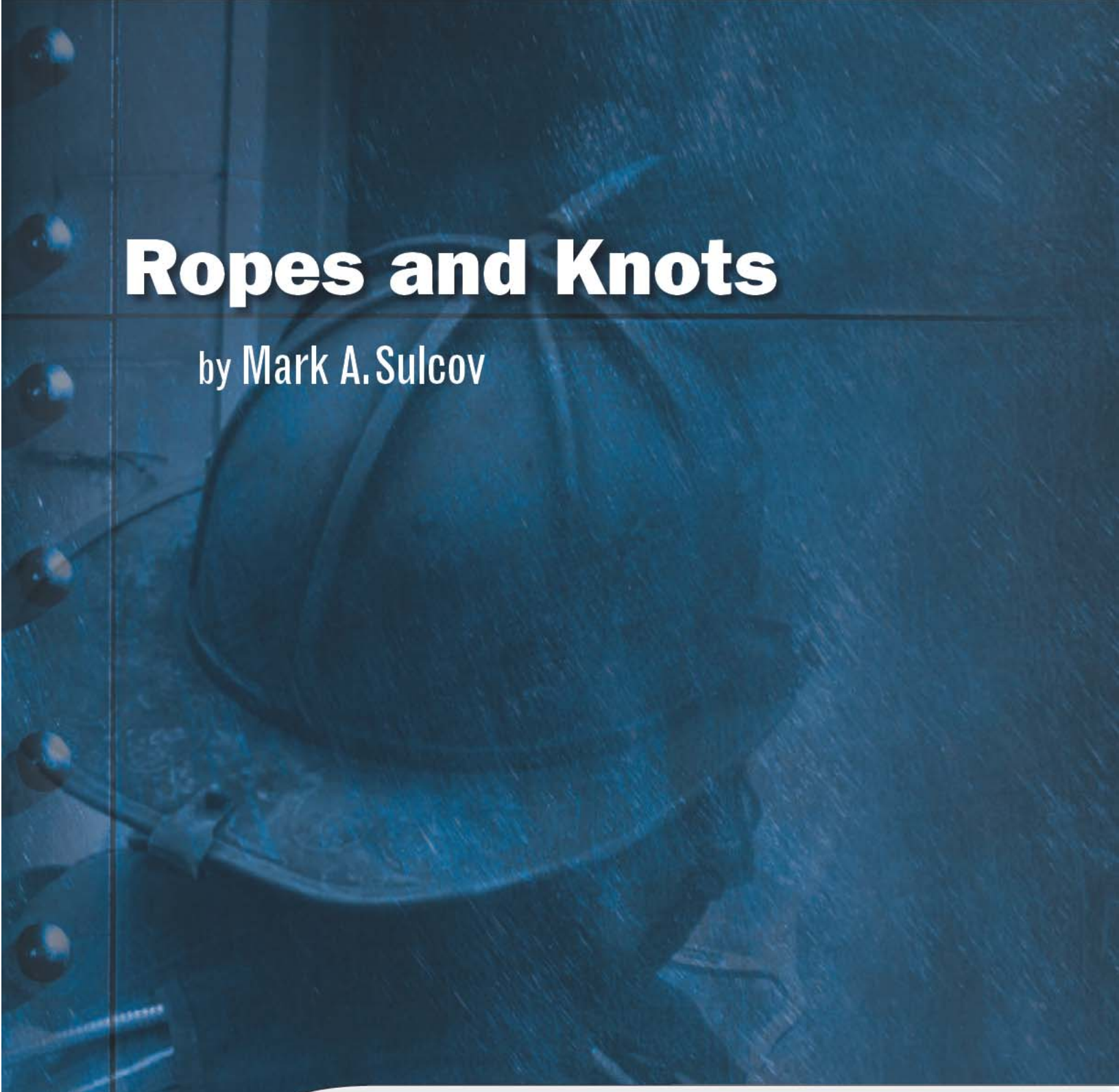

Ropes and Knots

by Mark A. Sulcov

This chapter provides required knowledge items for the following NFPA Standard 1001 Job Performance Requirements:

FFI 5.3.20

FFI 5.5.1

FFII 6.5.4

This chapter contains Skill Drills. When you see this icon, refer to your Skill Drill book for step-by-step instructions.

SKILL DRILL

OBJECTIVES

Upon completion of this chapter, you should be able to do the following:

- Identify the materials fire service rope is made from
- Identify and describe the terms and parts of the rope when tying knots
- Identify the basic knots used in the fire service
- Describe and demonstrate the methods used to tie fire service knots and what their primary uses are
- Describe the inspection process of ropes, how to maintain them, and the standard methods of storing them
- Recognize the difference between life safety ropes and utility lines
- Identify methods used to secure and hoist various fire service tools and equipment
- Understand why fire service rope is downgraded and/or put out of service

INTRODUCTION

Rope work is a very important part of the fire service. The firefighter needs to understand the importance of rope selection based on construction, strength, and what it will be used for. The firefighter also needs to understand the basic elements of knots; how to tie knots for fire service use; and the proper inspection methods, storage, and maintenance procedures for ropes.

