STANDARD ROPE PRACTICES

SAN FRANCISCO FIRE DEPARTMENT

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Standard Rope Practices
January 2008

San Francisco Fire Department
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FOREWORD

The goal of this manual is to establish standard operating practices as authorized by the Chief of Department and implemented by the Division of Training.

The purpose of this manual is to provide all members with the essential information necessary to fulfill the duties of their positions, and to provide a standard text whereby company officers can:

- Enforce standard drill guidelines authorized as a basis of operation for all companies.
- Align company drills to standards as adopted by the Division of Training.
- Maintain a high degree of proficiency, both personally and among their subordinates.

All manuals shall be kept up to date so that all officers may use the material contained in the various manuals to meet the requirements of their responsibility.

Conditions will develop in fire fighting situations where standard methods of operation will not be applicable. Therefore, nothing contained in these manuals shall be interpreted as an obstacle to the experience, initiative, and ingenuity of officers in overcoming the complexities that exist under actual fire ground conditions.

To maintain the intent of standard guidelines and practices, no correction, modification, expansion, or other revision of this manual shall be made unless authorized by the Chief of Department. Suggestions for correction, modification or expansion of this manual shall be submitted to the Division of Training. Suggestions will be given due consideration, and if adopted, notice of their adoption and copies of the changes made will be made available to all members by the Division of Training.

Joanne Hayes White
Chief of Department

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INTRODUCTION

Rope is one of the oldest tools used by the fire service. Rope is a very valuable tool used for hauling equipment, accomplishing rescues from areas of different elevations, stabilizing vehicles, and cordoning off areas. Firefighters must be knowledgeable about the different types of rope so that the correct rope will be chosen to do the required job. The ability to tie the proper knots is crucial to the safety of rope handlers. The knots discussed in this manual are limited only to those basic knots taught during firefighter probationary training and are the basic knots required for all firefighters. Firefighters may be required to know additional knots or to use different methods than shown in this manual when working with rescue ropes, high and low angle rescue or confined space rescue.

A working knowledge of ropes, knots, and ties and their proper application is essential in many fire department operations. An improperly tied knot may easily result in failure to accomplish a job on which the saving of life and/or property may be dependent. Any knot or practice that deviates from the standard should be thoroughly tested under controlled conditions before use in life safety applications.

It is imperative that every member of the Department is familiar with the various types, sizes, and purposes of all rope issued and used by companies in the Department. Additionally, members must be able quickly and correctly to perform tasks associated with these ropes under stressful and adverse conditions.

The following source materials were used to organize information about ropes and knots in order to develop the practice and procedures for the San Francisco Fire Department:

I.F.S.T.A., ESSENTIALS OF FIRE FIGHTING, Fourth Edition, Chapter 6, Oklahoma State University, 1998

James A. Frank and Jerrold B. Smith, ROPE RESCUE MANUAL, Second Edition, CMC Rescue Santa Barbara, Ca 1992

San Francisco Fire Department, STANDARD ROPE PRACTICES, 1996

California State Fire Training, RESCUE SYSTEMS 1 , December 2000, Chapters 9 and 10

California State Fire Training, LOW ANGLE ROPE RESCUE OPERATIONAL, January 2007

N.F.P.A. 1983, STANDARDS FOR LIFE SAFETY ROPE AND EQUIPMENT FOR EMERGENCY SERVICES, 2006 Edition

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SECTION 1. TYPES OF ROPE AND THEIR USAGE

Fire service rope falls into two use classifications: life safety rope and utility rope. *Life safety rope* is used to support rescuers and/or victims during actual incidents or training. *Utility rope* is used in any circumstance, except life safety applications, where the use of a rope is required, as in hoisting tools, hose and hose appliances, securing unstable objects, or to cordon off areas.

Based on the material that ropes are constructed of and the type of construction method, firefighters will be able to select the proper rope for a given application.

ROPE MATERIALS

The materials used to construct fire service rope can be divided into two basic types: natural fibers and synthetic fibers. Each has its own advantages and disadvantages.

Natural Fibers

For many years natural fiber rope was the primary type of rope used for rescue. However, after extensive testing and evaluation, natural fiber rope is no longer accepted for use in life safety applications. It is acceptable to use natural fiber rope for utility purposes; however, it must not be used for SPECIFIC RESCUE PURPOSES. Natural fiber ropes being used by the San Francisco Fire Department are made of manila and cotton.

Manila

The manila fiber is a strong, hard fiber. The fiber is woven together into rope from many short fibers, resulting in a rope with uncertain strength. The rope is biodegradable and is subject to normal rot and decay from various environmental conditions. Manila rope should be considered “used” if it is six months old and has not been employed. Manila rope is still in use as halyards on the 35’ and 50’ wooden ladders.

Cotton

Cotton fiber is used when a soft, pliable rope is needed. Cotton’s tensile strength is slightly less than that of sisal and considerably less than that of manila. Cotton rope is the most susceptible to physical abrasion and damage. If still in regular use, it should be given careful examination for problems similar to those listed for manila. Cotton rope is still in use as halyards on the Attic Extension Ladder and the Baby Extension Ladder.

Synthetic Fibers

Advances in synthetic rope construction have made the use of synthetic rope preferable to natural fiber rope, especially in life safety applications. Synthetic fiber rope has excellent resistance to mildew and rotting, excellent strength, and easy maintenance. Unlike natural fiber rope, which is made of short overlapping strands of fiber, the synthetic rope has continuous fibers running the entire length of the rope.

Nylon

Nylon rope is the strongest, size for size, of the synthetic fiber ropes. It has three to three and one-half times the tensile strength of manila rope. The high tensile strength of nylon permits the use of smaller diameter rope to obtain the equivalent strength of larger rope made from different materials. The advantage of using smaller ropes is that they are easier to handle and require less space for storage. Nylon has high resistance to abrasion, high tensile strength, and has basic properties resistant to moisture and most chemicals. However, acids and ultraviolet rays will harm nylon after repeated or concentrated exposure. Nylon stretches more than other synthetic or natural ropes without permanent damage to its fibers or construction.

