hold best, will resist sliding down, and is the most comfortable.

Note: Secure the ends of water knot A with overhand knots.



Swiss seat-sling for climbing

APPENDIX I—SELECTION OF ANCHOR POINTS FOR THE TOP ANCHOR BELAY SYSTEM, TOP ANCHOR RAPPEL SYSTEM, AND BOTTOM BELAY SYSTEM

In selecting these anchor points, observe the following guidelines:

1. *Anchoring* is the process of attaching oneself to a fixed point, commonly a tree or boulder independent of the other ropes.

2. When selecting a tree for an anchor system, the tree should not be any less than 6 inches in diameter. If in doubt of choice, either use a second tree as an anchor safety backup, or select a different anchor point. (See number 13.)

3. The anchor point should not be directly at the edge of the cliff. Allow at least 10 to 20 feet of distance from the cliff's edge when choosing an anchor point.

4. If using a tree as an anchor point, the tree's *root system* should not be unsafely exposed. If in doubt, again, either use a second tree as an anchor safety backup, or select a different anchor point.

5. If using a tree for an anchor point, be sure that the tree is living. In the winter months, check to see whether the tree has small buds on it. If so, then the tree is alive.

6. If using a boulder as an anchor point, it should be large enough, at least 2,000 pounds, so that it will not budge or roll.

7. Be sure that the rope or webbing cannot be pulled off or under the boulder if a strong force must be held.

8. Check the boulder for sharp edges, burrs, ridges, or spikes, and pad the rope or webbing, if possible, to protect it from abrasion.

9. In many cases, 1-inch tubular webbing is used to wrap around boulders, and the rope is then clipped into the webbing with carabiners. This ensures more adequate strength, and because of the webbing's flat construction and increased surface area, will hold quite securely. On some boulders or rock protrusions, a rope, due to its rounded construction, could possibly roll off.

10. Always use a separate anchor point for the belay system than you use for the rappel system.

11. The anchor point used in setting up a rappel system should be in direct line with the rappel sight, and the belay anchor system should be at a slight angle to the rappel rope to keep the belay rope from rubbing the rappel rope and to keep the two ropes from getting tangled or twisted with each other.

12. The anchor point used in setting up a belay system for a climb should be in direct line with the climbing sight. This will eliminate a pendulum effect in case of a fall.

13. If the anchor point is at all questionable, incorporate another, secondary anchor into the system. This secondary anchor should be strong enough to hold the entire load if the primary anchor fails.

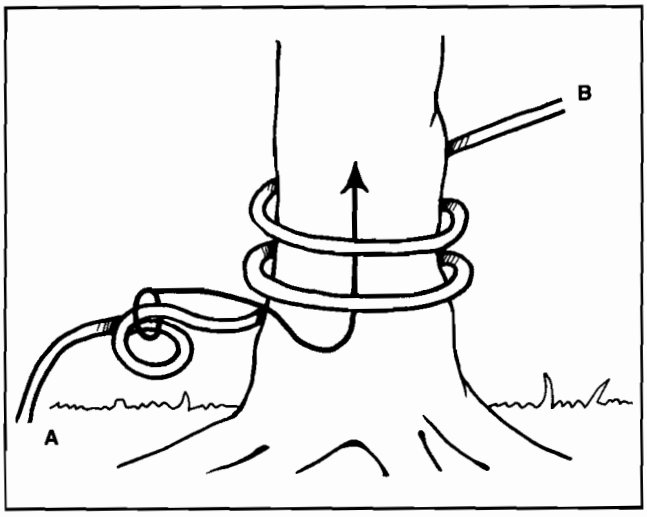
14. Anchorings should be checked and double-checked by all individuals present. Anyone, including experts, can make errors, and your effort is for everyone's safety, including your own.

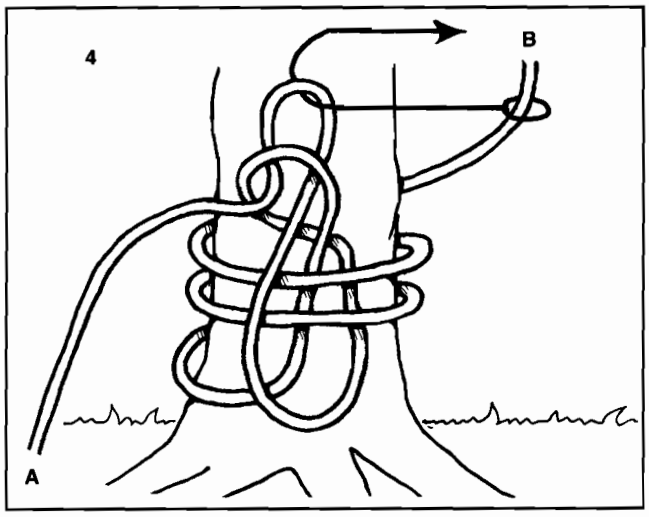
15. When selecting an anchor, it is far better to find a natural anchor (tree, rock, etc.) rather than placing an artificial anchor (stake, pole, etc.).

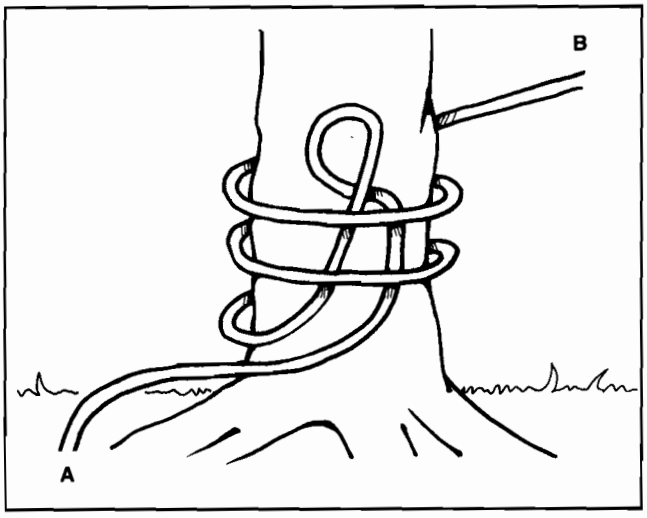
16. Remember, it does not matter how strong your rope is or how well you tie your knots if your anchor is not strong enough.

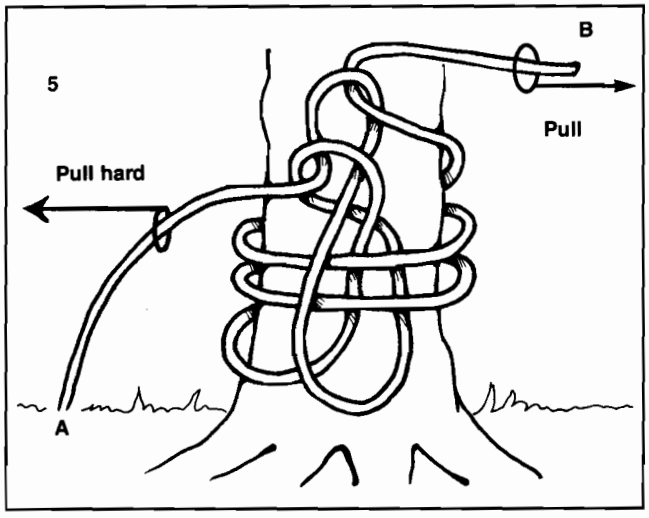
Bowline on a Coil

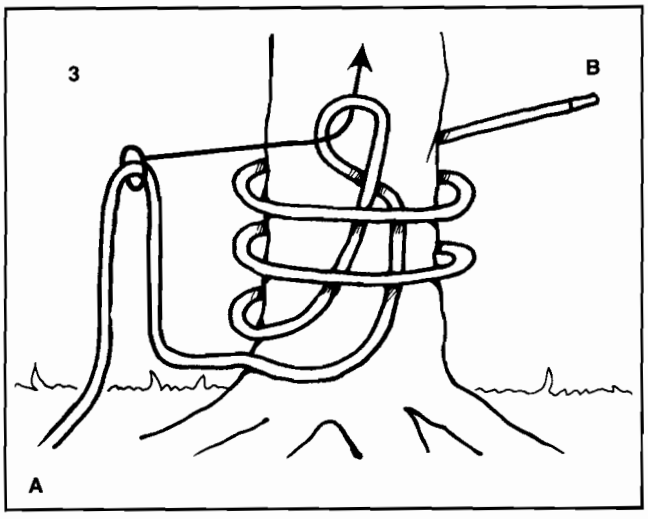
The bowline on a coil is an anchor knot used in rappelling, belaying, and rock climbing. Also see "The Coil Wrap/Tensionless Rigging."

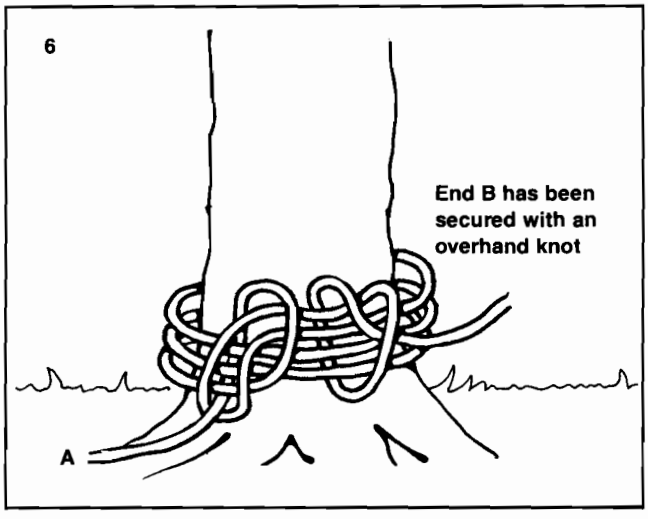








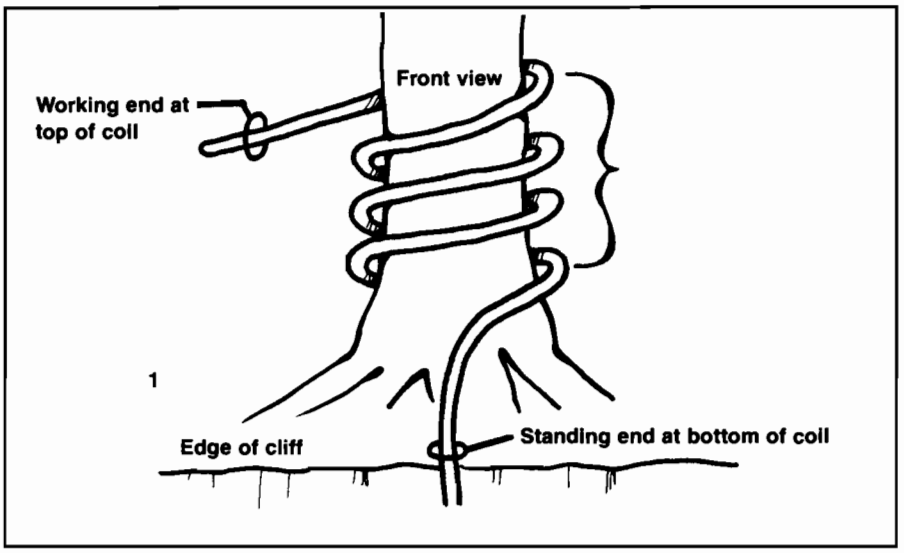


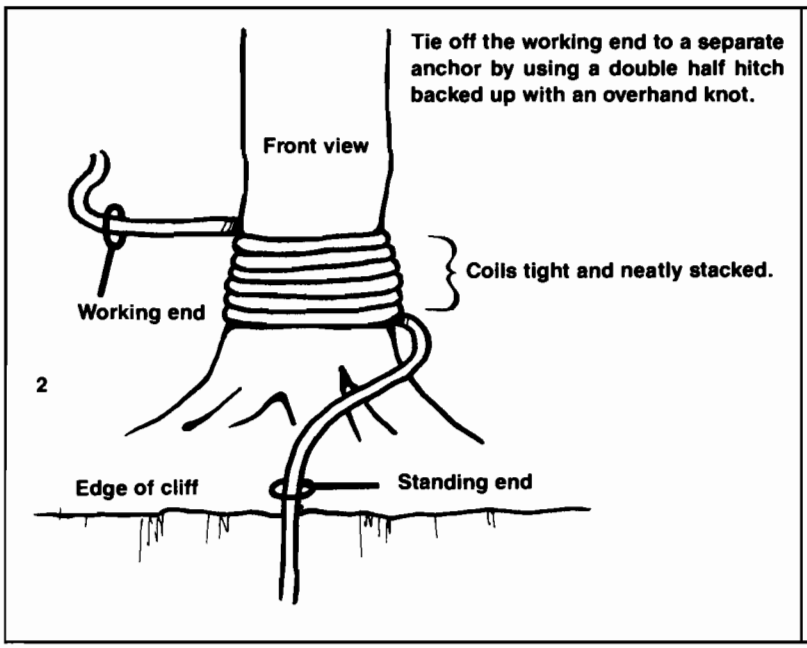


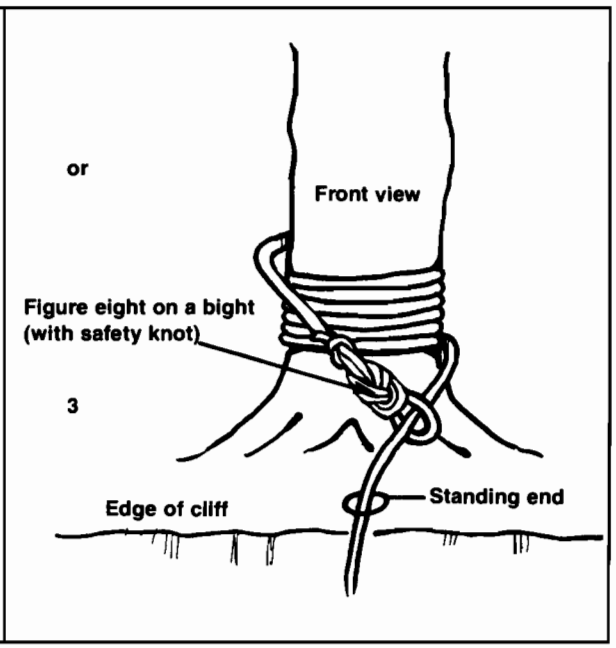
Coil Wrap

The coil wrap is an anchor system used in rappelling and is also known as tensionless rigging.

This type of anchor system is highly accepted by N.O.L.S. and various rope-course instructors because the system requires no knots on which stress is placed, as happens with the bowline-on-a-coil system. With the coil wrap system, the anchor point receives the maximum amount of stress, with the rope receiving the minimum.