It is important to note that knots can be tied in more than one way. This chapter provides specific ways to tie knots; your instructor may show you other ways to tie a particular knot. For example, being left-handed or being right-handed affects the way people tie knots. With practice, you may be able to tie a knot with your left or right hand. In addition, people who are left-handed will take this as a personal challenge. Relate this to having more tools in your tool box. There are many tools that do the same job, but do the job differently. In your career, you will find that there is no one tool that fits all situations. Have a selection available.

ROPE MATERIALS AND CONSTRUCTION

Rope is made from either natural or synthetic material. Each has different characteristics that affect their use in the fire service (table 8–1). The first ropes used by humans, made of natural fibers such as live vines, were used to construct rope bridges. In the fire service, the natural fiber material first used was manila hemp (essentially dead vines).

Natural fiber ropes were in service in fire departments until the 1980s, when they were replaced by synthetic materials (fig. 8–1). In addition, a disastrous, fatal firefighting rope rescue failure in New York City in 1980 focused attention on fire service ropes and the need for a national standard on their design and use. In 1982, the National Fire Protection Association (NFPA) began the process of developing a standard that was first issued in 1985 and is known today as NFPA 1983, *Standard on Life Safety Rope and Equipment for Emergency Services*. It covers ropes and their uses, that is, life safety versus utility, harnesses, and hardware.

Natural materials

There are three basic natural materials that are used for rope: manila, cotton, and sisal. All of the natural ropes suffer from the same problems:

- Mildew
- Rot
- Deterioration
- Poor **abrasion** resistance
- Size-to-strength ability (natural fiber rope needs to be thicker to be stronger)
- Little predictability in terms of expected strength

Fig. 8–1. Natural fiber rope is made from organic materials and isn't generally used for fire or rescue purposes.

Manila. Manila rope is made from fibers from plants. These small fibers are twisted together (not knotted) to form longer fibers. The twisting of the fibers creates longer and longer strands that are then twisted with more strands to make the natural fiber rope. There is a definite relationship of size (diameter) to strength. The thicker the rope, the stronger it is.

Note: When looking at manila fiber rope, you can see numerous fiber ends sticking up out of the rope. These are the fiber ends that are exposed or have broken due to either stress on the rope or abrasion.

Cotton. Cotton rope is made with the same cotton seed fibers that cotton thread is spun from. Because of the very short cotton fibers, the rope is soft and pliable, but this results in very low strength and makes the rope susceptible to damage by abrasion.

Sisal. Sisal is another natural fiber that comes from plants. It is a very weak fiber that has less strength than cotton. Thus it is only used to make very small diameter rope. Cotton and sisal fiber ropes are used less today in the fire service because of the emergence and widespread acceptance of synthetic fiber ropes.

Table 8–1. Rope material characteristics

	Manila	Polypropylene	Polyethylene	Nylon	Polyester
Loss of strength, °F (°C)	180 (82)	200 (93)	230 (110)	300 (149)	300 (149)
Melting or charring temperature, °F (°C)	375 (191)	275–300 (135–149)	285 (141)	400–500 (204–260)	450–650 (232–343)
Loss of strength when wet	50%	0	0	25%	Minimal
Float	No	Yes	Yes	No	
Acid resistance	None	High	High	Low	Limited
Elongation under loads	Yes			Yes	Low

Natural material ropes are not used for *life-saving* purposes—they are never used to support a human being. When used, they are used for *utility* purposes only. Downgraded life safety rope should be labeled as utility rope.

Synthetic materials

The most widely used synthetic materials in the manufacturing of ropes are nylon, polyester, polypropylene, and polyethylene (fig. 8–2). These materials have excellent resistance to rot and mildew. Deterioration due to age is not considered a factor. Synthetic ropes are also more resistant to physical and abrasion damage, but are still susceptible to damage/destruction from the heat of a fire. The biggest advantage of synthetic materials is that, because they are manufactured, each fiber is the same and so are their properties. Each continuous fiber of the same length is just as strong as the others. In contrast, natural fiber is made up of short pieces, and thus it is weaker. This increased strength factor makes synthetic fiber rope preferable for fire service use.

Fig. 8–2. Synthetic rope is used in a wide variety of applications in the fire service, including technical rescue.

Nylon. Nylon was invented in the 1930s by the Dupont Corporation. First used to make stockings for women, nylon was used during World War II for parachutes and cords due to the shortage of raw materials. One nylon strand is called a **filament**. Rope is made from multifilament lines, either twisted into strands or covered with sheathing. The biggest disadvantage with nylon is that it is damaged by acids.

Polyester. Polyester material, unlike nylon, is resistant to most acids. Polyester also has relatively low stretch under a load, but does not hold up well if a shock load is encountered.

Polypropylene. **Polypropylene rope** is primarily used for water applications, that is, water rescue or any area with a high degree of moisture, because of its ability to float. Polypropylene also resists rot and mildew and has a strong tolerance to chemicals and acids. Polypropylene will break down easily from sunlight, heavy loads, and abrasion.