Polypropylene

Polypropylene rope is the least costly of the common synthetic ropes. The major advantage is that it floats. Polypropylene rope is best suited for use where buoyancy is a major factor, such as in a water rescue. Under load, its hard texture allows it to slip and can even cut a firefighter and can be difficult to secure into good knots and hitches. Polypropylene has excellent resistance to rotting, mildew, and abrasion. However, it deteriorates rapidly from sunlight. It has moderate elastic properties and about 60 percent of the energy absorption capacity of nylon but maintains a relatively low breaking strength.

Polypropylene is quickly affected by heat and should not be exposed to any source of heat. Polypropylene begins to lose its strength at around 200˚F (93˚C) and will begin to melt at around 285˚F to 300˚F (140˚C to 149˚C).

SECTION 2. ROPE CONSTRUCTION

The most common types of rope construction are laid, braided, braid-on-braid, and kernmantle.

Laid Rope

Laid rope is constructed by twisting together yarns to form strands. Generally, three strands are twisted together to make the final rope. How tightly these ropes are twisted will determine the rope's properties. Twisted rope is susceptible to abrasion and other types of physical damage. Twisting a rope leaves all three load-bearing strands exposed at various points along the rope. Although this exposure allows for easy inspection, it also means that any damage will immediately affect the rope's strength. Polypropylene rope used for water rescue is an example of laid rope construction.

Braided Rope

Braided rope is constructed by uniformly intertwining strands of rope together. This results in a rope without an outer sheath or inner core. A braided rope reduces or eliminates the twisting which is common to laid ropes, but leaves the load-bearing fibers subject to abrasion.

Braid-On-Braid Rope

Braid-on-braid rope is a jacketed rope and is often confused or mistaken for kernmantle rope. Braid-on-braid rope is just what the name implies: it is constructed with both a braided core and a braided sheath. However, this rope does remain a static-type rope.
The appearance of the sheath is that of a herringbone pattern. Braid-on-braid rope is very strong. Half of its strength is in the sheath and the other half is in the core. Disadvantages of braid-on-braid rope are that it does not resist abrasion as well as the kernmantle rope and sometimes the outer sheath slides along the inner core.

Kernmantle Rope

Kernmantle is a jacketed rope composed of a braided covering or sheath (mantle) over the main load-bearing core (kern). The kern consists of continuous parallel fibers throughout the length of the rope. This increases the rope stretch resistance and load characteristics. The sheath (mantle) is a braided jacket with half of the strands having a left twist and the other half having a right twist. The sheath provides 10%-25% of the rope's strength. With this type of construction, the sheath absorbs most of the abrasion and protects the load-bearing core. Static kernmantle rope is most commonly used for rescue rope.

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SECTION 3. ROPE MAINTENANCE

ROPE INSPECTION

Life safety rope, cord and webbing shall be inspected monthly, and after each use. If a problem is noted during the inspection, it shall be reported to the Company Officer. The inspection of life safety and utility rope should check for the following:

- Damage to sheath
- Visible damage to core
- Soft spots or necking down
- Chemical or petroleum contamination
- Burns, (glazed, glossy, or melted spots)
- Heavy surface fuzz
- Stiffness
- Rust contact – (Discolor is the prime indicator)

CARE OF ROPE WHILE IN USE

- Do not step on ropes
- Protect ropes against chafing and running over sharp corners or edges
- Protect ropes from exposure to chemicals, petroleum products, battery acids and vapors
- Protect ropes from mechanical or heat damage
- Avoid running nylon ropes across nylon (or synthetic across synthetic)
- Keep nylon ropes away from heat
- Attempt to keep ropes dry, as rope loses approximately 15% of its strength when wet

ROPE STORAGE

Rope should be flaked (laid in a forward-reverse flat pattern that allows for complete visual inspection) in a rope bag and stored in a cool dry area. Damage to rope could occur if:

- Exposed to petroleum products, chemicals, or fuel and their vapors
- Exposed to battery acid, vapors or residue
- Exposed to bleach or bleach vapors
- Stored on concrete floors, as moisture in the concrete will produce a mild acid and vapor
- Stored when contaminated with dirt or grit
- Stored in sun light, as ultraviolet light can damage most ropes
- Stored with knots left in rope

CLEANING OF LIFE SAFETY ROPE

All safety ropes, cords, and webbing used for life safety are cleaned by the Bureau of Equipment. The B.O.E. uses a front loading washing machine, as a top load agitator machine will damage the rope.
Wet ropes are not dried in sunlight but are hung or chained to be air-dried. When rope, webbing or cords are returned to the company they shall be inspected upon return before being placed in service.

CRITERIA FOR REMOVING LIFE SAFETY ROPE FROM SERVICE

Life safety ropes will be removed from service when:

- Rope exhibits obvious fault or damage
- Worn out from excessive age or usage
- More than half of the outer sheath yarns are broken
- Exposed to an observable shock load
- Stressed by a load beyond what it was designed to support
- Contaminated by chemicals
- Usage cannot be accounted for
- Maximum life span reached (10 years for a life safety rope, but most rope manufacturers and rescue teams use a 5 year standard)
- At the discretion of the company commander with approval of the Officer in Charge of the Bureau of Equipment

REMOVAL OF LIFE SAFETY ROPE FROM SERVICE

Rope shall be turned into the Bureau of Equipment with a General Form Report documenting the reason for removing from service and requesting a replacement rope.

SECTION 4. ACCOUNTABILITY

LIFE SAFETY ROPE NUMBERING

Each life safety line is assigned a serial number, which will be found at each end of the rope. The serial number indicates, the company/unit the rope is assigned to, the rope length, and the rope ID number.

Example: RS21001
Means: Rescue Squad 2 – 100' long – Rope number 1

Life Safety rope shall be marked on the standing part only with tape or special rope paint that is provided by the Bureau of Equipment.

LIFE SAFETY ROPE LOG

A rope log is kept and maintained with the company/units by the unit(s) carrying a life safety rope as part of their assigned unit inventory. An entry in the rope log is required to record:

- Color
- Type of load
- Length/Diameter
- Incident # or Training site location
- Date rope is washed
- Date rope is inspected
- Any unusual loading
- Whether a fall was caught
- Discarded and made unusable for rescue rope purposes

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SECTION 5. TYPES OF FIRE SERVICE ROPE USED BY THE S.F.F.D.