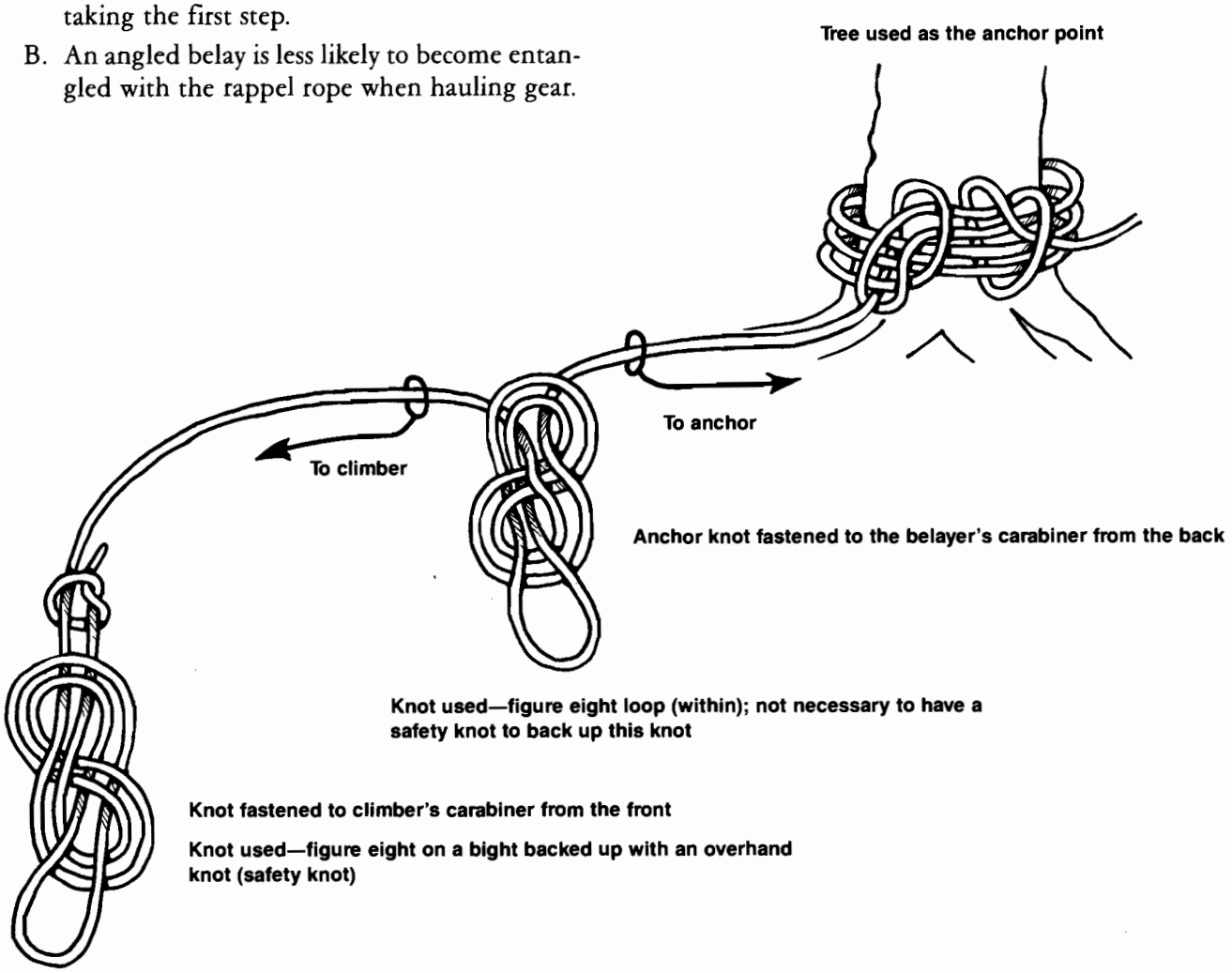


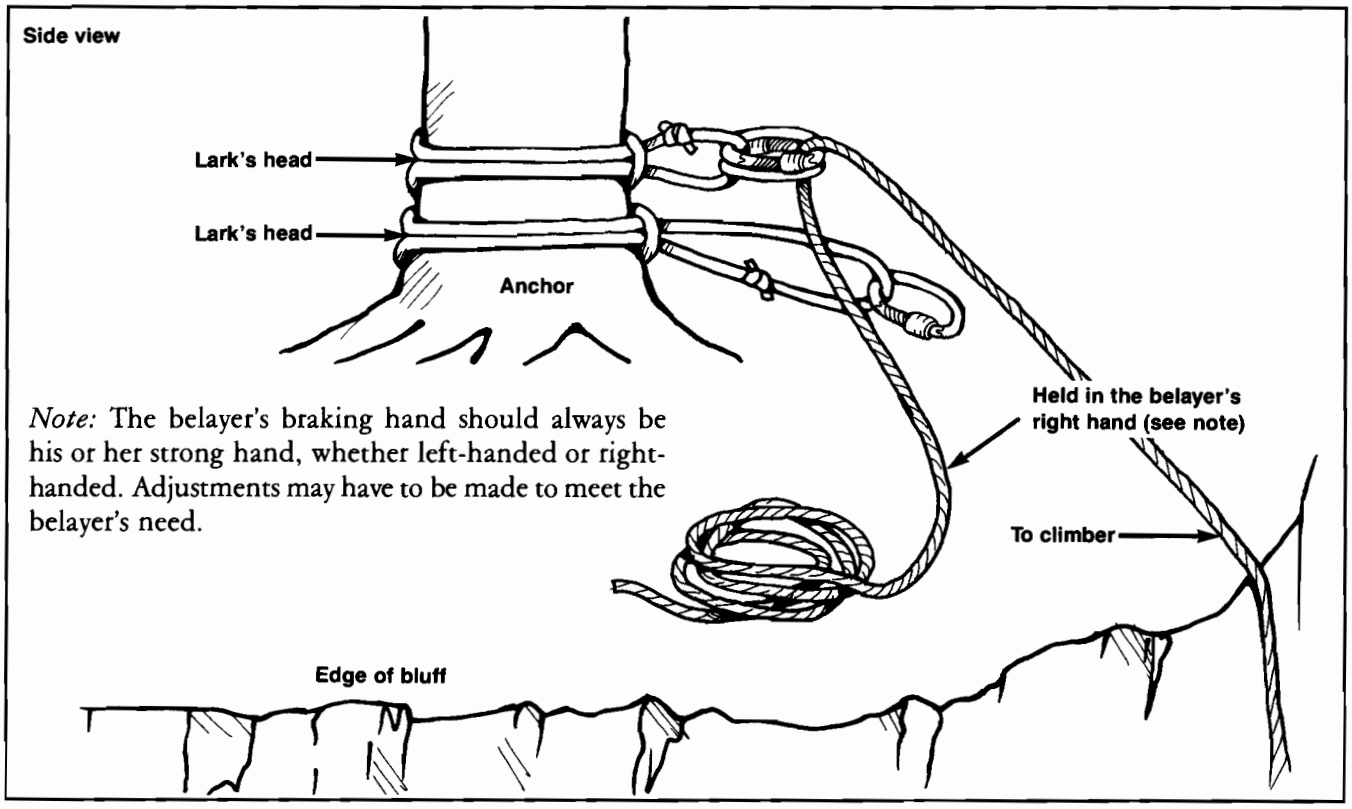


Top Anchor Belay System Rules

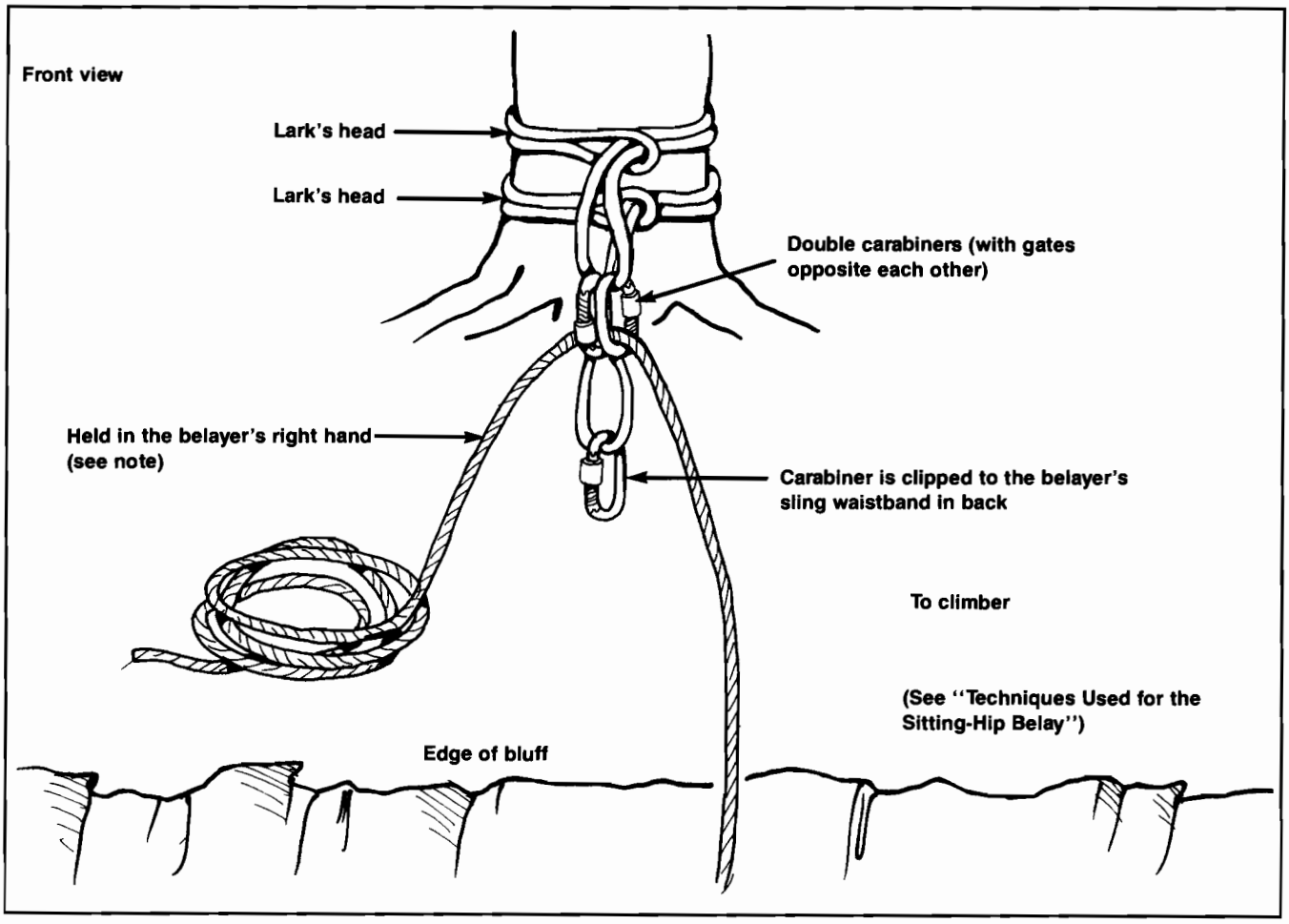
This system is used in sitting-hip belay for rock climbing and rappelling.

1. The anchor should be independent of the rappel rope.
2. For the best belay, the belay rope is not parallel to the rappel rope.
   A. A belay that is angled to the rappel rope provides the rappeller with greater support while taking the first step.
   B. An angled belay is less likely to become entangled with the rappel rope when hauling gear.





Note: The belayer's braking hand should always be his or her strong hand, whether left-handed or right-handed. Adjustments may have to be made to meet the belayer's need.



Techniques Used for the Sitting-Hip Belay

1. Use the bowline on a coil to anchor the belay rope. (See diagram.)
2. Attach the belayer to the anchor rope by clipping a small figure eight loop to his or her sling waistband in back (see "Top Anchor Belay System" diagram). The old method of sitting in a larger figure eight loop does not allow a belayer to remain tied in when moving around at the belay station. Additionally, the clipped-in method prevents the belayer from slipping out of the large belay loop. Use a locking carabiner to clip in.
3. Be securely seated. The standing belayer is easily pulled off his or her feet by a fall. If the standing belay method *is* used, use the technique mentioned in number 5.
4. Keep the anchor rope taut. A slack anchor rope will allow a falling person to pull the belayer readily forward, which can be dangerous.
5. Brace legs as firmly as possible against the direction of pull.
   A. The leg on the side of the rope going to the climber is the most important one.
   B. Brace this leg straight so as to use leg bones instead of muscles.
6. The guiding hand on the side of the rope going to the climber aids in taking the rope in and letting it out and in feeling what the climber is doing.
7. The rope that runs around the hip and over the belay anchor is handled by the holding hand, which stops the falls.
8. The holding hand *never* releases the rope.
9. The belay rope should pass *over* the anchor rope to assure that the belay rope cannot slip under the belayer. (See number 17.)
10. The belayer should be positioned so that the rope passes over trouser-protected hips rather than the vulnerable waist.
11. The belayer should use a leather or canvas pad on the back, if available, for protection against friction burns from rope.
12. Gloves are necessary for the belayer to assure the safety of both climber and the belayer and to prevent rope burns.
13. Keep communications clear. The belayer should know what the climber is doing, where the climber is, where the rope is, and how the rope is doing in respect to tension or slack.
14. The belayer should be facing the cliff's edge, *sitting,* in a position that minimizes any twisting action caused by a fall. The body should be braced in the direction of the fall.
15. The belayer should be aware of the rope stretch caused by a fall between the belay seat and anchor point and, accordingly, be positioned a safe distance (approximately 10 feet) from the edge of the cliff.
16. The belayer should be sitting as close to the belay anchor as practical so as to reduce stretch in the belay rope.
17. If the climber is below the belayer, the rope runs over the belayer's tie-in. If the climber is above the belayer, the rope runs under the belayer's tie-in. This is due mainly to the direction of pull in case of a fall and also applies to any standing belay methods used.

Note: The standing belay method is basically the same as that discussed here.