Polyethylene. **Polyethylene rope** is nearly identical to polypropylene, also floats, and comes in many colors. It is weaker and stiffer than polypropylene, but does have better abrasion resistance.

Construction

There are two types of rope used in life safety applications: dynamic and static. **Dynamic rope** is high stretch and very flexible. It is used mostly in rock climbing to absorb falls and put less stress on the anchoring system. **Static rope** is low stretch and is used in most fire department applications, namely, rescue, hauling, and rappelling. It has very little stretch.

Laid (twisted) rope. The laid or twisted method of construction is for natural or synthetic fiber rope. The yarn is twisted into strands, and the strands—typically three—are twisted together to make the rope (fig. 8–3).

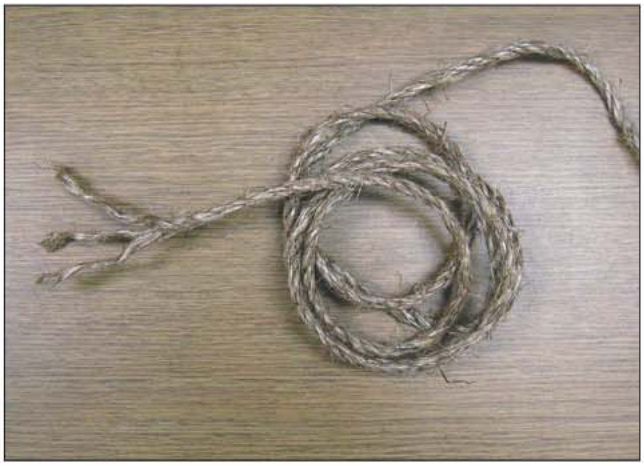

Fig. 8–3. Laid or twisted rope construction involves the twisting of three strands of natural or synthetic rope.

Note: The quality of the fiber and the tightness of the twist determine the specific strength of a particular rope. A twisted rope leaves the three strands exposed to all the elements, leaving it open to damage, especially by abrasion. You can easily inspect twisted rope by looking at all surfaces for cuts and abrasions; chemical damage; or embedded dirt, metal, or glass pieces. **Laid rope** can be easily twisted back to expose the inside area and checked for debris that can damage the rope. If any damage is found, the rope should be taken out of service.

Braided. Braided ropes are made from natural and synthetic fibers. The most common and the only one the fire service will use is made from synthetic fibers. The rope is made by braiding the strands together uniformly, just like braiding hair. Braided rope reduces twisting when used for rappelling. The rope is very smooth to the touch, but like laid rope, the majority of the fibers are exposed and subject to damage (fig. 8–4).

Fig. 8–4. Braided rope is commonly found in synthetic rope used by the fire service. A drawback of this type of rope is that all strands are exposed to damage from abrasion.

Braid-on-braid. Braid-on-braid is constructed by covering a braided rope with another braid (some manufacturers call this *jacketed*). The outer braid usually has a distinctive design pattern (fig. 8–5). This type of rope is very soft, and just like braided, it has the same poor characteristics. The inspection process for braided and braid-on-braid is mostly the same. We should look for cuts, abrasions, or excessive picks (fuzz) or deformities in the rope (soft spots). In braid-on-braid, we must also look for sliding of the inner and outer braid. If this is found, the rope must be taken out of service.

Fig. 8–5. Braid-on-braid rope has many of the same drawbacks as simple braided rope, except that the outer core creates a protective "jacket" for the rope.

Kernmantle. **Kernmantle rope** is composed of two sections: The *kern* is defined as the inner core of the rope, and the *mantle* is the outer cover. There are three types of kerns: twisted, braided, and continuous filament fiber. The first two types create dynamic rope, and the continuous filament fiber creates static rope. To put it simply, the mantle is a tightly woven outer shell that protects the kern. In all cases, the kern carries the majority of the load (strength), normally 75%–80%. The strength of the mantle is 20%–25%. This type of rope is primarily for life rescue (fig. 8–6).

Fig. 8–6. Kernmantle rope is the most common fire service rope since it is designed for life safety operations.

Webbing. **Webbing** is not really rope, but rather woven fabric that is either flat or tubular (fig. 8–7). It is often used for slings and anchoring. Some firefighters carry small-width webbing instead of personal rope. Webbing can be used to aid in securing loads, dragging trapped people, and lowering loads. One of the advantages of webbing is that it loses very little of its strength when bent correctly around a carabiner.

Fig. 8–7. Webbing can be utilized in complex rescue rigging arrangements or carried by firefighters to aid in maneuvering hoselines or carrying tools.

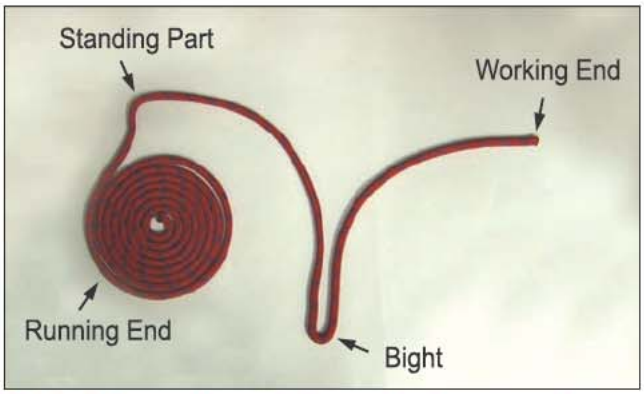

Fig. 8–8. The working end of a rope is the area used to tie a knot, while the running end is used for hoisting and pulling.