As stated before, Fire Service rope falls into two use classifications: LIFE SAFETY ROPE and UTILITY ROPE. Life safety rope is used to support rescuers and/or victims. Because these situations demand a high degree of safety, the rope used must conform to the standards set forth by N.F.P.A. 1983 Standard on Life Safety Rope and Equipment for Emergency Services, 2006 Edition. Life safety rope is defined by the N.F.P.A. as “rope dedicated solely for the purpose of supporting people during rescue, fire fighting, other emergency operations, or during training evolutions.” Only rope constructed of continuous filament fiber is suitable for life safety requirements. The San Francisco Fire Department will remove a life safety rope from service when it receives a “SHOCK LOAD”. Once taken out of service, it may be reused for utility purposes only.

LIFE SAFETY ROPE

Life safety ropes fall into two construction categories: static and dynamic.

Static (low-stretch) rope is the rope of choice for rescue incidents. It is designed for low stretch without breaking. Dynamic (high-stretch) ropes stretch more than static lines both under weight and shock load and are typically used by rock climbers. Both static and dynamic ropes may be constructed in a variety of ways.

Life safety rope may be issued in varying lengths to accommodate specific needs of different companies. Stuff bags shall be issued with each rope. Life safety ropes in varying lengths (under 100’) used for anchor slings and other rigging functions are called Rigging Ropes.

Life safety rope used by the San Francisco Fire Department is static kernmantle rope, 1/2" diameter, with a minimum breaking strength of 40 kN or 9,000 lbf that meets or exceeds all the physical requirements of N.F.P.A. Standard 1983 for general use.

UTILITY ROPE

Utility rope can be used in any instance, **EXCLUDING** life safety applications, where the use of a life safety rope is required. Utility rope can be used to hoist equipment, secure unstable objects, or cordon off an area. Utility rope can be made from natural or synthetic material and can be from any of the construction

methods. There are no standards of strength set forth for utility rope. Examples of utility rope used by the San Francisco Fire Department are:

1. HYDRANT JUMPER ROPE
   15' long, 5/8" diameter manila hemp rope with an eye splice on each end
2. SUCTION ROPE
   40' long, 5/8" diameter manila hemp rope with an eye splice on each end
3. OFFICER'S ROPE
   3/8" diameter, 100' long, red static kernmantle rope with an orange/red stuff bag.

THROWLINE

A throwline is not technically a utility rope but does not qualify as a life safety rope. It is a floating rope intended to be thrown to a person during water rescues or as a tether for rescuers entering the water. It has a minimum breaking strength of 13kN or 3,000 lbf. Throwlines are issued in 100' and 200' lengths of polypropylene rope.

ROPE RELATED SOFTWARE

Prusik Cord

Prusik cord is an 8 mm nylon static kernmantle rope that falls under the same standards as life safety rope. Prusik cords are and tied into a continuous loop using a double overhand bend, creating a Prusik Loop. The Prusik Loop is then used in the construction of Raising and Lowering Systems. Prusik cords are issued in 70" and 62" lengths to facilitate use in tandem prusik belay systems for rescue operations.

Webbing

All webbing issued by the Bureau of Equipment for rope rescue operations is 1" tubular webbing (shuttle loom or needle loom construction). Rescue Squads, Cliff Rescue Unit, Light Rescue Units and Truck Companies are issued webbing, in designated colors indicating length, specifically for rope rescue operations.

The inspection and maintenance of prusik cord and webbing used in life safety systems are the same as that used for life safety rope.

ROPE AND ROPE RELATED SOFTWARE COLOR

Rope Color

Rescue ropes are issued in varying colors as determined by the company commander and the Officer in Charge of the Bureau of Equipment.

The use of different color ropes is essential in rope rescue work as this can be a major safety issue. Use of different color ropes can eliminate confusion by allowing a rescuer to request a particular color rope to be tensioned or slacked rather than to attempt to describe which of the many ropes of the same color to operate

Prusik Cord Color

Companies that are issued prusik cords are given the cords in two different colors to easily differentiate the lengths of prusik loops during operations.

Webbing Color

The following colors are universal for webbing in rope rescue operations and will be used by the San Francisco Fire Department: Again, these colors are used to easily differentiate the lengths during operations.

COLOR	LENGTH
Orange	20’
Blue	15’
Yellow	12’
Green	5’

ROPE INVENTORY FOR COMPANIES AND UNITS

Engine Companies

One (1) 100’ utility rope
One (1) hydrant jumper rope
One (1) suction rope

Truck Companies

Two (2) 200’ life safety ropes
One (1) 100’ utility rope
**Prusik Cord
** Webbing

Rescue Squads And CBRNE Unit

Four (4) 300’ life safety ropes
Three (3) 200’ life safety ropes
Two (2) 200’ life safety ropes
Two (2) 50’ rigging ropes
One (1) 200’ throwline rope
One (1) 100’ throwline rope
** Prusik Cord
** Webbing

Cliff Rescue Unit

Three (3) 350’ life safety ropes
Three (3) 200’ life safety ropes
Two (2) 100’ utility ropes
Two (2) 50’ utility ropes
** Prusik Cord
** Webbing

NOTE: The rope inventories listed above are the authorized minimum. The initial inventory of prusik cord and webbing and the final total rope inventories may be adjusted at the discretion of the company officer with approval of the Officer in Charge of the Bureau of Equipment. Personal inspection of the assigned apparatus is the best way to determine the size and the types of ropes carried.

SECTION 6. KNOTS

The ability to tie knots is a vital part of fire and rescue operations. Improperly tied knots can be extremely hazardous to both rescuers and victims. Good knots should be: easy to tie, easy to identify, easy to determine if knot is tied correctly, free from working loose on their own, relatively easy to untie after loading, and, have minimal impact on rope strength. Dressing and setting the knot is essential for easy identification of the knot and ensuring the knot operates correctly.

Regardless of the terminology, all knots depend on friction created by turns in the line. This friction weakens the line.