The Leg Belay

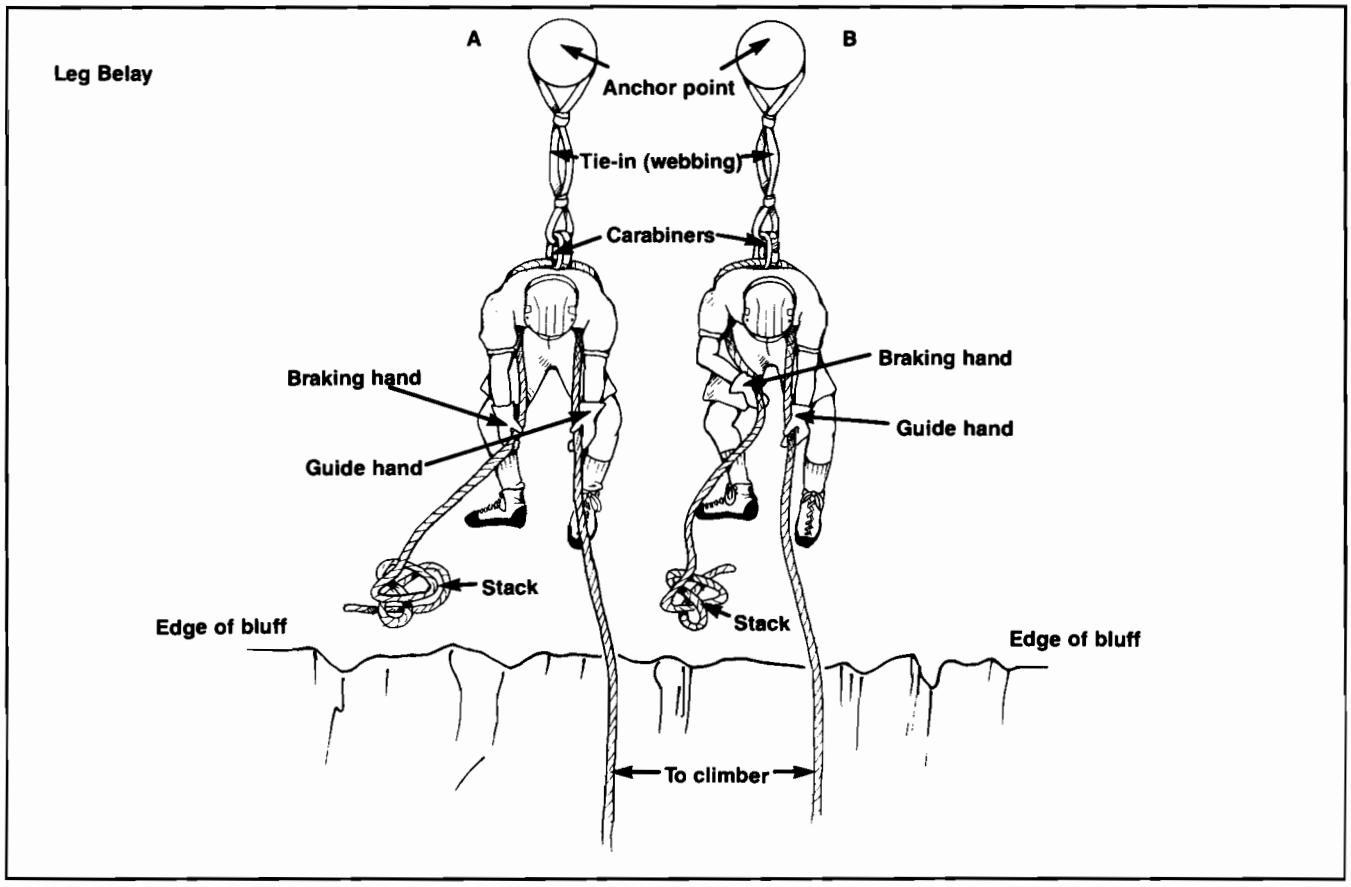
This belaying technique is commonly used, both in the sitting-hip belay and in the standing belay, where the belayer brings the braking rope (right hand) over his or her right leg to lock off a climber's fall (see figure B and the note following).

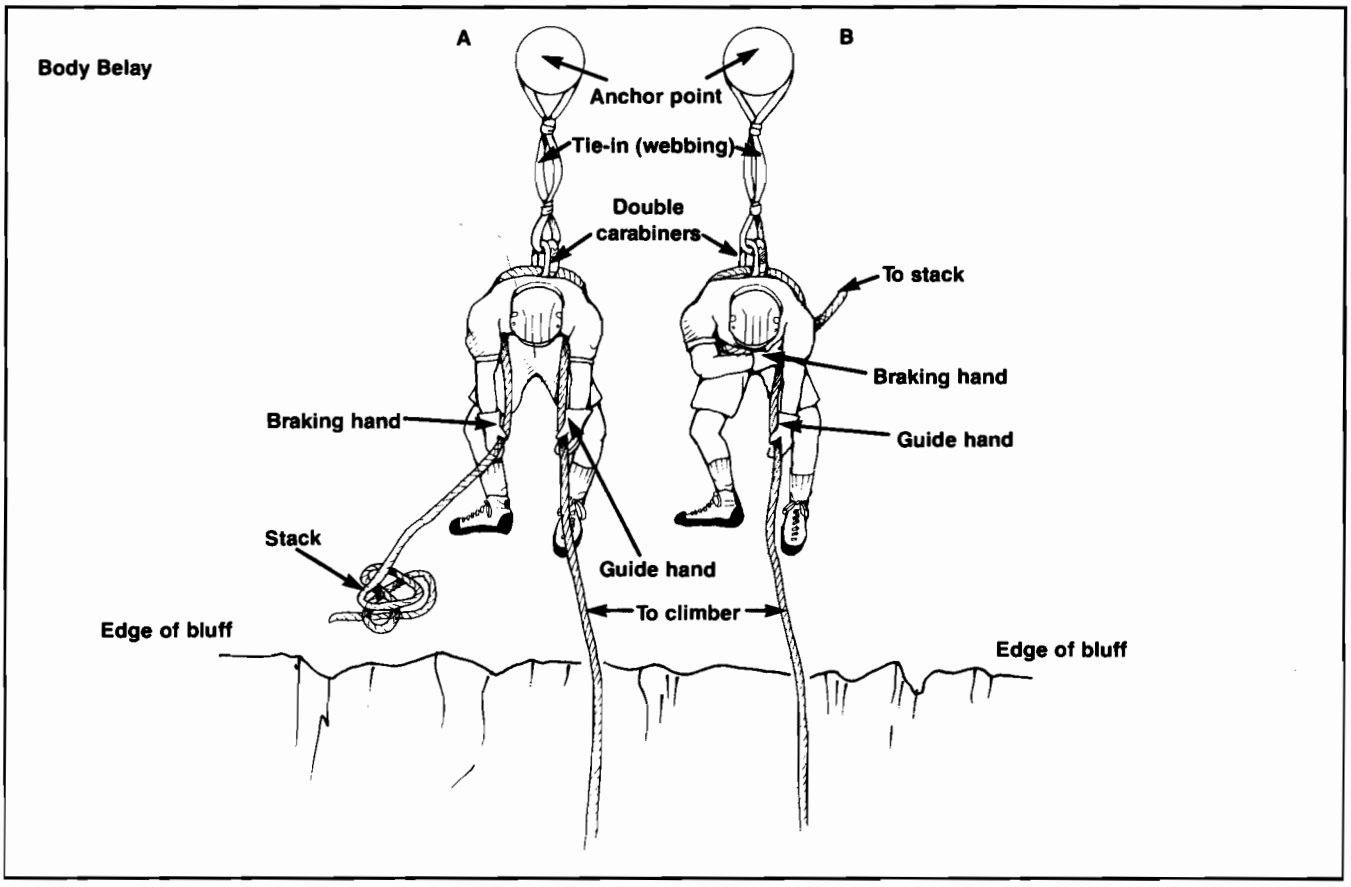
Note: With a left-handed the belayer, the belaying technique is reversed, and the left hand becomes the braking hand.

The Body Belay

Rather than using the belayer's right leg to lock off a climber's fall, which is also an acceptable belay technique, the belayer brings the braking hand (rope) across his or her midsection (see figure B) in order to lock off a climber's fall.

Note: This belaying technique can be used in both the sitting-hip belay and standing belay methods.

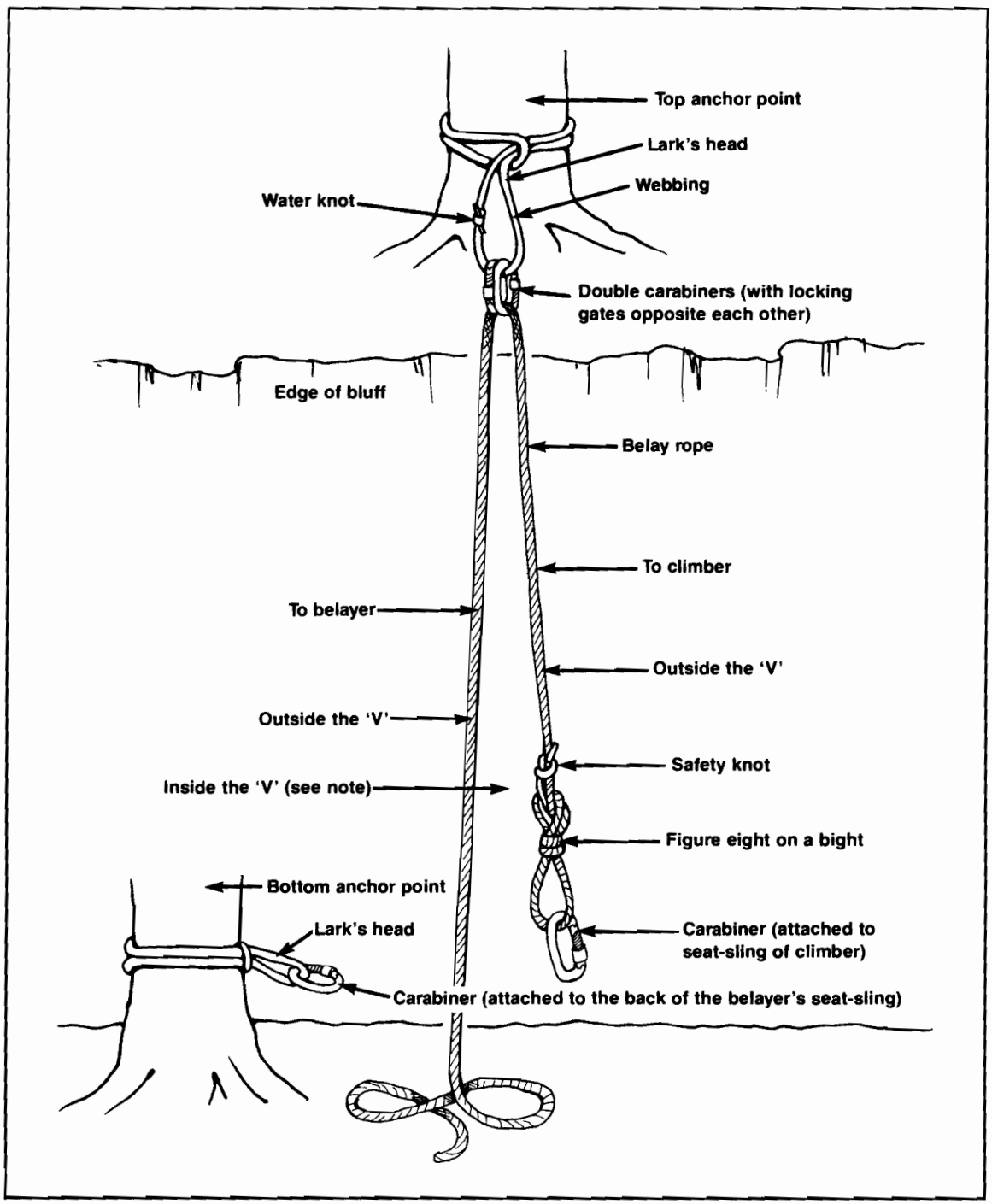

Leg Belay
A
B
Anchor point
Tie-in (webbing)
Carabiners
Braking hand
Guide hand
Braking hand
Guide hand
Stack
Stack
Edge of bluff
Edge of bluff
To climber


Body Belay
A
B
Anchor point
Tie-in (webbing)
Double carabiners
To stack
Braking hand
Braking hand
Guide hand
Stack
Guide hand
To climber
Edge of bluff
Edge of bluff

Bottom Belay System/Running Ground Belay

Note: The lark's head and carabiners, connected to the top anchor, should lie fairly close to the cliff's edge but *not hang over the edge.* This allows the climber to be on belay all the way to the top and over the edge of the bluff.

Note: The belayer should always be positioned inside the 'V.'



Top Anchor Belay System Using Boulders

Boulders should weigh approximately 2,000 pounds.