ROPE NOMENCLATURE

Primarily rope falls into two categories, utility and life safety. Utility rope is used for such tasks as hoisting and lowering of tools, securing objects, and many other nonemergency uses. Rope used for search and rescue and other non-life-threatening uses also does not fall into the life safety category. Note that these are normally **downgraded** life safety ropes and need to be marked accordingly and stored in a compartment remote from any life safety rope.

Before we can start tying knots, we must first understand what the different parts of the rope are called and what makes up a knot. First, the rope itself can be divided into three sections:

- **Working end.** This is the part of the rope that is used to tie the knot (fig. 8–8).
- **Standing part.** This part of the rope can be above or below the knot, but must be between the knot and the remainder of the rope.
- **Running end.** This is the rest of the rope used for the work of the rope such as hoisting, pulling, and so forth.

Elements of a knot

For a knot to be used in the fire service, the knot must be easy for you to tie and untie while wearing firefighter gloves. This is where repetition and practice come into play. Someone may be able to show you a knot and how to tie it. But you must practice. No one else can learn it for you.

A **bight** is made by bringing the rope back along itself side by side. A **loop** is made by placing a twist in the rope and having the standing part of the rope continue in the same direction. A **round turn** is made by making a loop and then having the standing part go back in the direction from which it came.

KNOT TYPES AND USES

SKILL DRILL

FFI 5.3.20 The fire service family of knots consists of the overhand (also known as a safety), half hitch, clove hitch (open and closed), becket bend, bowline, figure eight, figure eight on a bight, figure eight follow-through, water, and handcuff. The tying instructions for these knots are located in your Skill Drill book.

Note: In the emergency services, there are numerous ways to tie various knots. The tying instructions in your Skill Drill book are only demonstrating one way. This should not stop you from learning other ways to tie knots. Try to think of it as putting another tool into your tool box, thus having a selection of ways to accomplish the same goal no matter what obstacle is in your way.

Overhand (safety) knot. This is used as a backup to the primary knot. The overhand knot prevents the loose end of the rope from walking out of the primary knot, so that it does not untie (fig. 8–9).

Fig. 8–9. An overhand safety knot is used to provide a margin of safety with other knots.

Half hitch. Always used in conjunction with another knot, the half hitch is effective at securing and hoisting long tools, such as a pike pole. The half hitch keeps the tool stabilized as it is lifted to an upper floor window (fig. 8–10).

Fig. 8–10. A half hitch being used to hoist an axe

Clove hitch (open). Basically, the clove hitch is two half hitch knots. The clove hitch secures tools or posts with the hitch, using the open end of the rope (fig. 8–11a).

Fig. 8–11a. An open clove hitch

Clove hitch (closed) knot. This is the same as the open version, but used when there is no open end of a rope. The closed clove hitch should always be backed up with a safety knot (Fig. 8-11b).

Fig. 8-11b. A closed clove hitch

Becket bend. With the becket bend, two ropes of unequal diameter are tied together. This knot places a bight in the larger-diameter rope to join to another rope or to a chain. The becket bend should not be used for life safety procedures (fig. 8–12).

Fig. 8–12. A becket bend can be used to tie two ropes together.

Bowline. Use a bowline knot to form a secure loop that will hold up to tension and not constrict the object it is placed around. This is one of the most widely used knots in the fire service (fig. 8–13).

Fig. 8–13. A bowline forms a secure knot when tension is applied to the rope.

Figure eight. This knot is used to form several other fire service knots, including the figure eight on a bight and the figure eight follow-through. A figure eight knot will effectively stop a rope from slipping through a pulley or through the grommet of a rope bag (fig. 8–14).

Fig. 8–14. A figure eight knot

Figure eight on a bight knot. This knot forms a secure loop at the open end of a rope. The figure eight on a bight is a good life-safety knot. It is also good for securing the rope to an anchored piece of equipment(fig. 8–15).

Fig. 8–15. A figure eight on a bight

Figure eight follow-through knot. This knot is for tying a figure eight on a bight through an object (fig. 8–16).

Step 1. Make a basic figure eight, leaving sufficient rope on the working end to go around the object you're securing the rope to.

Step 2. Wrap the rope around the object to be tied.

Step 3. Now follow the rope back through the knot in the opposite direction.

Fig. 8–16. A figure eight follow-through

Water knot. This is the most effective knot for joining two pieces of webbing to make a longer piece, or for forming a single piece of webbing into a loop. The water knot is similar to a figure eight. Unlike a knot made with rope, the water knot must lie flat (fig. 8–17).

Fig. 8–17. A water knot is typically used to tie ends of webbing together.