Examples of How Knots Reduce the Strength of the Rope:

Normal Rope……..	100%
Bowline……	60
Clove hitch……..	60
Square……..	45
Two half-hitches……	70-65

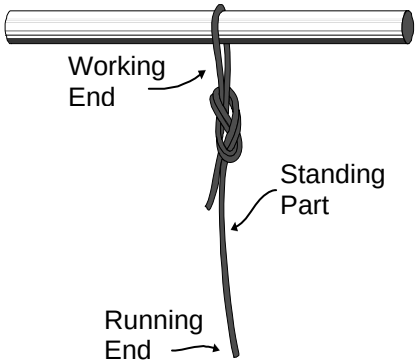
ELEMENTS OF A KNOT

Knots weaken a rope because bends are created in the rope in order to form the knot. The fibers on the outside of the bend are stretched, and the fibers on the inside of the knot are crushed. A knot with sharp bends weakens a rope more than a knot with easy bends. The bends that a rope undergoes in the formation of a knot or hitch are known as the bight, loop, and round turn.

The bight is formed by simply bending the rope back on itself while keeping the sides parallel. The loop is made by crossing the side of bight over the standing part. The round turn consists of further bending one side of the loop.

KNOT TERMINOLOGY

There are many different names for knots. In an effort to standardize terminology, this unit will attempt to use the current names for each knot, but will list other names by which they are known.



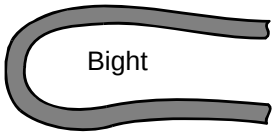
The **running end** of a rope is the part that is to be used for work such as hoisting, pulling, or belaying.

The **working end** of a rope (also known as the loose end or bitter end) is the part used in forming a knot.

The **standing part** of a rope is between the working end and the running end.

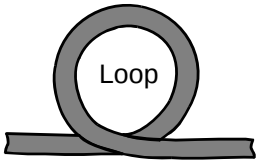
A **knot** is a rope or webbing that is intertwined.

A **bend** is two rope or webbing ends connected together.



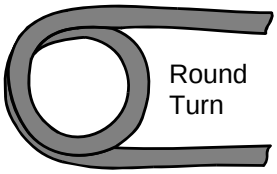
A **hitch** is a rope or webbing around an object (if the object is removed the hitch will fall apart).

A **bight** is formed by simply bending the rope back on itself while keeping the sides parallel.



A **loop** is made by crossing one side of a bight over the standing part so that the rope crosses itself.

A **round turn** is made by continuing to cross one side of a loop all the way around to form a circle with the ends of the rope parallel as in a bight.

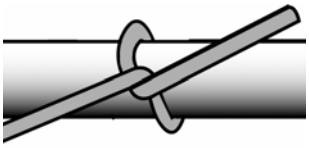


BASIC KNOTS

These knots are used for utility rope purposes or to complete other knots. All firefighters should be familiar with these knots and be able to tie them in limited visibility conditions.

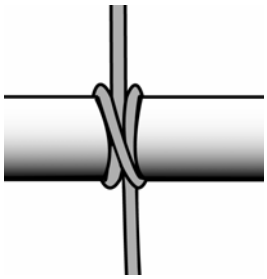
NOTE: The explanations and illustrations are intended to assist in identifying the basic knots only. Refer to the SFFD Drill Manual for proper tying techniques.

Half Hitch



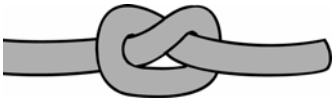
Half hitches are temporary knots that are not intended to support a lot of strain. They are used to complete and make other knots stronger, for hanging, tying, and hooking objects. The half hitch is one of the best known knots and is widely used in a variety of situations.

Clove Hitch



The knot known to sailors as the clove hitch is also known under other names such as the peg knot in camping and the boatman's knot in climbing. It is a safe knot that is easy to make and is used in a variety of situations. The clove hitch may be formed anywhere in the rope from one end to the middle. It consists of two half hitches. The principal use is to attach a rope to an object such as a pole or post, or, to attach an appliance or hose for lifting. When properly applied, it will stand a pull in either direction without slipping.

Overhand Knot



The overhand is one of the most fundamental knots and forms the basis of many other knots. The overhand knot is very secure, to the point of being difficult to untie once loaded. It is often used as an anti-slip or safety knot or to prevent the end of a rope from unraveling.

Square Knot

The square knot is also called a reef knot because it is used when securing a reefed sail to a boom. It can be used to fasten two lines of equal size or two ends of the same line. However, it is useful only when no

great load is anticipated, such as in tying packages. If used to bend two lines of unequal size together, it will slip. When the knot is under tension, it is very difficult to untie. If unequal tension is applied, such as a jerk on one side, the knot is apt to turn into two half hitches. When tied, a square knot should have both ends on the same side. If the ends are on opposite sides you have tied a "thief's knot or granny" which will slip under tension.

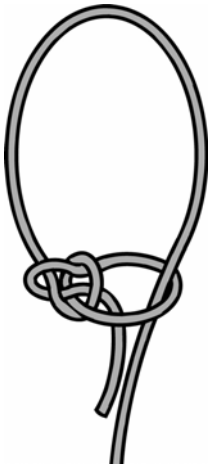
Bowline

A bowline is used to form a temporary but fixed size loop at the end of a line. It is often called the "King of Knots" because of its many uses. Bowlines are easy to untie even after being under a load. Bowlines are used to tie lines of equal or unequal sizes together.

Running Bowline

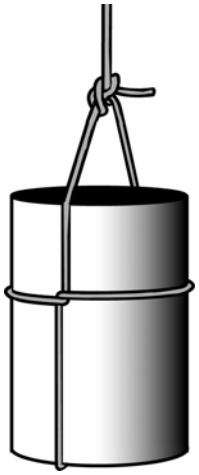
The running bowline is mainly used for hanging objects of different diameters with ropes. The weight of the object determines the tension necessary for the knot to grip. The running bowline is strong and secure, does not weaken the rope excessively, slides easily, and unties just as simply.

When a running bowline is to be passed over an object, it is only necessary to make a bowline to simulate an eye-splice and then form an eye-loop.



Equalizing Bowline

The equalizing bowline is used when a bowline can be used but the loop size must be adjusted or the knot centered prior to loading. Examples of such instances are tying a barrel, a large ladder or a litter basket. Once tied, the equalizing bowline should look like the bowline.

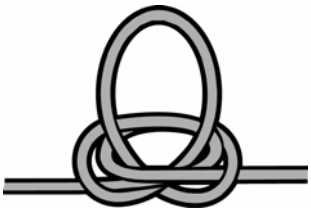


RESCUE KNOTS

The rescue knots illustrated in this manual are not a comprehensive list of all knots used during rescue operations. These knots encompass the very minimum that all firefighters should be familiar with.