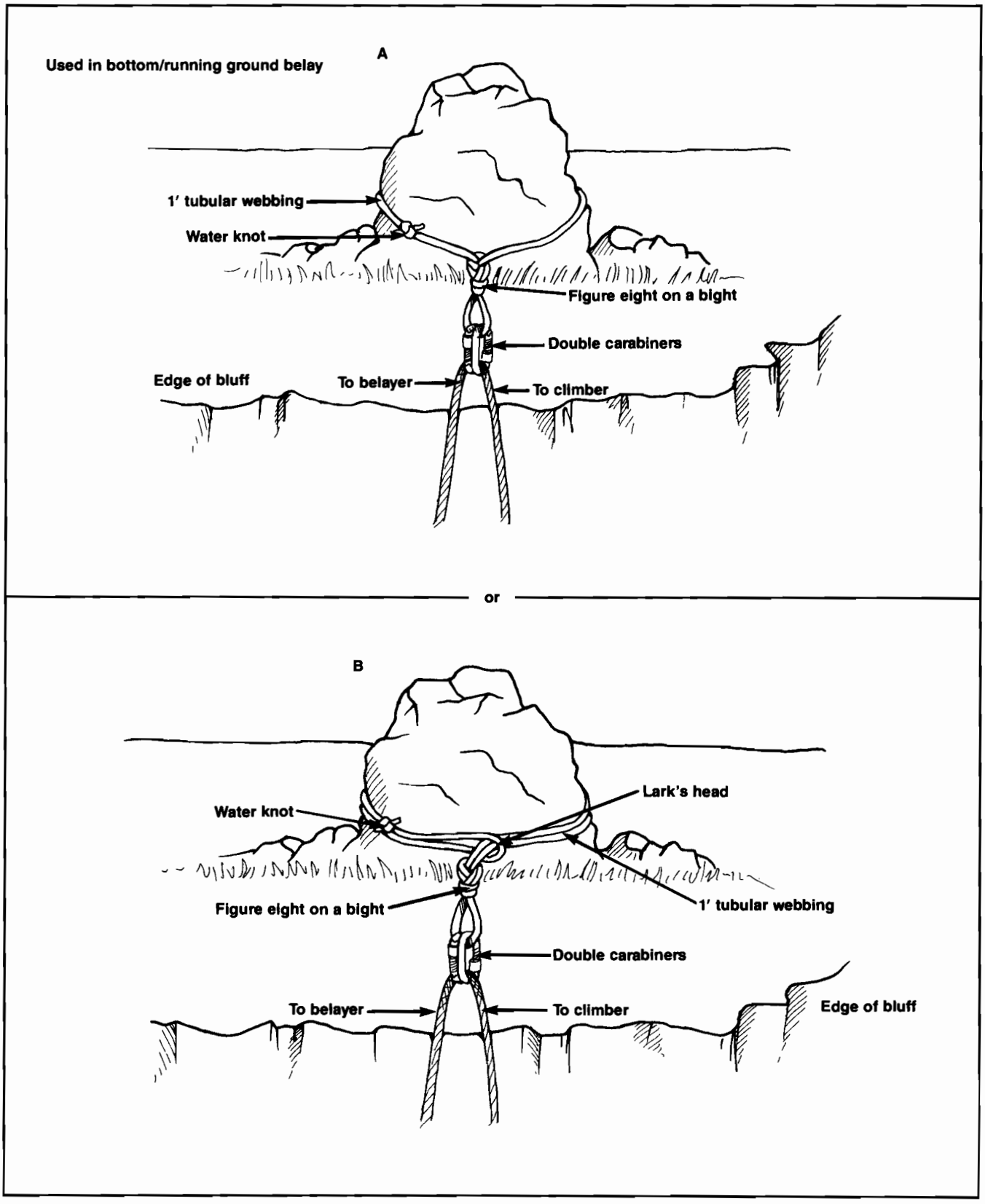
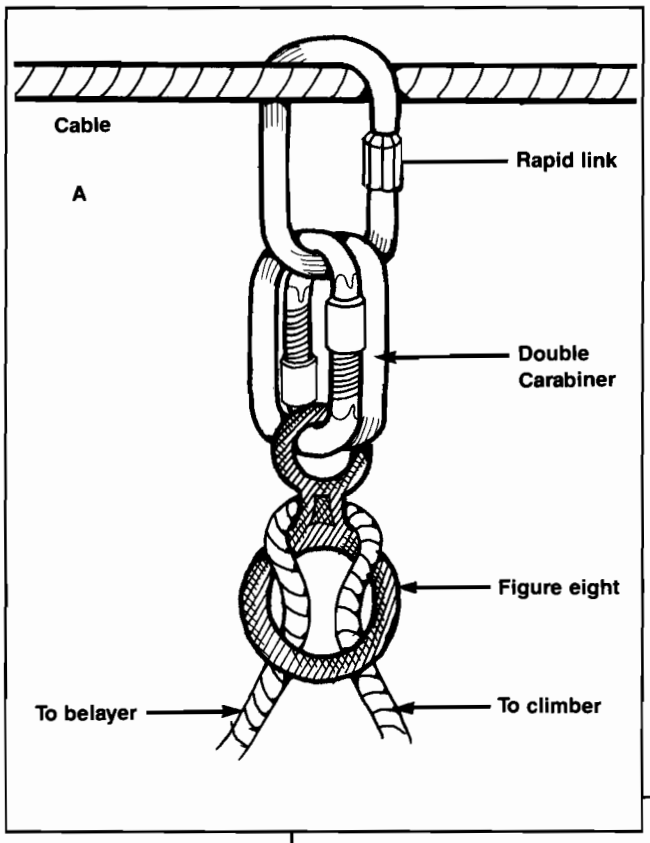
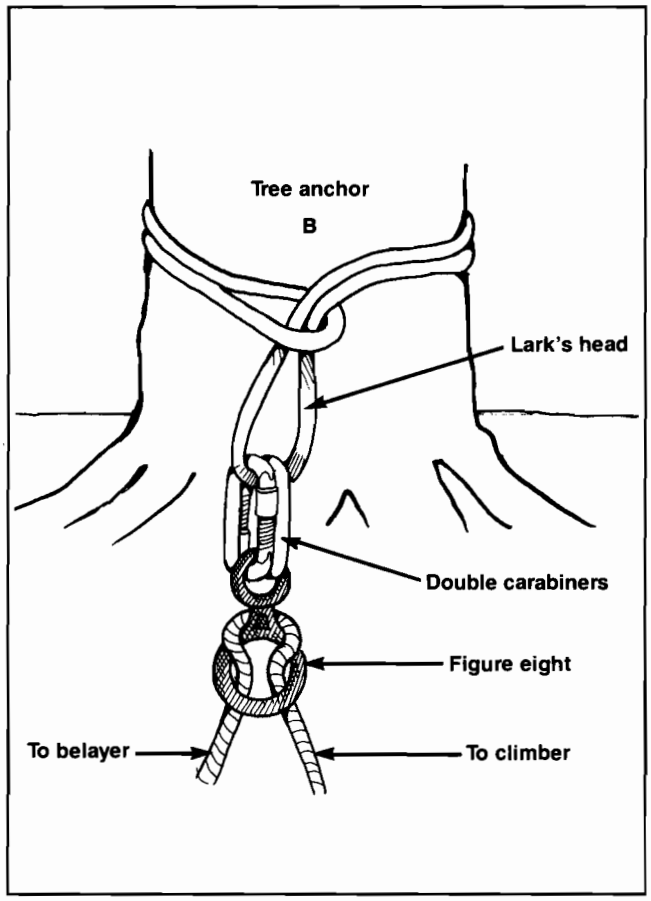


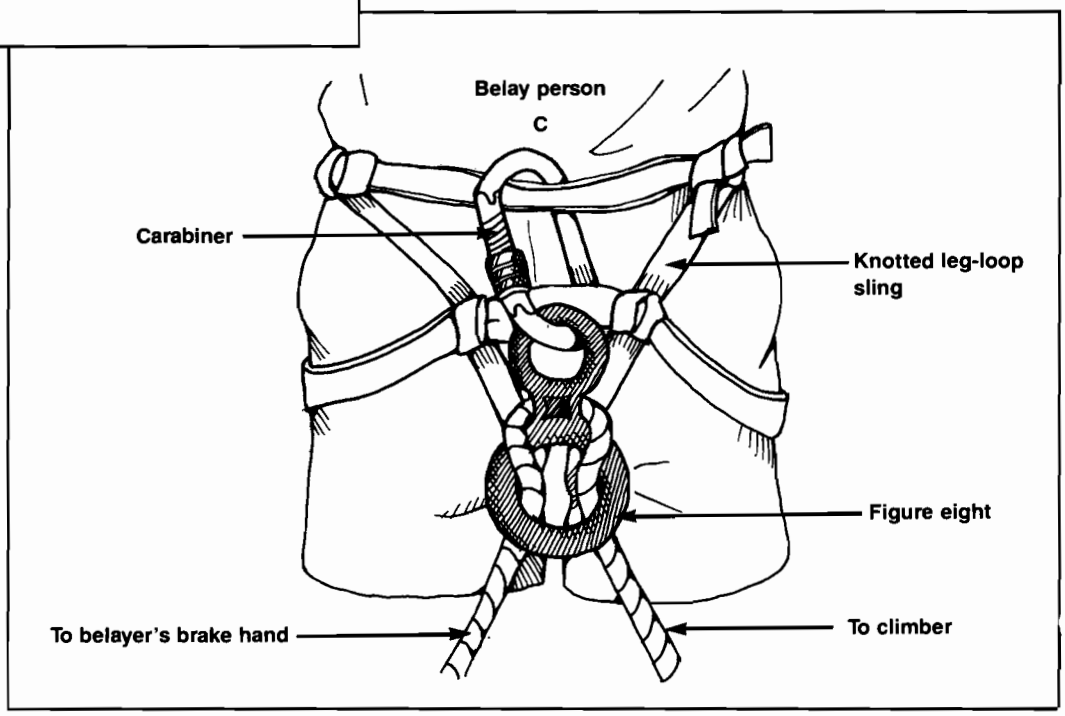
Figure-Eight Belay

This belaying setup is used mostly on a running-ground belay system and creates much more drag than the carabiner-type setup. It is often used in belaying heavier people, which lessens the load on the belayer. This comes in handy when the climber is much heavier than the belayer.



Note: One drawback in using this belay technique with Goldline rope is that it has a tendency to kink and twist the rope with each belay.





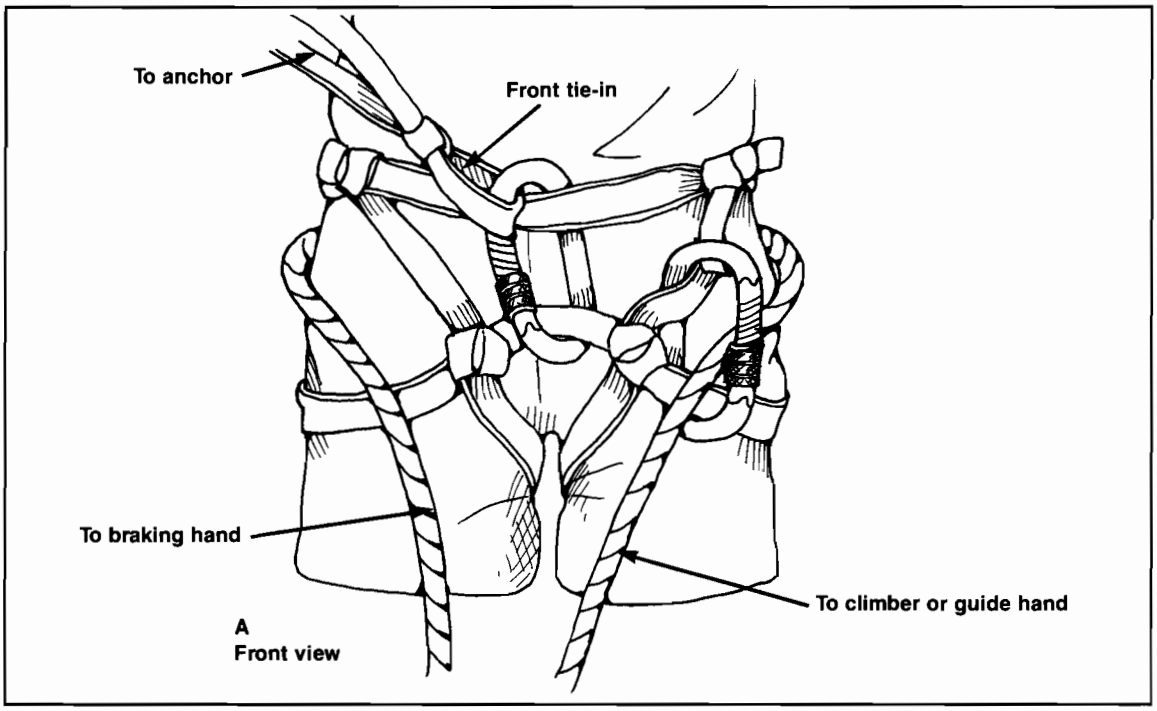
APPENDIX J — ELEMENTS OF CLIMBING AND BELAYING A CLIMB

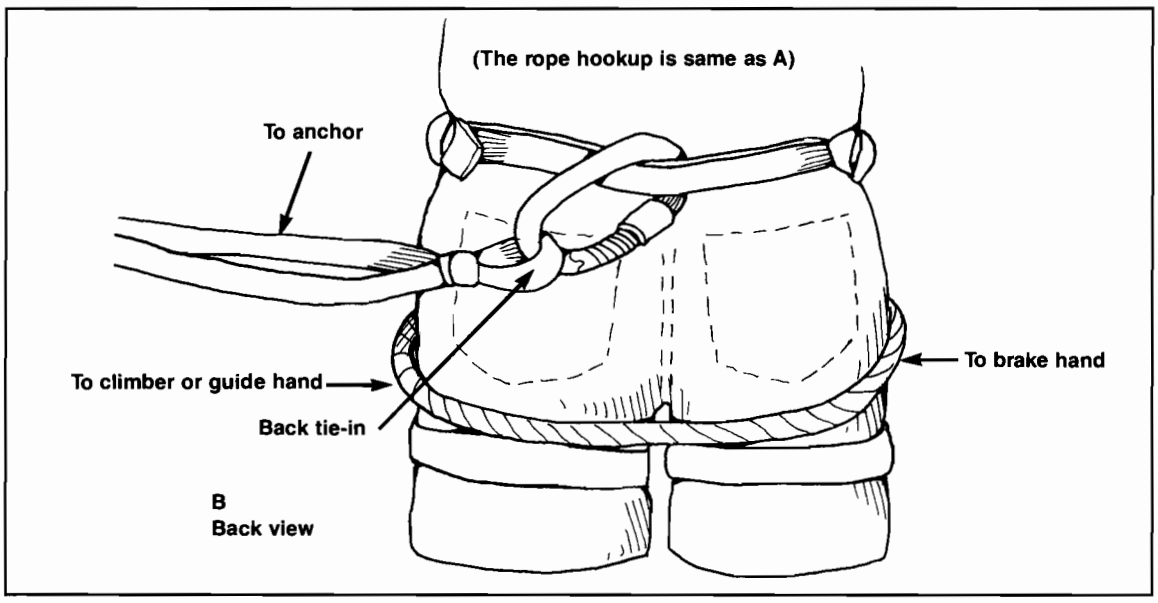
1. Tie the climber directly into the belay rope with a bowline on a coil around either the waist or the upper chest, according to the facilitator's preference.

   or

   Clip the climber on the belay rope with a locking carabiner to a climbing seat-sling by using a figure eight on a bight clipped into the carabiner.
2. There should be *one* belayer per climb on top of the cliff and *one* person at the base of the cliff to check tie-ins or clip-ins to belay rope and to guide the climb in progress. This position at the bottom should never be oversimplified. It is a key position in keeping the operation running smoothly and quickly. It is also a tremendously important position for all-around safety, such as keeping students a safe distance away from the danger of falling rock.
3. The belay rope should be as near as possible over the route of the climb in order to prevent pendulum swings in falls.
4. As always, the belayer should be as close as possible to the belay anchor and should be wearing gloves. The belayer should always position himself or herself inside the belay system's 'V.'
5. The belayer should be familiar with the climb he or she is belaying and know what to expect. It also helps to know the skill and experience levels of the climber.
6. It is the belayer's responsibility to know where the climber is and the relation of the rope to the climber's position.
7. The belayer has the additional responsibility of keeping members of the group a safe distance from the cliff's edge.
8. The climber should keep his or her weight directly over feet.
9. The climber should plan the route. Climb with your eyes.
10. The climber should save his or her arms by using the legs and should stay off of knees.
11. The climber should rest, relax, look around, make a plan, and try it.
12. Once the climber has reached the top, he or she should stay on belay and not untie until in a safe area.