Handcuff. This is a life safety knot with two adjusting loops that is useful for hoisting a firefighter or victim from a lower level. As the rope is pulled taut, the loops close up, forming a handcuff, which allows the person to be pulled upward. It is simple to tie, and very strong (fig. 8–18).

Fig. 8–18. A handcuff knot can be used to rescue and then drag a downed firefighter.

PROPER USE OF ROPE

There are some important points to remember when dealing with rope. A firefighter should think of these as the list of do's and don'ts with respect to rope.

1. When using a rope, always find a way to protect the rope over sharp edges. Use a rounded object such as a hose roller, ladder rung, or handle of a tool. Don't let the rope run over construction materials that have a 90° angle, like the edge of a roof or window. If possible, use **edge rollers**, which are made of metal and can be placed over edges and sharp corners to protect a rope while in use (fig. 8–19). They also reduce the amount of friction. Hose rollers are an ideal way of preventing abrasion to a hose.
2. Be aware of the effect that shock loads have on rope, and avoid creating these shock loads.
3. Regardless of the rope material, ropes and fire don't mix well. The heat from a fire can seriously damage a rope. Never let the rope pass through flames or heated gases while it is being used, regardless of the purpose. The rope could fail suddenly and without warning.

Fig. 8–19. Hose rollers can be used to protect hose and rope when drawn over sharp edges.

HOISTING TOOLS AND EQUIPMENT

One of the primary functions of rope is to hoist equipment to an elevated location. The utility rope can be used for this job. All equipment being hoisted should have a **tag line** on the ground. This line is used to keep your tools and equipment away from the structure or obstructions like branches, overhangs, or anything else it could get caught on. Remember that all knots should have safeties.

Axe or Halligan tool

SKILL DRILL

Place an open clove hitch over the handle or an axe or Halligan tool and slide it all the way to the head of the tool and tighten (fig. 8–20). Remember to leave enough rope past the hitch to later tie a tag line to. Now make a bight around the head of the tool and bring the rope back up the handle, and secure with an underhanded half hitch.

Fig. 8–20. Using a clove hitch and a half hitch, along with a tag line, you can successfully raise a Halligan tool to an upper floor.

Pike pole

SKILL DRILL

Like all tools, the pike pole is also tied with the heavy end down (the hook). This method will give greater control at the head of the tool to clear any obstructions. Place an open clove hitch over the handle of the tool and tighten by the hook (fig. 8–21). Remember to leave enough rope for the tag line. Take a bight around the head of the tool and bring up toward the handle. *Rule of thumb*: For every length of an axe in the handle, there should be that many half hitches.

Fig. 8–21. Usually one half hitch and a clove hitch can secure a pike pole to be hoisted.

Exhaust fan

SKILL DRILL

Tie a bowline around the top two handles of an exhaust fan (fig. 8–22). Try to get all three sides of the triangle to be equal. It will look like a triangle when tension is placed on the line. The tag line is simply a closed clove hitch.

Fig. 8–22. A bowline tied around the top of an exhaust fan, along with a clove hitch for a tag line, can allow the fan to be hoisted to an upper floor.

Hoselines, charged and uncharged

SKILL DRILL

It is preferable to hoist both charged and uncharged hoselines the same way to keep it simple. First tie a closed clove hitch behind the first coupling. Then take a bight in the rope and pass it through the bale and over the nozzle. By pulling the rope, the bale is guaranteed to stay shut (fig. 8–23). *Note:* No tag line is necessary, so you can use the hose itself as a tag line. Also, tying the clove hitch just below the coupling eliminates stress on the coupling.

Fig. 8–23. A hose line can be hoisted by tying a clove hitch below the first coupling.

Hoisting a ladder

SKILL DRILL

Using enough rope to make a 3-ft (1 m) loop, tie a bowline. Place the bowline under the top rung, over the second rung, and under the third rung. Now pull the rope toward the top of the ladder and place the loop over the beams of the ladder. Pull up on the rope to take up the slack while sliding the loop down the ladder. Attach a closed clove hitch as the tag line to the bottom rung. This will control the ladder while being hoisted (fig. 8–24). A figure eight knot may also be used to hoist the ladder instead of the bowline.

Fig. 8–24. Firefighters using a bowline and a clove hitch to hoist a ladder.

Tying a rope between objects

SKILL DRILL

This is also known as a chimney or taut line hitch (fig. 8–25). Secure the rope around an upright object (closed clove hitch). Now bring the rope around the other upright object and back approximately three quarters of the way. Pass the working end under the right-hand line; this looks like the number 4. Bring the working end into the loop, pull taut, and make another number 4 with the working end. Bring this end into the loop between the first one you made and pull taut. This last time, hold the rope again as a number 4. Bring the working end into a new loop in front of the other by itself and secure tightly against the first two. If you release tension, the rope gets slack in it and people will be able to pass. Pull taut and the line will be tight again.