NOTE: The explanations and illustrations are intended to assist in identifying the rescue knots only. Refer to the SFFD Drill Manual for proper tying techniques.

Butterfly Knot



The butterfly knot is a middle of the rope tie creating a loop that has a high breaking strength and can be loaded to either side of the rope. It can be used to attach a load to the middle of the rope or to isolate a worn section of rope while maintaining the rope's integrity.

Figure 8 Stopper

The figure 8 is the basis for tying the figure 8 follow through bend, the figure 8 follow through with a loop, and the figure 8 on a bight double loop. The figure 8 itself is a quick and convenient stopper knot which can be undone fairly easily.

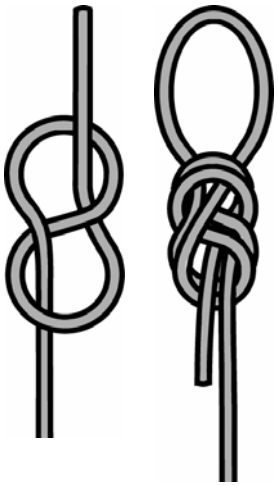


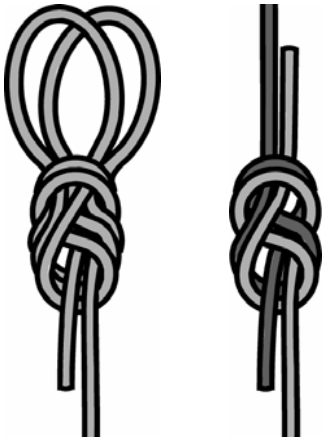
Figure 8 On A Bight Single Loop

The TFigure 8 on a bight single loop allows the simple and reliable figure eight loop to be tied to a ring, a carabiner, or your own harness. It is easily remembered, easily visualized, and easily checked.

Figure 8 Follow Through With A Loop

The figure 8 follow through with a loop looks exactly like a figure 8 on a bight single loop when tied. The difference in the tying technique allows it to be tied around an object rather than completely tied and then attached to an object, which is not always possible.

Figure 8 On A Bight Double Loop

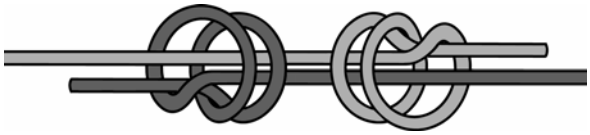


The two loops can be used as an improvised seat. It is also useful for equalizing the load on two anchors. In one top-roping technique, the loops are made very unequal. The much larger one is passed around both anchor points. The center of this loop is then secured with a carabiner to the small loop. During rappelling, this ensures a more even distribution of load between the two anchor points.

Figure 8 Follow Through Bend

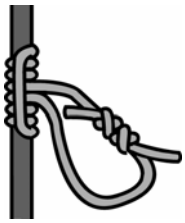
The Figure 8 follow through bend provides a safe and simple way to join two ropes. Its advantage over the less bulky double overhand bend is that even after considerable strain it remains relatively easy to untie.

Double Overhand Bend



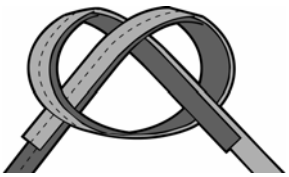
The double overhand bend, or fisherman's knot, is used to form a prusik loop. It is also an excellent and reliable way of joining two ropes of the same diameter. It can be difficult to untie after loading.

Three Wrap Prusik Hitch



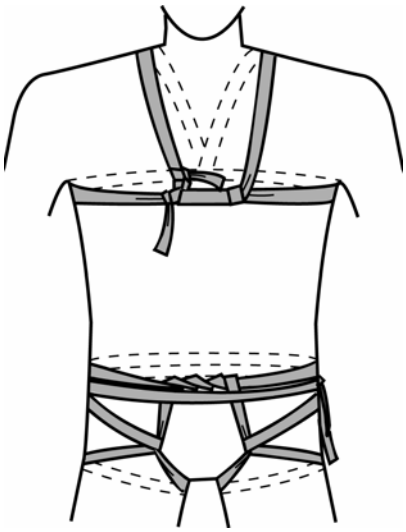
Also known as the prusik knot, the three wrap prusik hitch is used to attach a prusik loop to a life safety rope, forming a hauling, ratchet, or braking cam. The two wrap prusik hitch used in mountaineering doesn't have sufficient holding power for rescue operations and should not be used.

Overhand Bend



The overhand bend, or water knot, is used to form a continuous loop of webbing or to join two pieces of webbing together to increase its length. As a loop, the webbing can be used as an equipment sling, hasty harness, anchor strap, or hose and ladder strap among other things.

Chest Harness

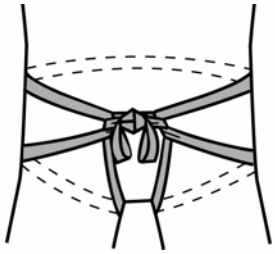


Made from a 12’ or 15’ length of webbing, the chest harness will keep the rescuer or victim from inverting while being suspended from a rope rescue system. It is to be used with a seat harness at all times. During low angle rescue operations a chest harness is not necessary.

Swiss Seat

The swiss seat harness is tied using a 15’ or 20’ length of webbing. It may be used alone in low angle operations but must be used with a chest harness during high angle operations. Improper adjustment before loading or long term use of the swiss seat can be extremely uncomfortable. It should only be used if a commercially made harness is not available.