APPENDIX K—HOOKUP AND TIE-IN FOR THE BELAYER





The type of belay system used or its setup

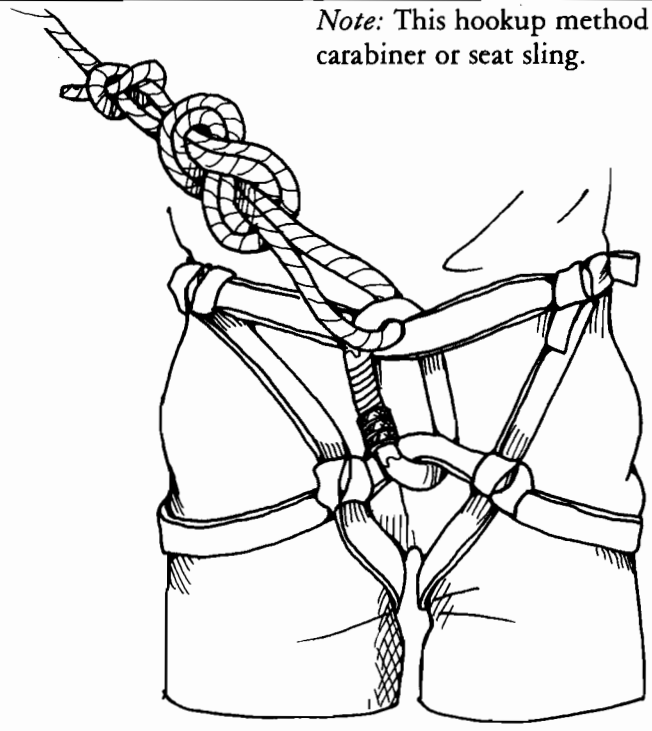
Note: A front tie-in or back tie-in is used according to the following:

A. The belaying situation (rock climbing or rappelling)

B. Position of the belayer at the climb or rappel sight

APPENDIX L—HOOKUP FOR THE CLIMBER

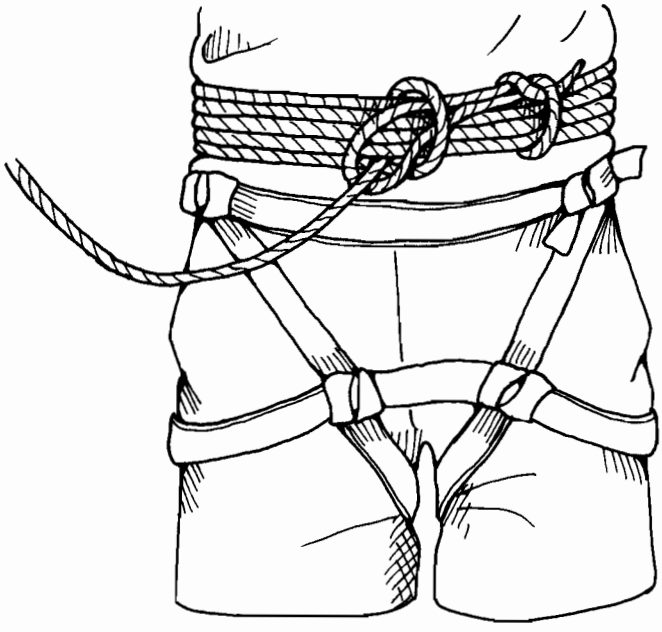
Note: This hookup method requires no carabiner or seat sling.



A

Figure eight on a bight clipped into climber's carabiner

or



B

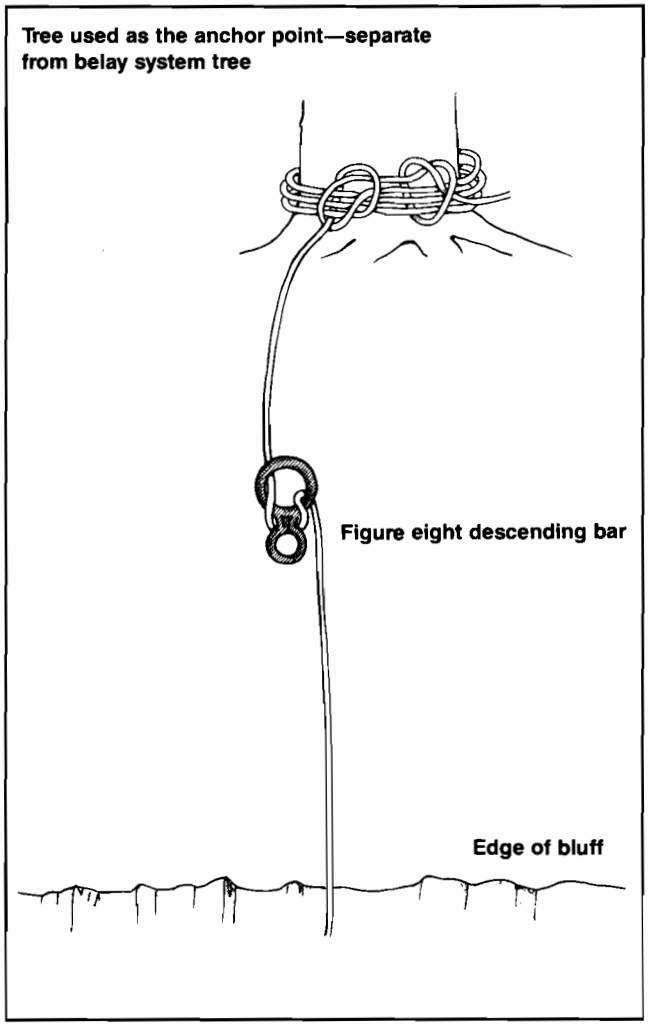
Bowline on a coil around climber's waist

APPENDIX M—TOP ANCHOR RAPPEL SYSTEM

Knot used: Bowline on a coil, backed up with an overhand knot (safety knot)

Note: The coil-wrap/tensionless rigging method can also be used as a top anchor rappel system.

Make a bight in the rope. Feed the bight through the back of the large opening of the figure eight descending bar and down over the small portion of the figure eight descending bar. The rope should be hanging from the right side of the descending bar if the rappeller is right-handed or from the left side of the descending bar if the rappeller is left-handed. This illustration shows the rope hanging from the right side of the descending bar. From this point, the rappeller should fasten the smaller opening of the descending bar to the carabiner (in front) that is attached to the seat-sling and lock the safety gate on the carabiner.

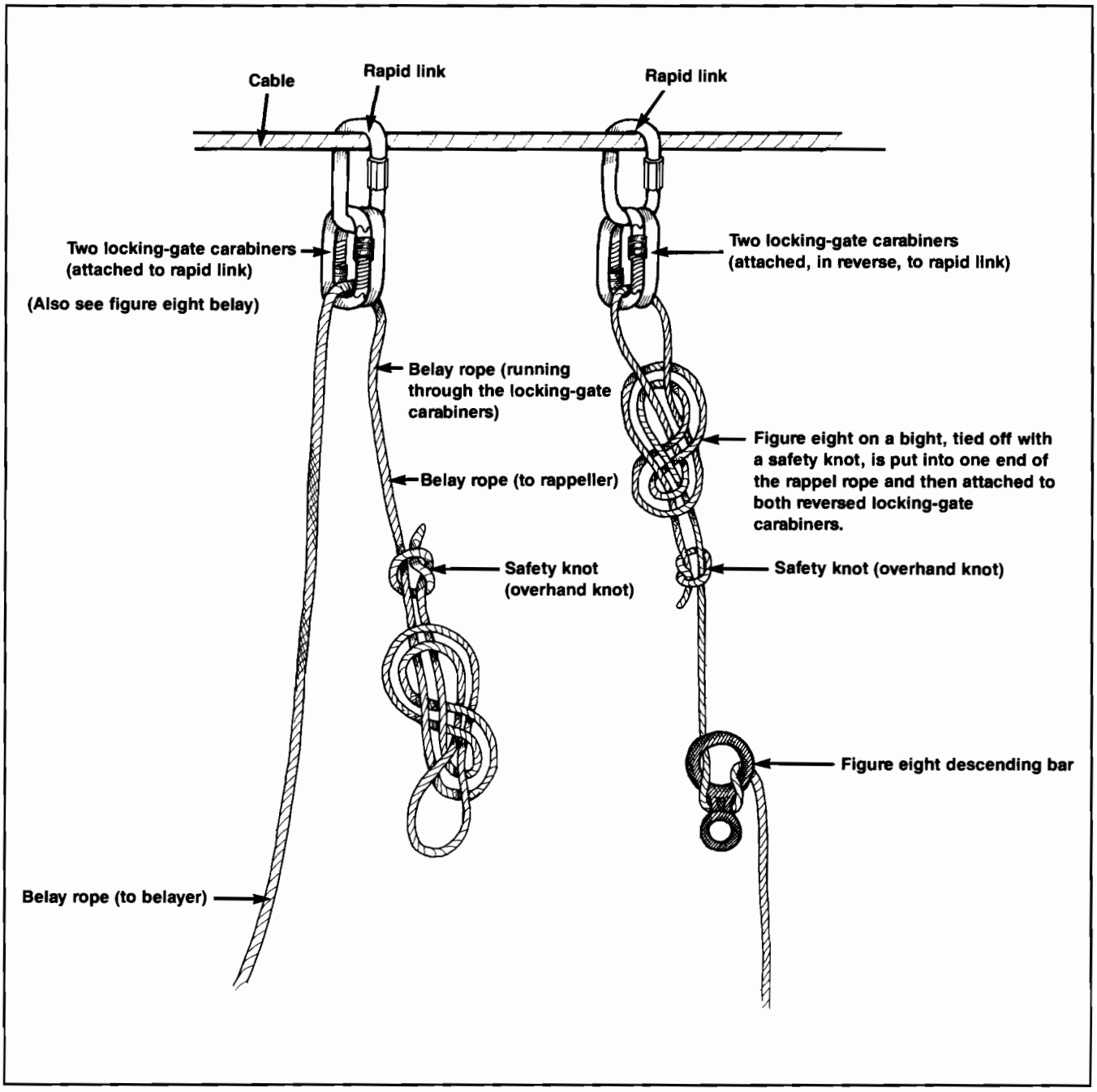


Techniques Used in Setting Up the Top Anchor Rappel System

1. Use the bowline on a coil or coil wrap to anchor the rappel rope.
2. The anchor should be independent of the belay rope anchor.
3. The anchor should be in direct line with the rappel sight.
4. If at all possible, the rappel rope should be protected from sharp cliff edges by canvas.
5. The rappel rope should be perpendicular to the cliff's edge.
6. Be sure that the rappel rope is free of obstacles from top to bottom, such as trees, brush, rocks, and so on.
7. The belayer should be tied in and the rappeller on belay as soon as possible in the rappelling operations. This allows the rappeller to be on belay while being hooked in and the belayer to focus total attention on belaying. *Never* expose an unbelayed, unhooked rappeller to a dangerous position. Be sure the rappeller is tied in before getting too near the cliff's edge.
8. Long hair, jewelry, loose webbing, loose clothes, and so on must be secured to prevent their being caught in rappelling hardware such as the figure eight descender.
9. Sharp objects (pencils, combs, etc.) on the rappeller can be dangerous and should not be carried.
10. Gloves are a must to prevent rope burns, especially on the hand with which the rappeller brakes.
11. Helmets are a must for the rappeller and the person working at the bottom.
12. Additional staff, independent of the belayer, are needed for hooking people in for the rappel and unhooking the student at the bottom of the cliff. This position at the bottom should never be underestimated. It is a key position in keeping the operation running smoothly and quickly.
13. The belay rope should be at a slight angle from the rappel rope to prevent the two ropes from becoming tangled or rubbing together.
14. See also Appendix O, "Elements of Rappelling and Belaying a Rappel."

APPENDIX N — BELAY AND RAPPEL SYSTEM FROM CABLES

This diagram is set up for a right-handed rappel.



APPENDIX O — ELEMENTS OF RAPPELLING AND BELAYING A RAPPEL

1. Tie the rappeller directly into the belay rope with a bowline on a coil around the waist or the upper chest, according to the facilitator's preference.

   or

   Clip the rappeller on the belay rope with a locking carabiner attached to the left-front side of his or her seat-sling by using a figure eight on a bight clipped into the carabiner.
2. The belayer should be familiar with the rappel he or she is belaying and know what to expect. It also helps to know the skill and experience level of the rappeller.
3. It is the belayer's responsibility to know where the rappeller is and the relation of the rope to the rappeller's position.
4. The belayer has the additional responsibility of keeping members of the group a safe distance from the cliff's edge.
5. The belay rope should be at a slight angle from the rappel rope to prevent the two ropes from becoming tangled. The belayer should be positioned inside the belay system's 'V.'
6. After the rappeller has hooked into the belay rope, hooked into the rappel rope, and given the proper commands to the belayer, the rappeller should:
   A. Back to the cliff.
   B. Position the feet shoulder-width apart.
   C. Lean back.
   D. Take small steps.
   E. Keep legs straight and sit as if in a chair.
   F. Lean heavily back on the rappel rope, keeping the rope in the right hand under the right cheek of the rear at all times.
   G. Rappel slowly.
7. After the rappeller completes the rappel, he or she should give the belayer the proper commands, unhook from the belay rope and rappel rope, and carry all rappelling hardware back up to the next rappeller. Do not send the hardware back up on a rope.
8. See also "Techniques Used in Setting Up the Top Anchor Rappel System" in Appendix M.

APPENDIX P—CALL SYSTEM USED IN ROPED CLIMBING

Belay off: A call given by the belayer to the climber acknowledging the climber's command, "Off belay." At this time, the belayer will release the belay rope and step away from it. This call is telling the climber that the belayer is no longer on the belay rope.

Belay on: An information call given by the climber. The call means that the climber is hooked onto the belay rope and is making the belayer aware of this.

Climb: A call given by the belayer to notify the climber that he or she may start climbing. The call requires no answer, and the actual climbing begins following this call.

Climbing: A call given by the climber to notify the belayer that the climber is starting to climb. The climber should not start climbing until the belayer answers back with the command, "Climb."

Falling: A warning call given by the climber to notify the belayer that the climber is falling or that a fall is imminent. The call is given because, in many circumstances, the belayer cannot feel the fall. The call requires no answer, only a safe belay catch. (The exact wording may vary, depending upon the climber's mental attitude at the time.)

Off belay: A call given by the climber to notify the belayer that the climb has been completed and that the climber is on safe ground and no longer needs the assistance of the belayer or the belay system.

On belay: An information call given by the belayer. The call means the belayer is ready and able to provide a safe belay for the climber. The call requires no answer.

Rappel: A call given to the rappeller from the belayer, informing the rappeller that he or she is ready to belay the rappeller during the rappel. In other words, the belayer is giving the rappeller the go-ahead to rappel.

Rappelling: A call given to the belayer from the rappeller that he or she is starting the rappel. Very similar to "Ready to rappel."

Ready: The first call sometimes given by the climber to the belayer when the climber is ready to start climbing. If the climber does not receive an answer from the belayer, it may be because the belayer is not ready or has not heard the climber. The climber should not start to climb until the belayer answers.

Ready to climb: This command is often used instead of "Ready." Both commands have the same meaning.

Ready to rappel: Usually a first call given to the belayer by the rappeller, informing the belayer that the rappeller is hooked up to the belay rope and the rappel rope and is now ready to rappel.

Rock: A warning call given by anyone—climber, belayer, or bystander. The call means that something (rock, log, piton, etc.) is falling and that people below are possibly in danger of being hit.

Slack: A call given by the climber to notify the belayer to let out rope. Slack may be required to make a traverse, negotiate a tricky move, or untangle the belay rope. The call requires no answer, only action on the part of the belayer. (Only a small amount of rope should be let out at one time.)