Fig. 8–25. Securing a rope between two objects

Using rope or webbing to secure objects

A rope or webbing can be used effectively to secure an object in place. Some firefighters carry a short length of personal rope so they can control a door that has to be forced open just in case there is a fire or severe heat condition behind the door being forced (fig. 8–26). Once opened and firefighters are advancing, the same short piece of rope can be used to hold the door open. Ropes can also be used to secure objects that are moved out of the way of firefighters, such as fencing that may be cut and rolled back, tree limbs and branches, as well as gates. In warehouses and distribution centers where most of the storage is on racks, ropes can be used to secure boxes stored on racks to prevent them from falling out of the racks and injuring firefighters. Ropes are used as a last resort for securing a motor vehicle when cribbing or blocking are not available.

Fig. 8–26. Firefighters often carry smaller lengths of rope or webbing with them to secure and control doors while performing searches.

ROPE MAINTENANCE, INSPECTION, AND STORAGE

Inspection of rope

FFI 5.5.1 **FFII 6.5.4** Ropes need to be inspected just like any other piece of equipment in the fire service. In addition to a visual examination after each use, ropes should be inspected as part of the regular routine of inspection for all tools and equipment. A weekly inspection is a particularly good idea when the rope is used on a frequent basis. For those departments that use their ropes less frequently, monthly inspections are acceptable. Regardless of the frequency, the inspection should be documented in writing (fig. 8–27). There are commercially available rope inspection forms, or a department may elect to create its own form.

The inspection report should identify what rope was used and when the rope was used. This report should also include information on how the rope was used and what type of exposure occurred to the rope. The date of the inspection, the person conducting the inspection, and the condition of the rope should also be noted.

The rope should immediately be removed from service if the rope is found to be damaged or suspected of having been damaged. Follow your department guidelines on how many picks or yarn pulls from routine wear are considered enough damage to remove from service.

When conducting an inspection, the rope should be examined along its entire length and not just the section that is thought to have been used. The person conducting the inspection should look for damage to the rope from a cut such as a laceration (cut into the rope); abrasion (cut on the surface of the rope from friction); fraying; charring; melting (especially true of synthetic fiber ropes); and damage from exposure to chemicals such as acids, corrosives, and petrochemical products.

The rope should be passed through the hands so that the person conducting the inspection can feel changes to the rope as well as examine the rope visually. These changes include finding a spot that has a different feel (hard or soft spot vs. the regular feel); a slippery feeling; or foreign objects embedded in the rope including grit, dirt, stone, wood or metal pieces. The inspection should also tell if the rope appears to be coming apart, which could indicate some type of interior damage (fig. 8–28).

The best time to conduct one of these inspections is after the rope has been cleaned and thoroughly dried out. The presence of moisture will allow mold or mildew to form, which in turn will cause the rope to rot if it is composed of natural fibers. Synthetic ropes can also disintegrate if they have been exposed to certain chemicals, and those chemicals have not been fully washed off the rope and the rope dried out.

Some people prefer to inspect a rope as they are putting it away in a rope bag or coiling it. Others prefer to tie the rope off, then slowly run their hands over the rope while the rope has some tension on it. Regardless of the method selected, the important thing to remember is

that even a minor imperfection could be a tip-off of a major problem when the rope is placed under stress.

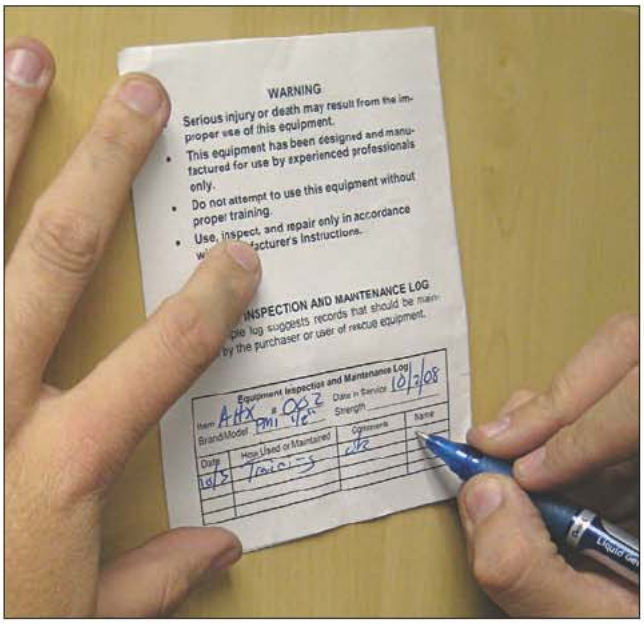

Fig. 8–27. Rope inspections must be documented and records kept in a conspicuous and accessible location.

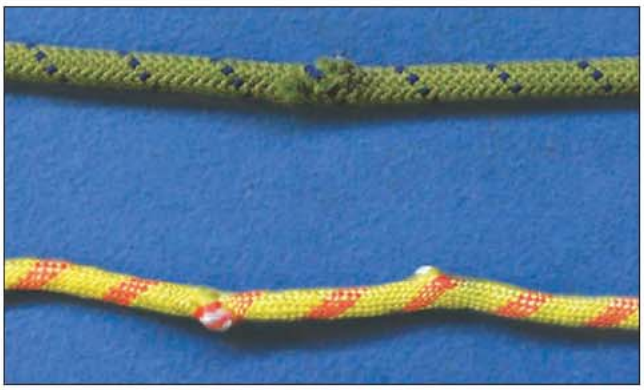

Fig. 8–28. When damaged rope is located during inspection, it should be removed from service.