Hasty Harness



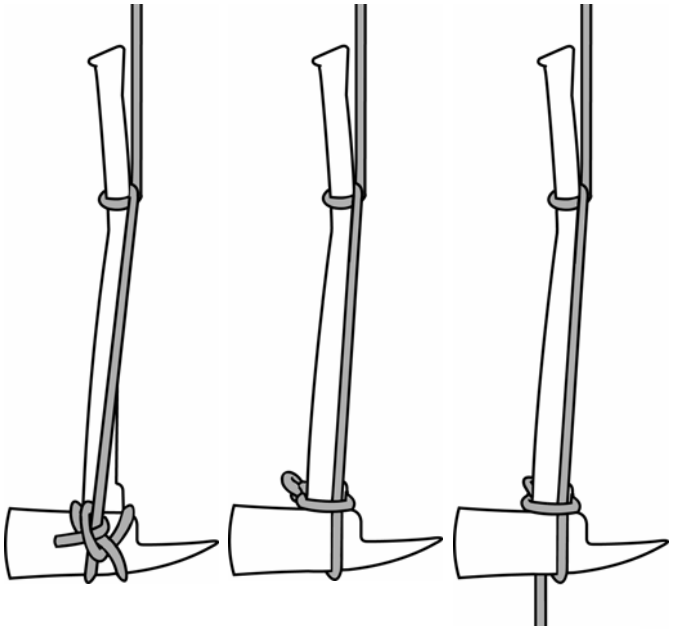
The hasty harness is the “last resort” option for a seat harness on a rescuer. A more acceptable use is as a victim harness because it can be attached to the victim with a minimum of disruption. It is formed using a loop created from a 15’ length of webbing with a water knot.

TOOL HOISTING TIES

The basic knots and hitches included in this manual can be used singly or in combination to form various rope ties in operations where hoisting or lowering of equipment is necessary. All firefighters should be familiar with these hoisting ties.

NOTE: The explanations and illustrations are intended to assist in identifying the tool hoisting ties only. Refer to the SFFD Drill Manual for proper tying techniques.

AXE HOIST



Clove Hitch

Formed by tying a clove hitch with a half hitch safety around the axe head, capturing the handle, followed by a half hitch on the axe handle near the base. (1)

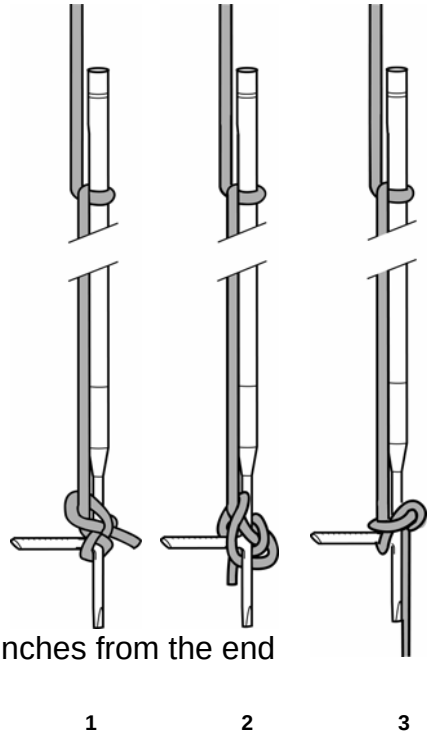
Running Bowline

Formed by placing the handle inside the bowline, with the running part around the axe head, followed by a half hitch on the axe handle near the base. (2)

Middle Of Rope Tie

Formed by making a slip knot around the axe handle, capturing the axe head, followed by a half hitch around the axe handle near the base. (3)

CEILING HOOK HOIST



Clove Hitch

Formed by tying a clove hitch with a half hitch safety around the point of the ceiling hook, capturing the hook, followed by a half hitch 12 inches from the end of the ceiling hook. (1)

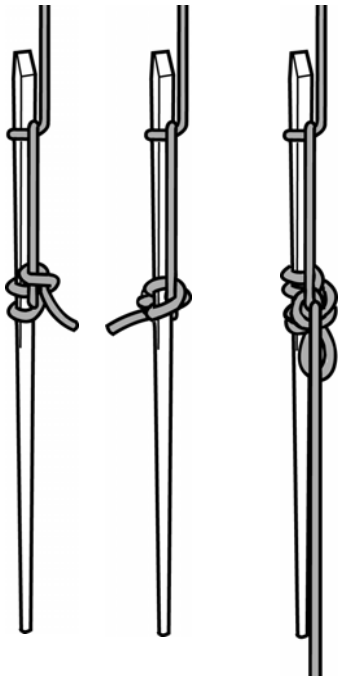
Running Bowline

Formed by placing the hook inside the bowline, with the running part of the bowline around the point of the ceiling hook, followed by a half hitch 12 inches from the end of the ceiling hook. (2)

Middle Of Rope Tie

Formed by making a slip knot around the point of the ceiling hook, capturing the hook, followed by a half hitch 12 inches from the base. (3 previous page)

CROW BAR HOIST



1 2 3

Clove Hitch

Formed by tying a clove hitch with a half hitch safety around the handle, just under the shoulder of the bar, followed by a half hitch on the large end of the bar 12 inches from the tip. (1)

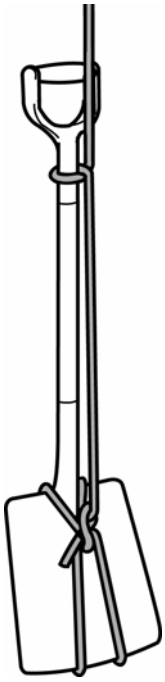
Running Bowline

Formed by tying the running bowline around the handle and cinching it just under the shoulder of the bar, followed by a half hitch on the large end of the bar 12 inches from the tip. (2)

Middle Of Rope Tie

Formed by making two back-to-back overhand loops from a bight in a rope, and then put the top loop underneath the bottom one and cinching it (forming a clove hitch) around the handle just under the shoulder of the bar, then a half hitch safety on the clove hitch, followed by a half hitch on the large end of the bar 12 inches from the tip. (3)

SQUARE SHOVEL HOIST



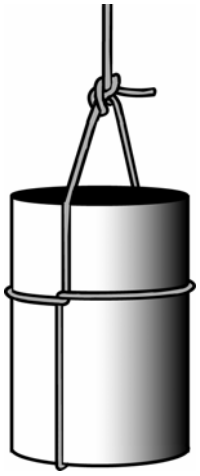
Clove Hitch

Formed by tying a clove hitch with a half hitch safety around the scoop and capturing the shovel handle followed by a half hitch near the bale of the shovel.

BARREL TIE HOIST

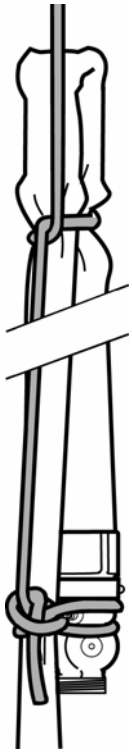
Equalizing Bowline

Formed by placing the barrel on the rope and tying
an overhand knot above the top of the barrel,
separating the overhand knot and slipping it over the sides of the barrel 1/3 down from the top, then cinching the rope and tying an equalizing bowline at the top of the barrel.