Tension: A call given by the climber to notify the belayer to take up as much of the belay rope as his or her strength will allow. This may be required for a rest stop, for a tricky move, or simply for the climber's confidence. The call requires no answer, only action on the part of the belayer.

Test: A call given by the belayer in answer to the call, "Testing." This call means that the belayer is ready for an actual belay system test. The call requires no answer, and after hearing this call, the climber conducts the test of the belay system.

Testing: A call given by the climber to inform the belayer that the climber desires to test the belay system. This call requires an answer before any action can be initiated.

That's me: A call given to the belayer from the climber to inform the belayer that all slack has been taken out of the belay rope and that the belayer is now tugging at the climber.

Up rope or **take up slack:** A call given by the climber to notify the belayer to take up the rope. It is important to the climber that no slack develop in the belay rope. The call requires no answer, only action on the part of the belayer.

APPENDIX Q—CALL SYSTEM, IN SEQUENCE, FOR RAPPELLING

1. Rappeller—*"Ready to rappel" or "Belay on"*
2. Belayer—*"On belay"*
3. Rappeller—*"Rappelling"*
4. Belayer—*"Rappel"*
5. Rappeller—*"Off belay"*
6. Belayer—*"Belay off"*

APPENDIX R—CALL SYSTEM, IN SEQUENCE, FOR ROCK CLIMBING

1. Climber—*"Up rope"*
2. Climber—*"That's me"*
3. Belayer—*"On belay"*
4. Climber—*"Climbing"*
5. Belayer—*"Climb"*
6. Climber—*"Off belay"*
7. Belayer—*"Belay off"*

APPENDIX S—CALL SYSTEM FOR ROCK CLIMBING AND RAPPELLING

Camp Pa-He-Tsi uses this call system for both rappelling and rock climbing to simplify matters and lessen confusion.

1. Belayer—*"On belay"*
2. Climber or rappeller—*"Climbing"*
3. Belayer—*"Climb"*
4. Climber or rappeller—*"Off belay"*
5. Belayer—*"Thank you"*

APPENDIX T—EMERGENCY RESCUE SITUATIONS AND SOLUTIONS

1. At times during a rappel, an emergency situation may arise that prevents the rappeller from continuing down the rappel rope. Some possible causes could be:
   A. Hair, clothing, and so on caught in the figure eight descending bar.
   B. Rope tangled in the figure eight descending bar.
   C. Rope tangled directly below the rappeller.
   D. Any other problem that prevents the rappeller from continuing down the rappel rope.
2. In case of an emergency rescue situation involving a rappeller, there are usually certain rescue sequences that should be followed.
   A. *Verbally* aid the rappeller to solve the problem unaided, for example:
      1. Have the rappeller untangle the rope, etc., by pulling up enough on the belay rope so that slack will appear in the rappel rope.
      2. Have the rappeller climb back up.
   B. Have the instructor or facilitator go down on the extra rope that should be set up at every site to assist the person in trouble.
   C. *Directly* aid the rappeller by cutting the rappel rope at the anchor point and lowering the rappeller down with the belay rope. *This is done only as a last resort.* (This is why it is important to have a knife or scissors at every rappel site.)
      1. Inform the rappeller of what you are going to do and of what he or she should expect and do.
      2. Aid the belayer by having one or more people slow the feeding of rope into the belayer's brake hand.
      3. Cut the rappel rope at the point of anchor.
      4. Slowly lower the rappeller to the ground.
3. There are additional safety considerations, such as:
   A. There is no reason for a rescuer to be in a dangerous, unbelayed position.
   B. The importance of a safely accessible belay position is apparent during a rescue. Without a safe way to the belayer, aid can be very difficult.
4. *Prevention* is the key to a successful rappel, so check all clothing, hair, ropes, hookups, and so on before the rappel begins.

APPENDIX U — CUTTING AND COLOR-CODING YOUR ROPE

1. Measure out the length of rope desired from the spool, and mark where the rope is to be cut. The rope should be measured to a length approximately 5 percent longer than needed to allow for shrinkage.
2. Tape the end of the rope to be cut on both sides of the mark before cutting to prevent unravelling.
3. Melt both ends with a lighter or candle to prevent unravelling.
4. Select a color to identify rope lengths and recorded use. Apply paint by dipping rope ends into the paint. Do this to both rope ends.
   A. Scale: 1 inch of paint to 25 feet of rope.

      Example: One inch of paint on the end of a rope would mean a rope length of 25 feet. Two inches of paint on the end of a rope would mean a rope length of 50 feet. Three inches of paint would mean a rope length of 75 feet. Four inches of paint would mean a rope length of 100 feet, and so on.

   B. Use acrylic or enamel paint.
5. If numerous ropes are used, you can use a two-color code system, which allows you to use a combination of colors when available colors are limited.
   A. In single-coloring, the length of the color indicates rope length and is also used for identification.
   B. In double-coloring, the first color represents the rope length. The second color is for rope identification. (This second color doesn't have to be any certain length and can be brushed on instead of dipped.)

      Example: If you have four 150-foot ropes and only two plain colors (red and blue), you can color one rope red, one rope blue, one rope blue/red, and one rope red/blue.
6. A black color code always means that the rope has been retired and is no longer in use except as lashing or slash rope.
   A. Retire a rope after 200 hours of hang-time (rule of thumb), or earlier if it shows signs of damage or wear.
   B. Retire a rope that has been struck by a large rock, used as a tow rope, or has had excessive stress placed on it.
7. The following information should be recorded on the form in each block beside the rope used.
   A. Date rope used
   B. Used by whom
   C. Purpose of use (ropes course, rock climbing, rappelling, belaying, etc.)
8. When all blocks are filled beside each rope, total up hang-time hours, transfer the total to another form, and continue the record.
9. After hours total 200 or rope is damaged, dip the ends in black paint, retire the rope, and cross it off the form as no longer in use.
10. In cutting webbing, use a candle or hot iron to melt the ends, which will prevent fraying. No color code is needed if you change webbing color each time you purchase some. In this way, you will know which webbing is the oldest by its color. Check webbing periodically for damage and/or wear, and retire it when necessary.

Appendix V—Amount of Force Generated by Free-falling Objects

Static Weight	5 ft.	10 ft.	15 ft.	20 ft.	25 ft.
100 lbs.	500	1,000	1,500	2,000	2,500
125 lbs.	625	1,250	1,875	2,500	3,125
150 lbs.	750	1,500	2,250	3,000	3,750
175 lbs.	875	1,750	2,625	3,500	4,375
200 lbs.	1,000	2,000	3,000	4,000	5,000

The IUAA (International Union of Alpinists Association) requires Kernmantle ropes to withstand an impact of 2,650 pounds to meet its standards. Practically new Goldline has an approximate braking strength of 5,500 pounds, while Perlon (a Kernmantle rope) has a braking strength of about 6,100 pounds. Wear and knots can seriously reduce these figures, however.

APPENDIX W—PRACTICE TOWER FOR CLIMBING AND RAPPELLING

THIS FACILITY PROVIDES AN EXCELLENT OPPORTUNITY FOR THE NOVICE TO BECOME INITIATED TO THE SKILLS OF CLIMBING AND RAPPELLING. AFTER MASTERING THE CHALLENGES OF ALL FOUR SIDES, THE LEARNER CAN THEN PERFECT THE FOUR-SIDE TRAVERSE WHICH WILL INTRODUCE HIM TO THE ADVANCED TECHNIQUES NEEDED TO DEVELOP HIS SKILLS IN CLIMBING.

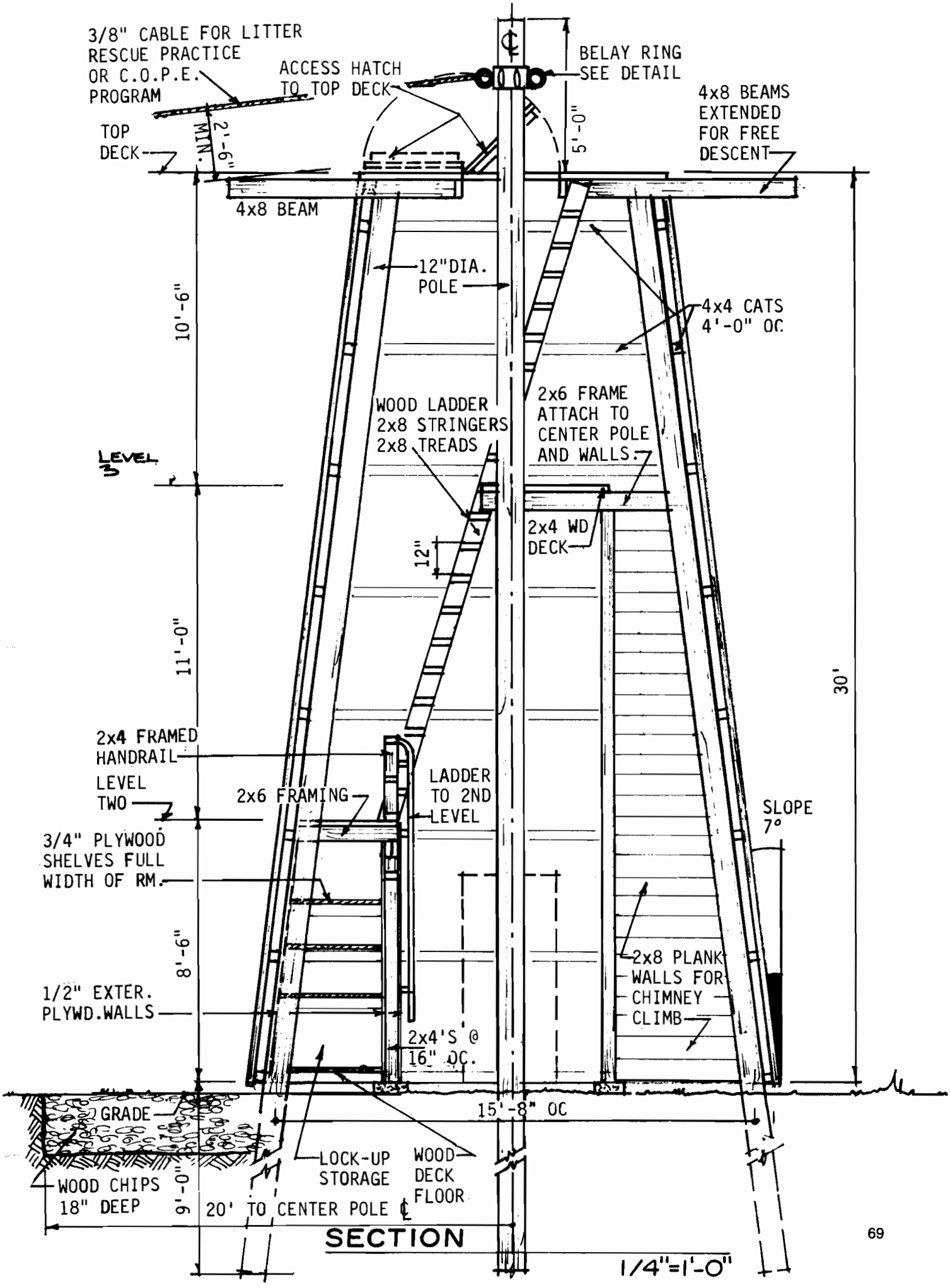
IN ADDITION, THE TOWER OFFERS THE OPPORTUNITY FOR EXPERIENCED CLIMBERS TO PERFECT THEIR TECHNIQUES IN PUSH AND PULL HOLDING, FRICTION HOLDS, LIEBACKS AND WEIGNT DISTRIBUTION, ALL OF WHICH ARE THE NECESSARY "WARM-UP" BEFORE MAKING A DIFFICULT ASCENT OR DESCENT ON THE ACTUAL CLIFF FACE.

E S S E N T I A L S A F E T Y R E Q U I R E M E N T S

NO PROGRAM ACTIVITY RELATED TO THE TOWER SHALL TAKE PLACE WITHOUT DIRECT SUPERVISION OF QUALIFIED INSTRUCTORS. OPERATIONAL PROCEDURE MUST INCLUDE AN INSTRUCTOR AND A BELAYER ON THE TOP, AND AN INSTRUCTOR AT THE BASE OF THE TOWER, WHO WILL COORDINATE CLIMBING AND RAPPELLING BY PARTICIPANTS.

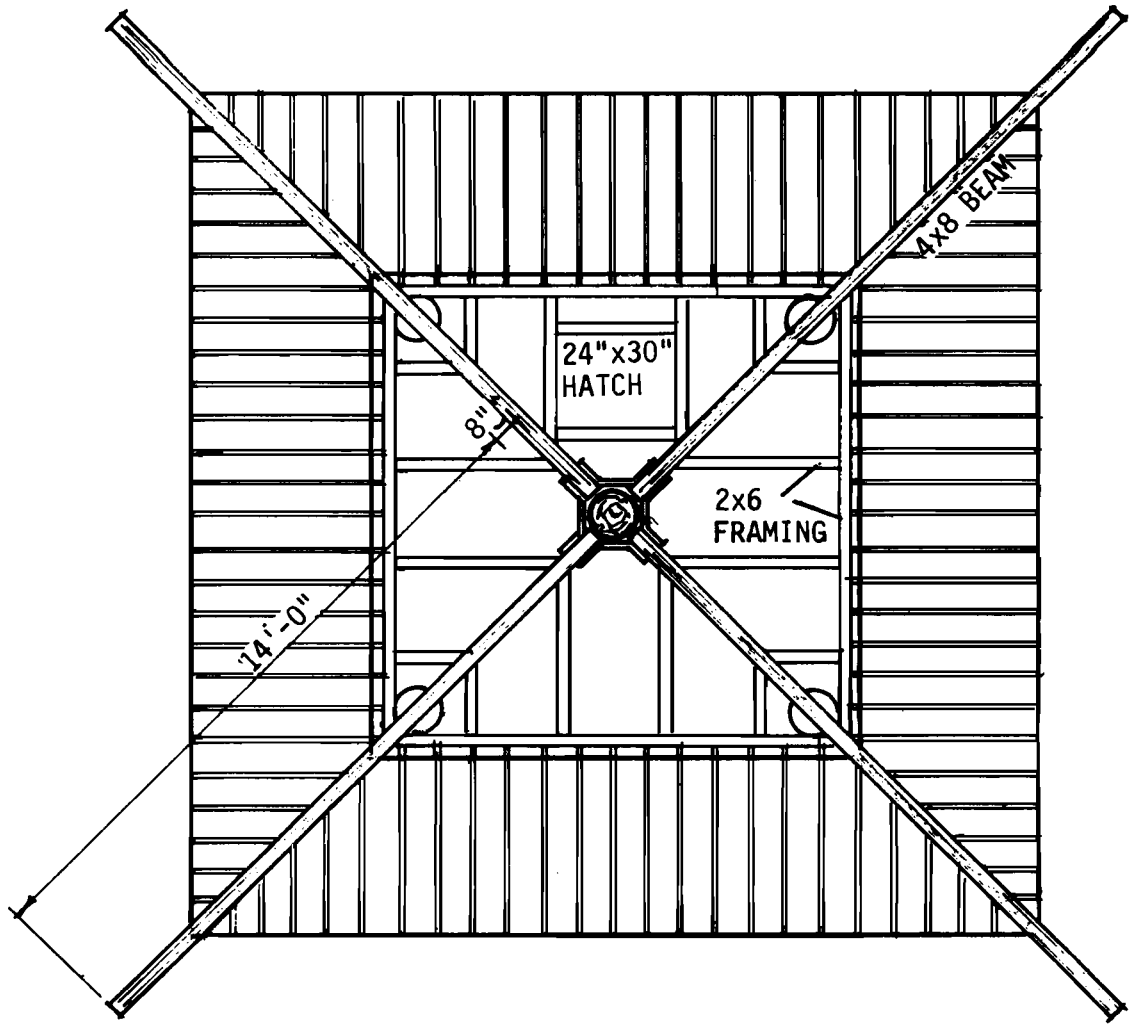
TOWER SECURITY CONTROL MAY BE IMPLEMENTED BY INSTALLING AN 8' HIGH FENCE SURROUNDING THE STRUCTURE WITH A SECURED GATE AND NOTICES STATING "OFF LIMITS EXCEPT DURING TRAINING SESSIONS" POSTED ON ALL SIDES OF THE TOWER AT VISIBLE LOCATIONS NOT INTERFERING WITH TRAINING FUNCTIONS.