Ropes that are laid or twisted together can be untwisted to reveal the inside portion of the rope during an inspection (fig. 8–29). This is not true of braided, braid-on-braid, or kernmantle type ropes, because there is really no way to twist the rope apart to reveal the inner portion of the rope. The key with inspecting these ropes is to feel for differences when running the rope through your hands. Synthetic ropes are especially good candidates for conducting a tactile inspection while putting the rope under slight stress or tension. Any irregularities in the feel should be noted, and the rope removed for more thorough inspection. Whether the situation is one braid running over the other, flat spots, bunching, stiffness, or a different feel, these ropes could be damaged and in need of replacement.

Fig. 8–29. Untwist the strands of twisted or laid rope to inspect.

Proper maintenance of life safety and utility ropes is required to ensure that they are ready for service. Most fire service ropes come with instructions on how to properly clean, dry, and store the ropes.

Cleaning

SKILL DRILL

FFI 5.5.1 **FFII 6.5.4** Please follow the manufacturer's instructions. If your rope did not come with care instructions, then follow the general guidelines for cleaning, drying, and storage of ropes.

Natural fiber. A major drawback to the use of natural fiber rope is that it loses strength when it gets wet. And natural fibers do not regain lost strength. That means that using water to wash or clean a rope made of natural fibers simply cannot be done. The only way to clean a rope of natural fibers is to brush off the loose dirt and foreign material with a stiff broom or brush. This is another reason why ropes made of synthetic fibers are growing in popularity in the fire service.

Synthetic rope. Synthetic material can be cleaned in a number of ways. Again, remember that it is best to follow the manufacturer's instructions. The following is a general procedure to follow:

- Only use cold tap water, not hot water.
- Only use a mild detergent that is well-diluted. Do not use bleach or soap with bleach.

The cleaning and inspecting of kernmantle rope is difficult and time consuming because the damage might not be obvious. This inspection is done by touching all the rope as it passes through your hands. You are feeling for hard and soft spots. Note that some spots may have been made by a tight knot and are only temporary. This could indicate damage to the core, but on closer visual inspection, if the outer mantle is not damaged at that spot, then the fibers in the core may be temporarily misaligned and will relax. If there is any damage to the outer mantle, then

the rope should be taken out of service. You should also look for cuts, odd shapes or weave, discoloration from chemicals, glass, metal, roughness (this may occur when a rope moves over another, stationary piece of rope), or an excessive amount of picks (fuzzies). If this or any condition presents itself, and you're not sure whether the rope is really damaged, then you should seek out someone with the training, knowledge, and experience to determine if the rope should be downgraded to another use. All ropes should be inspected after every use.

Hand washing. This is the most basic way of cleaning. Naturally, there are several methods that can be employed. One is to use a large sink or bucket and let the rope soak a few minutes, then move it around with your hands and scrub the rope with a small brush. Although some people suggest using your bare hands to wash the rope, the safer practice is to use a brush in case there are any sharp pieces of wood or metal embedded in the rope. Another method is to lay the rope out on the floor of the apparatus room. Since the apparatus bay is usually a fairly large area, the rope can be laid out in its entirety. Wet the rope with a hose and then scrub the rope with a stiff brush. If there is need to add detergent, you can place the cleaning solution in a bucket and dip the brush, then scrub.

One thing to remember regardless of the method selected to wash the rope is that if a detergent is used, the rope must be thoroughly rinsed of all detergent residue or cleaning solution (fig. 8–30). You can use a bucket of freshwater, pass the rope under a running faucet, or hose it off. However, if you use the hose, remember to turn the rope during the rinse process to get to the soap that is hidden between the rope and the floor.

Fig. 8–30. When washing rope, it is important to remove all detergent, if used.

Rope washer. A commercially available mini-version of a hose washer is the rope washer. The difference here is that the rope washer allows you to attach it to a threaded faucet or hose bib. You then run your rope through it, back and forth. The rope washer should have arrows that indicate the end into which the rope is placed and the end from which the rope emerges. Multiple small jets of water are directed at the rope as it is pulled through the rope washer. If connected to a faucet, the discharged water falls harmlessly into the sink. Using a hose bib may create a slip-and-fall hazard. The major downside to using a rope washer is that you cannot use any detergent in the process.

Washing machines. Only front-loading washing machines should be used. Top-loading machines should be avoided because this type of washing machine has an agitator that may damage the rope. Ideally, the rope should be placed in a mesh-type bag so that the rope does not get caught on anything inside the washing machine. If a mesh bag is not available, you can tie the rope in a **daisy chain** and place it inside the washing machine (fig. 8–31).

You may also want to select a front-loading washing machine that has a window so that you can visually check from time to time to make sure that the rope does not get snagged or damaged during the washing cycle. Add the proper detergent and make sure that all of the dirt and residue are rinsed out. One caution should be kept in mind. If the rope has been exposed to any type of chemical, you should avoid using a washing machine. The rope should be washed by hand or sent to a commercial vendor that specializes in decontamination of equipment when exposed to chemical environments.