SECTION 7. HOSE LINES AND APPLIANCES TIES

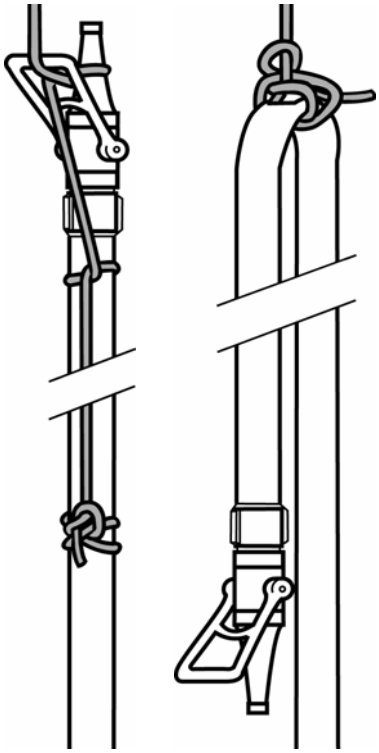
LARGE LINE HOIST



Dry Line

Formed by folding the Gorter shut-off and hose back at least four feet over the top of the hose with the shut-off handle facing into the fold, then tying a clove hitch with a half hitch safety around the shut-off above the collar followed by a half hitch around 1 foot from the hose bight.

SMALL LINE HOIST – READY LINE



Charged Line

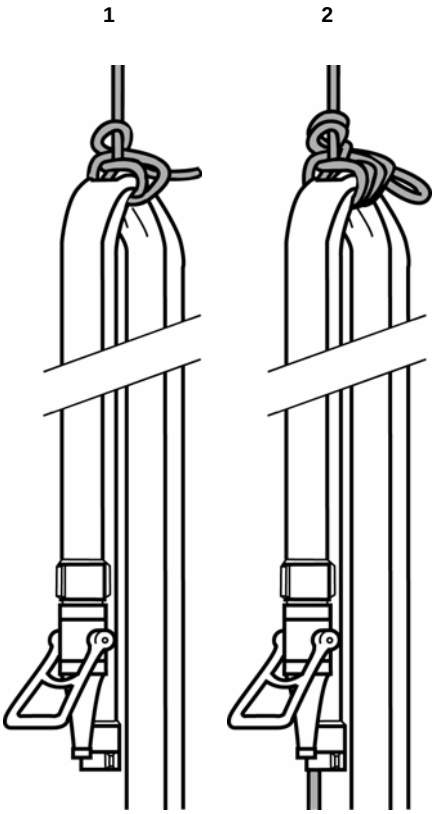
Formed by tying a clove hitch with a half hitch safety around the hose 4 feet behind the nozzle, then a half hitch around the hose 3 to 6 inches back from the nozzle connection followed by a half hitch slipped through the nozzle bale and around the nozzle. (1)

Dry Line

Formed by tying a clove hitch with a half hitch safety 4 feet behind the nozzle. (2)

1 2

SMALL LINE HOIST – BUNDLE



Clove Hitch

Formed by placing the nozzle side of the hose over the female end of the hose and lining up the female coupling even with nozzle tip, then tying a clove hitch with a half hitch safety around both the nozzle end and female end of the hose at least 4 feet behind the nozzle connection**.** (1)

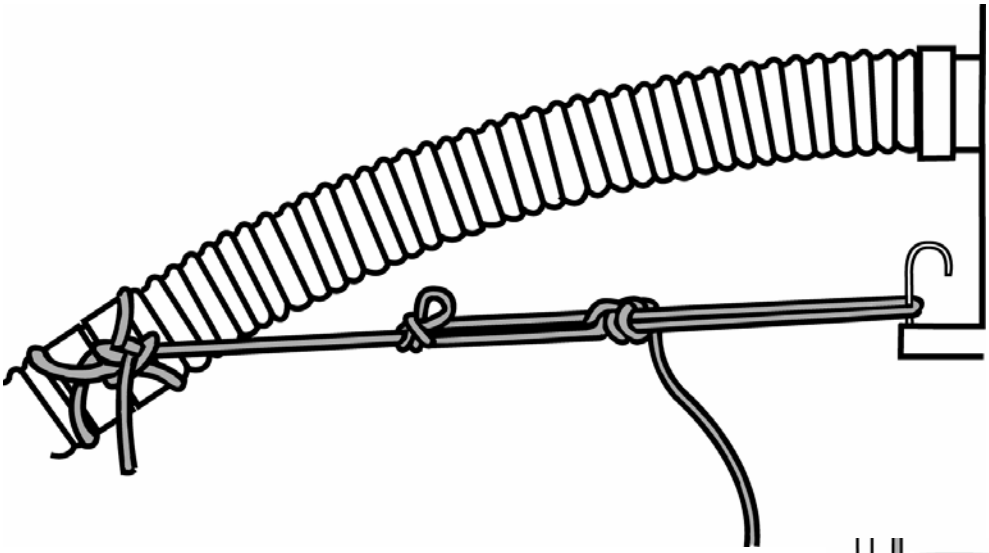
Middle Of Rope Tie

Formed by placing the nozzle side of the hose over the female end of the hose and lining up the female coupling even with nozzle tip, then tying a clove hitch on a bight with a half hitch safety around both the nozzle end and female end of the hose at least 4 feet behind the nozzle connection**.** (2)

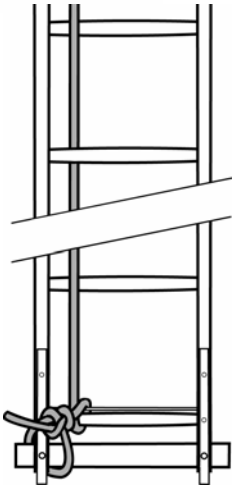
HARD SUCTION HOSE TIE

Firefighter's Hitch

Formed by tying a clove hitch with a half hitch safety around the double hose coupling, then placing standing part of rope around an anchor and throwing the running end of the rope across the standing part of the rope to the opposite side one is working from, then forming a bight in the standing part, bringing it over the inactive part of the rope, and securing it with a bowline knot, and finally taking up the slack with the running end of the rope and securing it with two half hitches.