CLIMBING AND RAPPELLING ACTIVITY SHALL BE LIMITED TO ONE PARTICIPANT AT A TIME, IN THE INTEREST OF SAFETY AND EFFECTIVE INSTRUCTION.



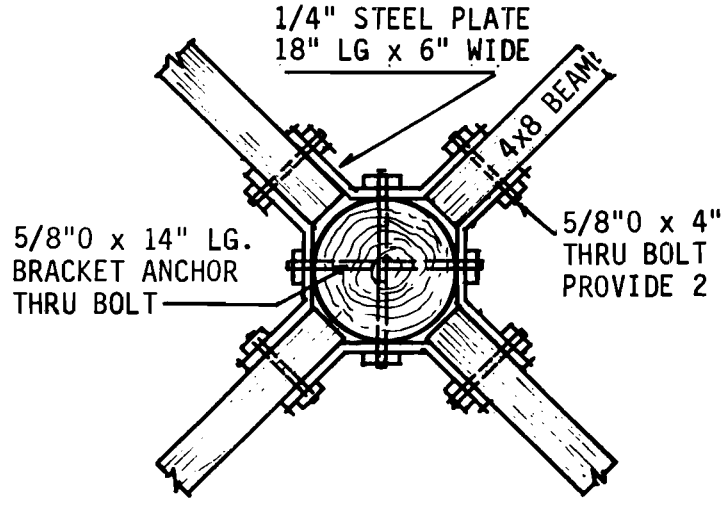
SECTION

1/4"=1'-0"



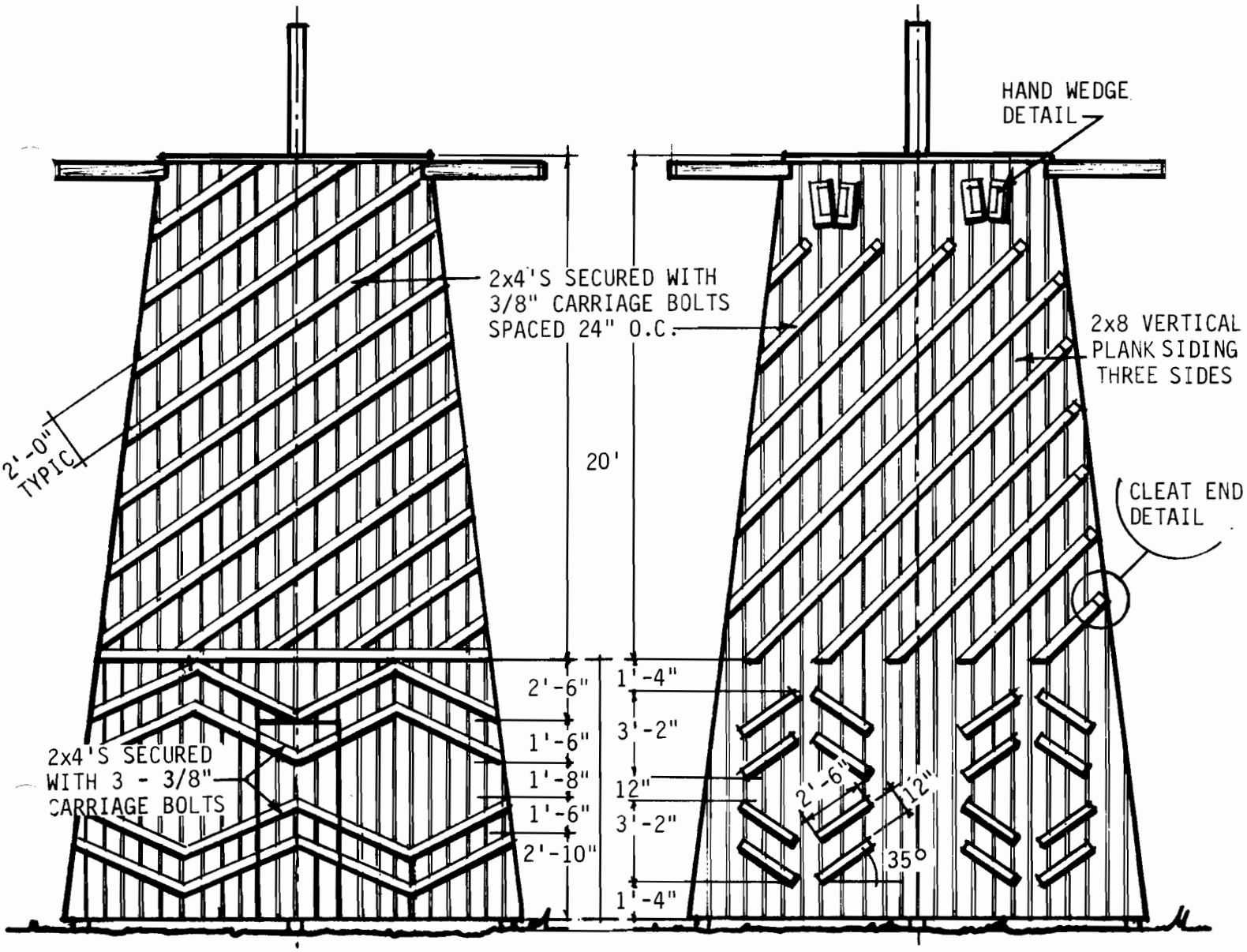
TOP DECK FRAMING PLAN

1/4"=1'-0"



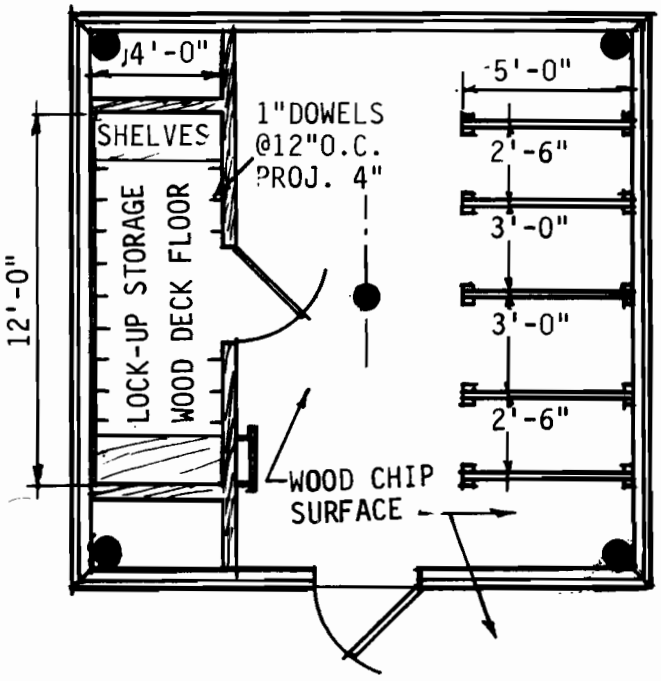
CENTER POLE ATTACHMENTS

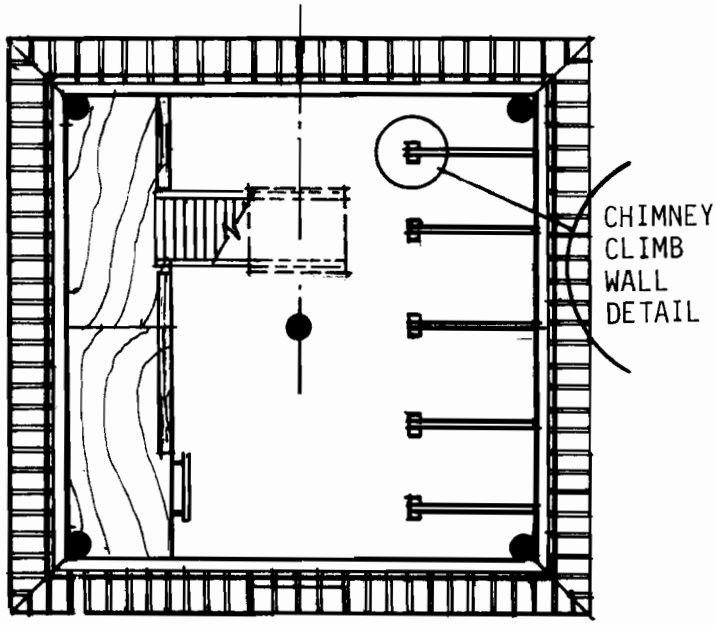
3/4"=1'-0"