Fig. 8–31. If you don't have a mesh bag, tie the rope in a daisy chain before placing it into a washing machine. See your Skill Drill book for steps to create a daisy chain.

Drying ropes. Before the rope can be stored it must be dried. The preferred method of drying a rope is to lay it flat over a ladder so air gets all around the rope. Never expose rope to direct sunlight. Hanging rope to dry is another method. The rope can be hung in a hose tower or suspended between or below bar joists or trusses. Extra attention must be taken not to get any contaminants onto the rope.

Rope storage

SKILL DRILL

It is imperative that rope be stored in a manner that keeps it clean and readily identifiable (length, size, and task), so a firefighter can quickly locate and deploy the proper rope for the task. The location on the apparatus where rope is stored needs to be a dedicated area that keeps the ropes from being buried under other equipment or being exposed to battery acid, fuel, fumes, or sunlight.

Bags. Rope storage bags will keep rope clean, neatly stored, and quickly deployable (fig. 8–32). Depending on the bag construction, some are better than others. Specially designed nylon or canvas bags are best for this purpose. A mesh bag is not. Nylon and canvas bags are best for protecting ropes from dirt, liquids, sunlight, and abrasion. A properly bagged rope is easier to deploy than a coiled rope.

Fig. 8–32. Rope bags help protect rope from abrasions and chemicals while being stored in fire apparatus.

Placing ropes into a bag. The purpose of the rope determines how the rope should be put into the bag. If placing in a **search bag**—used for carrying and deploying rope during a search—then place the rope through the grommet in the bottom of the bag, and tie a figure eight on a bight. This will give you a hand-hold to pull the rope from (bag stationary), or you can tie the bight off to the outside area and carry the bag deploying the rope behind.

If the rope is for a **drop (or life safety)** bag—used for raising tools, search or escape, and other fireground functions—then start out with a figure eight knot on both sides of the bottom grommet. This will keep the rope from being snagged and inadvertently being pulled out the bottom. Then simply load and coil the rope into the bag by starting around the inside edge and filling up the middle of the bag. You should tie a figure eight at the end of the rope and place it on the inside top of the bag.

Note: When deploying the bag, open the top of the bag drawstring and remove the figure eight, making sure that the eight has not pulled through any loops. This would cause multiple knots in the rope and a failed deployment.

Coiling and uncoiling rope

SKILL DRILL

Coiling a rope using the end of a ladders is a common practice that aids in keeping rope organized and easy to deploy (Fig. 8-33). Steps for coiling and uncoiling a rope are found in your Skill Drills book.

Fig. 8–33. The end of a ladder is a useful tool for creating an organized rope coil.

OTHER EQUIPMENT

There are several tools and other pieces of equipment that are used in conjunction with a rope. It's important that you as a firefighter have at least a basic knowledge of these items should you be asked to retrieve them or provide them for technical rescue team members at a fire or other emergency incident.

Carabiner

A **carabiner** is a loop-type device with a gate-type opening on one side that opens by depressing it (fig. 8–34). This allows you to slip a rope into the carabiner or to attach the carabiner to an object. It also allows for the carabiner to be attached to a stationary object or to a piece of tubular webbing. A carabiner allows for the rope to change direction with minimal loss of strength. Carabiners are also used as part of any firefighter escape devices that you may be provided with.

Fig. 8–34. A carabiner is the most common rope tool used in the fire service. When used in conjunction with a length of rope or webbing, it can create an emergency firefighter escape system.

Figure eight plate

A **figure eight plate** is used to assist in descending (fig. 8–35). As the name implies, the plate resembles a number 8. One ring is small, and the other is larger. The smaller ring is attached to a carabiner that a firefighter wears. The larger ring is for the rope. Some figure eight plates now come with ears that stick out at the bottom of the larger ring to prevent the rope from creating a girth hitch, which would essentially stop the firefighter from descending.

Fig. 8–35. A figure eight plate assists with descending on a rope.

Single-sheave pulleys

A **single-sheave pulley** has one sheave that allows a single rope to pass through it (fig. 8–36). Single-sheave pulleys are used to change the direction of pull on a rope. Sometimes the sheave has pivoting sides that allow the rope to be placed into it without having to start from one end or the other and can be inserted anywhere along the length of the rope.

Double-sheave pulleys

As the name implies, a **double-sheave pulley** is similar to a single-sheave pulley except that this device allows for two ropes to be inserted (fig. 8–37). A double-sheave pulley can be used to help create a **mechanical advantage** for raising or lowering a load.

Fig. 8–36. A single-sheave pulley

Fig. 8–37. A double-sheave pulley

QUESTIONS

1. When should a rope be inspected?
2. What are the advantages of synthetic ropes over natural materials?
3. What do you look for when inspecting rope?
4. When should a rope be removed from service?
5. What are the differences between kernmantle, laid, and braided rope?
6. Which would you choose for life safety applications and why?
7. Describe hoisting a hoseline.
8. What is the difference between a bight, loop, and round turn?