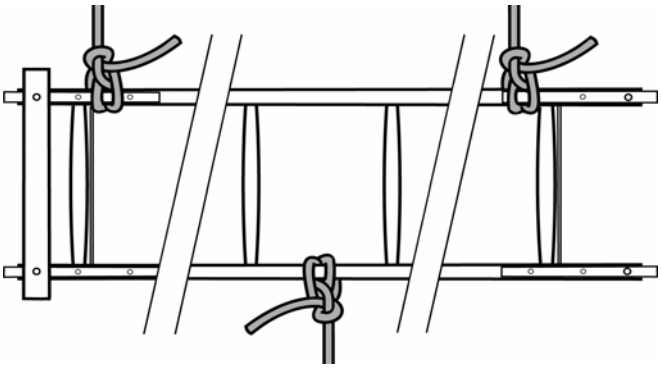


LADDER HOIST



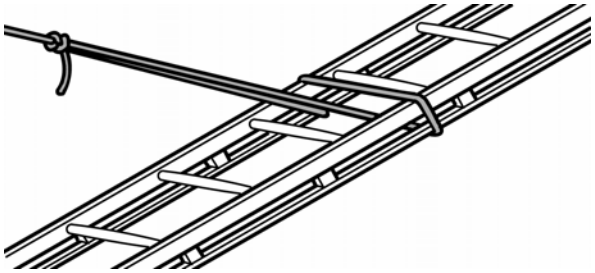
Vertical Ladder Hoist

The vertical ladder hoist is used should the need arise to raise a ladder from an elevated location. Examples of such situations are a window that can only be accessed from the flat roof of the building next door or a light well that the ladder must be lowered into. Always be aware of windowsills, protruding brickwork, or any other structural element that could snag the ladder as it is being hoisted. To better facilitate the raising of the ladder on a roof or the placing of a ladder in a light well, the ladder should be tied so that the butt of the ladder is raised first. The vertical ladder hoist is tied using a bowline knot.



Horizontal Ladder Hoist

When wires or any other obstruction prevent hoisting a ladder and bringing it over the fire wall in the normal (vertical) manner, the horizontal ladder hoist may be used. Two ropes from the roof and one rope as a guide line from the ground will be required. Ropes are attached to the ladder with clove hitches with half hitch safeties.



Bridging Tie

Used to bridge an open space between buildings, the bridging tie is formed by tying the equalizing bowline around a straight-trussed ladder. Once the ladder is placed, the rope is left attached but placed to the side to prevent it from interfering with the use of the ladder.

SECTION 8. GLOSSARY OF ROPE TERMS

ANCHORED: Fastened to some immovable object. Anchor is the general term for the combination of anchor points, rope web, and other equipment that allows you to securely attach your rope or yourself to an immovable object such as a rock, tree, building or truck.

BELAY LINE: The line is designated to provide fall protection. In a two line system, the Belay Line provides for protection while the Main Line controls the rate of travel. When adjustments are made in the systems, the Belay Line waits for the Mail Line to change first.

BELAY ROPE: The rope that will be used for the belay.

BEND: A knot that connects the ends of two ropes together.

BITTER END: The end of the rope with which you work when you tie a knot.

BIGHT: A bend in a rope forming a loop.

BOWLINE: One of the most used knots for utility purposes; the bowline should not be used for rescue operations.

CLOVE HITCH: Used for a safe, secure anchor when tying off a rope prior to lifting tools, appliances, hose, etc.

DRESSING: The practice of ensuring that all parts of the knot are lying in the proper orientation to the other parts of the knot.

DYNAMIC ROPE: A rope designed to absorb the energy of a fall.

EYE: Also called an eye splice, a loop formed at the end of a rope by splicing.

FATHOM: Approximately six feet; a measure of the distance a person can extend their arms from the side of their body in a horizontal position.

GUIDE LINE: Ropes held and controlled on the ground or lower elevations used to keep tools or equipment being hoisted from snagging or being damaged as they are hoisted.

HAUL: The act of pulling on a rope.

HAULING PART: The part of a rope which is loose or free and used to haul an object.

HITCH: A closed loop on a rope; a simple fastening of a rope by passing or crossing one rope over the other, but without actually knotting the rope.

KERNMANTLE: German word meaning “core” and “sheath” referring to a rope with a load bearing core held together (covered) by a protective sheath.

LIFE SAFETY ROPE: A line, rope or webbing used to raise or lower human life, lift objects off of human life, whose failure of the line, rope, or webbing will result in death or injury.

LINE: Another name for rope often used to refer to a rope that is in use.

LOAD: A general term for everything that is hanging on the rope at the end away from the anchor.

LOOP: A turn in the standing part of the rope crossing over itself and continuing on in the original direction of travel.

MAIN LINE: The rope designated as the primary line in a two rope system even though both ropes may have identical systems and be equally loaded. In a raising system it will be the haul rope with the mechanical advantage. In lowering, it controls the rate of descent.

PRUSIK CORD: 8 mm nylon static kernmantle ropes.

PRUSIK LOOP: A prusik cord made into a continuous loop by joining the two ends with a double overhand bend.

RUNNING END: The end of the rope that you are working with.

SETTING: Ensuring that the knot is snug in all directions of pull.

SHOCK LOAD: A load or impact being transferred to a rope suddenly.

STANDING END: The part of the rope attached to something, usually your anchor. The inactive part as opposed to the running end.

STATIC: Current usage defines a static or low stretch rope as one with less than 20% elongation at the breaking load and less than 2% at 200 pounds.

TENSILE STRENGTH: The greatest longitudinal stress (as pounds per square inch) a substance can bear without tearing apart. Amount of static force needed to break a rope, line or webbing. Tensile strength is not an indicator of rope strength. The N.F.P.A. standard for a life line is 9000.

UTILITY ROPE: A line, rope, or webbing used for pulling, lifting objects or equipment with no endangerment of human life.

WATER KNOT: Also called an overhand bend, used for tying ends of one inch webbing.

WORKING END: The end of the rope used to secure or tie off the rope.

WORKING STRENGTH: The maximum load that a rope should support without damage or failure, while in use. One-fifth of current tensile strength of the rope in use. The working strength is never constant and will vary with the type of use and will decrease with each use.