SIDE ONE - BEGINNER

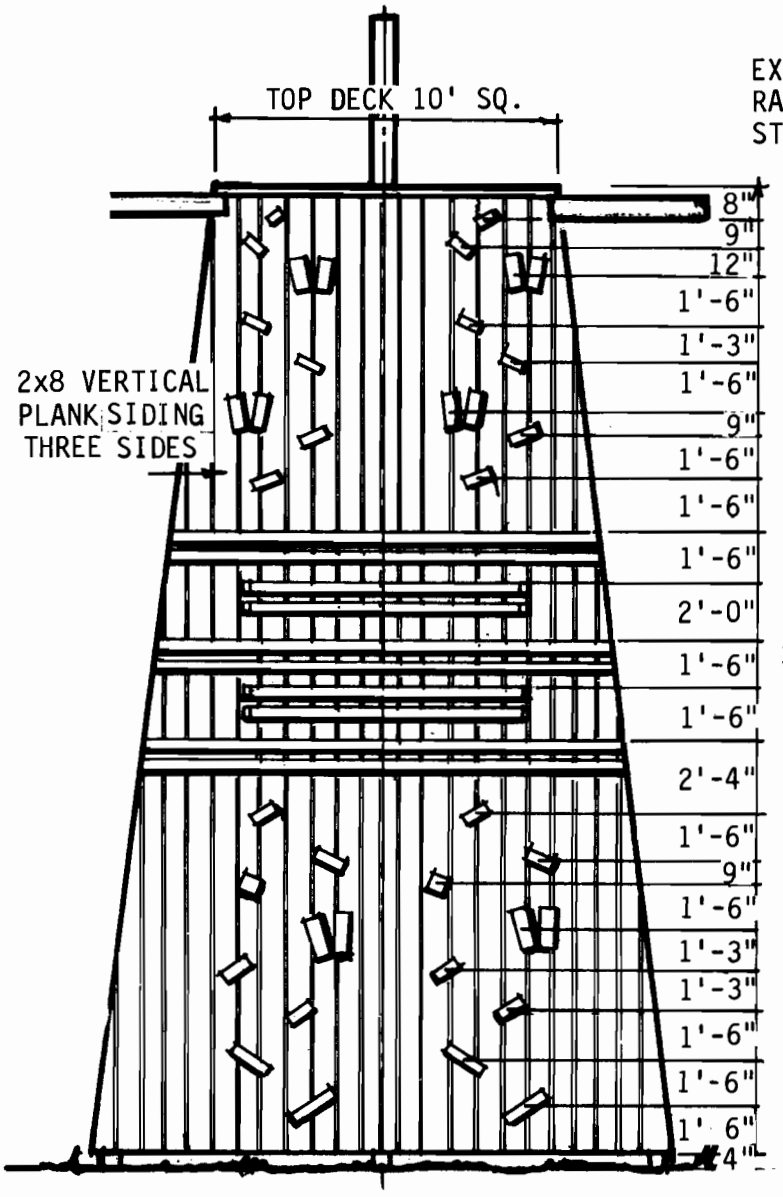
SIDE TWO - ADVANCED



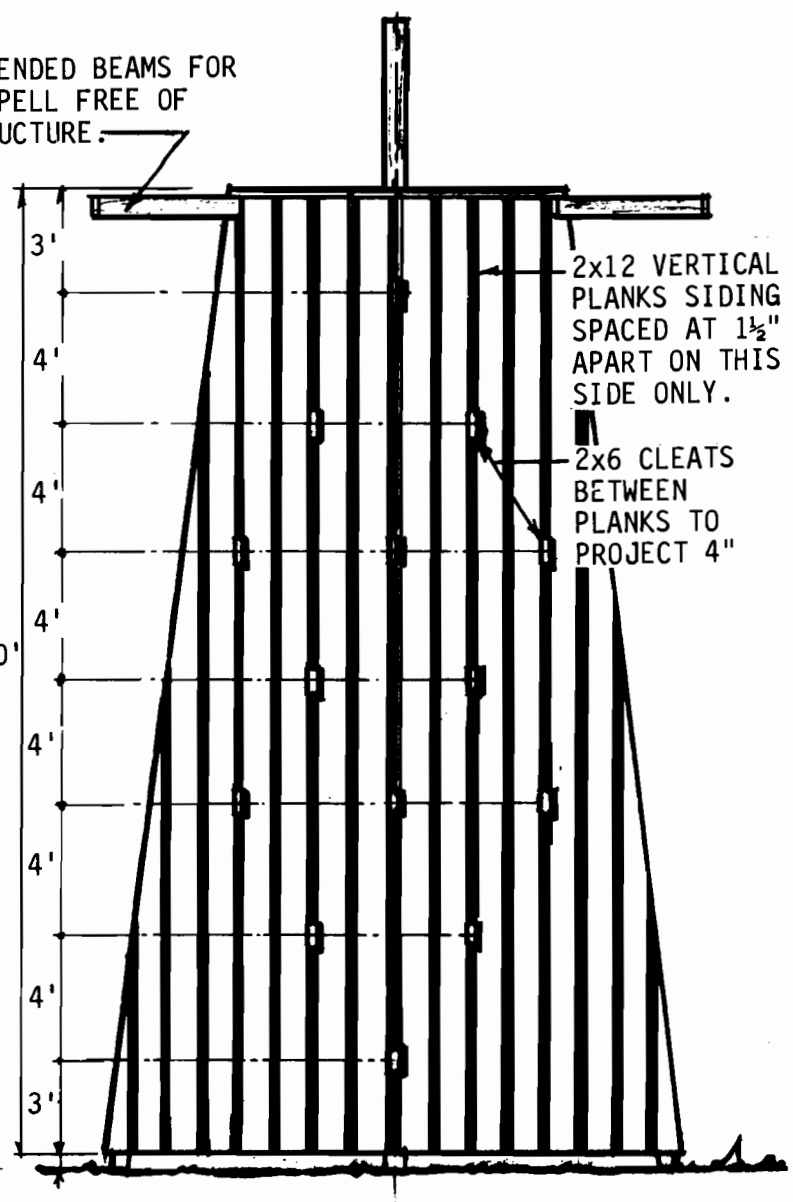


PLAN - BASE

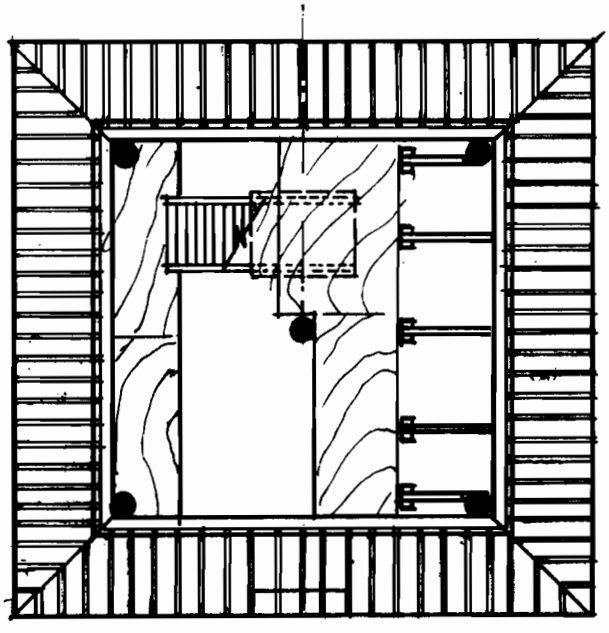
PLAN - LEVEL TWO



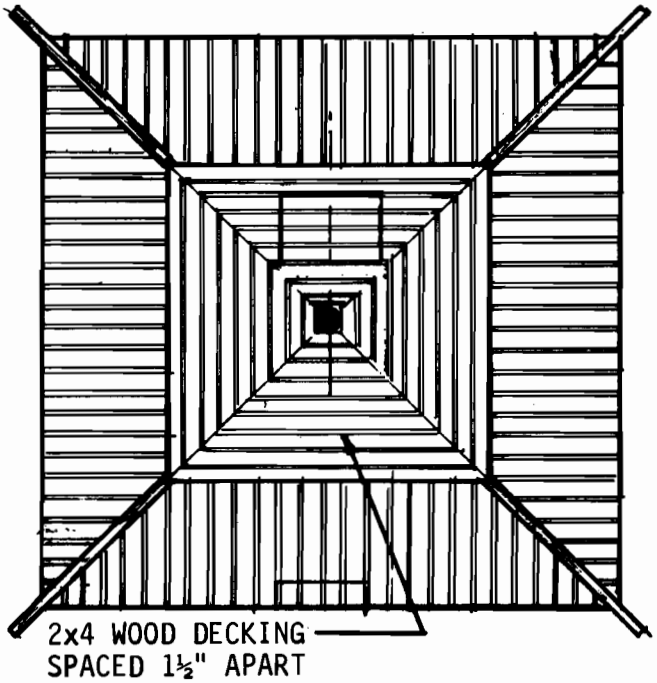
SIDE THREE - DIFFICULT



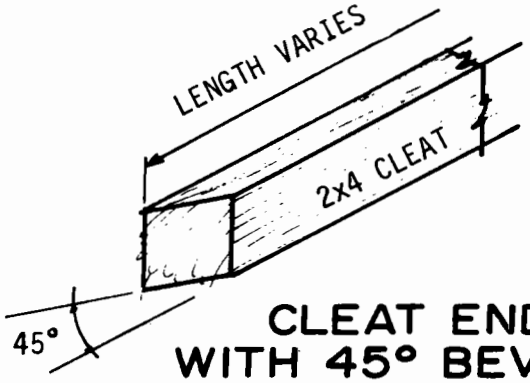
SIDE FOUR- EXPERIENCED



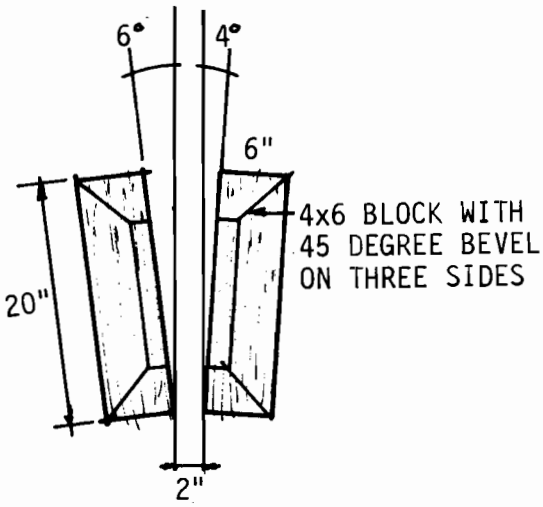
PLAN - LEVEL THREE



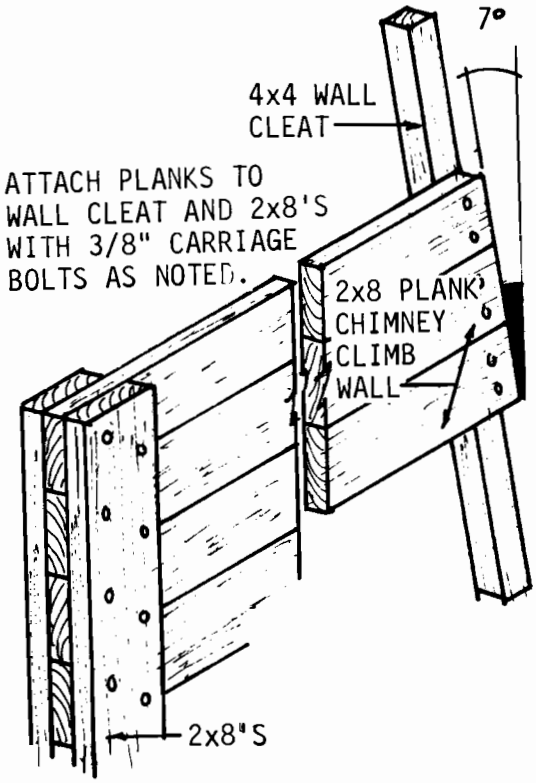
PLAN - TOP DECK



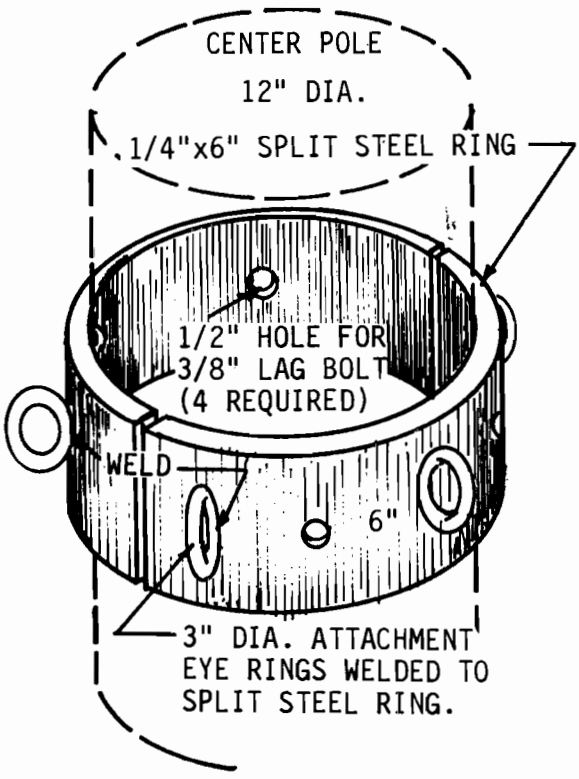
CLEAT END WITH 45° BEVEL



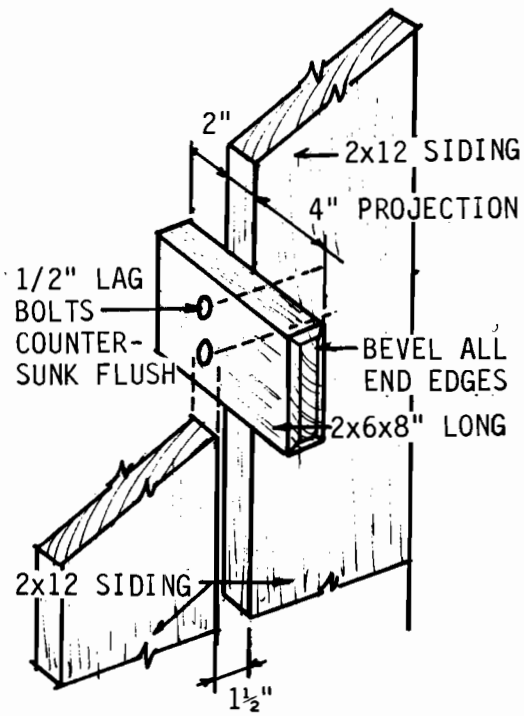
HAND WEDGE DETAIL



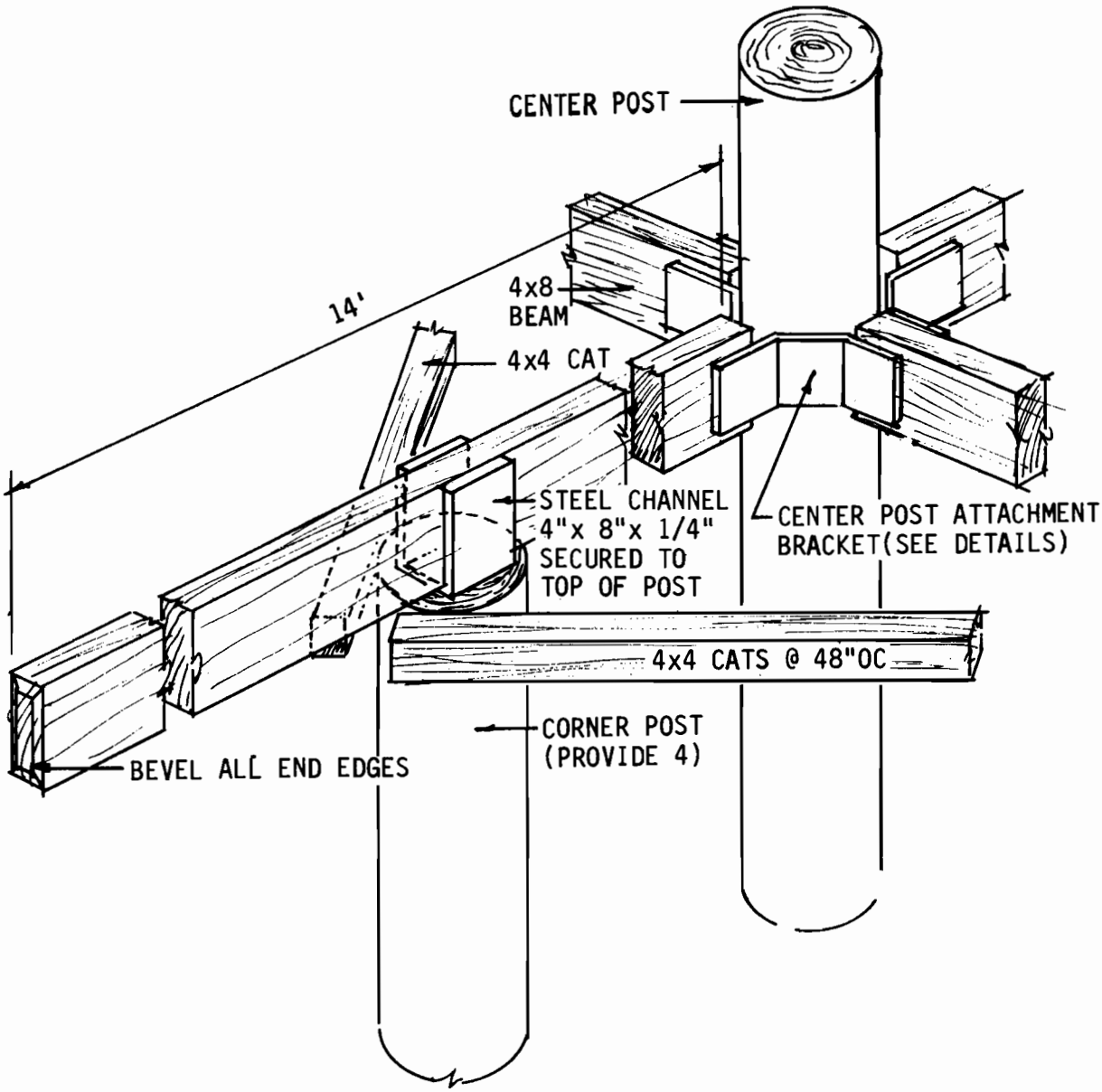
WALL DETAIL CHIMNEY CLIMB



BELAY RING DETAIL



SIDE 4 CLEAT DETAIL



FRAMING DETAILS - TOP DECK

ESTIMATED QUANTITY OF MATERIALS

SIDING(3 SIDES)	66 PCS 2x8	@ 20'	CLEAT STRIPS	1 PC. 2x6	@ 8'
	51 PCS 2x8	@ 10'		26 PCS 2x4	@ 16'
SIDING(1 SIDE)	14 PCS 2x12	@ 20'		12 PCS 2x4	@ 10'
	14 PCS 2x12	@ 10'	LOCKUP STORAGE	18 PCS 2x4	@ 8'
TOP DECKING	28 PCS 2x4	@ 10'		10 PCS 2x6	@ 6'
TOP DECK FRAMING	7 PCS 2x6	@ 8'		9 SHT 4x8 PLYWD	
CORNER POLES	4 PCS 12"	@ 40'	HANDRAIL	7 PCS 2x4	@ 8'
CENTER POLE	1 PC. 12"	@ 45'	CONC.SLAB	3.5 CUBIC YARDS	
CATS FOR SIDING	28 PCS 4x4	@ 18'	CONSTR. HARDWARE	AS NOTED ON DWGS	
CHIMNEY CLIMB WALL	14 PCS 2x8	@ 10'			
EXTENDED BEAMS	4 PCS 4x8	@ 14'			