Chapter 2

Construction Support

Topics

1.0.0 Using Lines and Slings

2.0.0 Moving Materials and Equipment

3.0.0 Hazardous Materials

4.0.0 Tools and Tool Kits

To hear audio, click on the box.

Overview

As a Construction Electrician you will be involved in many aspects of construction work. This chapter touches on a few of these, such as rigging and hoisting, equipment movement, hazardous material, tools, and tool kits. Although this chapter does not deal with electrical work, you need to study and refer back to this chapter for your safety and the safety of your shipmates.

Objectives

When you have completed this chapter, you will be able to do the following:

1. Describe the use of lines and slings.
2. Describe the procedures utilized for moving materials and equipment.
3. Describe the Hazardous Materials program.
4. Identify tools and toll kits utilized.
5. Identify the hand signals utilized.

Prerequisites

This course map shows all of the chapters in Construction Electrician Basic. The suggested training order begins at the bottom and proceeds up. Skill levels increase as you advance on the course map.

Test Equipment, Motors, and Controllers	↑	C E
Communications and Lighting Systems		
Interior Wiring and Lighting		
Power Distribution		
Power Generation		
Basic Line Construction/Maintenance Vehicle Operations and Maintenance		B A
Pole Climbing and Rescue		S
Drawings and Specifications		I
Construction Support		C
Basic Electrical Theory and Mathematics		

Features of this Manual

This manual has several features which make it easier to use online.

- Figure and table numbers in the text are italicized. The figure or table is either next to or below the text that refers to it.
- The first time a glossary term appears in the text, it is bold and italicized. When your cursor crosses over that word or phrase, a popup box displays with the appropriate definition.
- Audio and video clips are included in the text, with an italicized instruction telling you where to click to activate it.
- Review questions that apply to a section are listed under the Test Your Knowledge banner at the end of the section. Select the answer you choose. If the answer is correct, you will be taken to the next section heading. If the answer is incorrect, you will be taken to the area in the chapter where the information is for review. When you have completed your review, select anywhere in that area to return to the review question. Try to answer the question again.
- Review questions are included at the end of this chapter. Select the answer you choose. If the answer is correct, you will be taken to the next question. If the answer is incorrect, you will be taken to the area in the chapter where the information is for review. When you have completed your review, select anywhere in that area to return to the review question. Try to answer the question again.

1.0.0 USING LINES and SLINGS

The safety of personnel involved in rigging and hoisting operations largely depends upon care and common sense. Equally important is the proper selection of lines and slings for safe and stable lifts.

1.1.0 Inspections

The single most important operational check to be made on hoisting and rigging equipment is the line and rigging inspection. Such factors as ***abrasion***, wear, ***fatigue***, ***corrosion***, and ***kinking*** are of great significance in determining usable life.

The only way to determine the safety of a line, its life expectancy, and its load-carrying ability is by regularly inspecting every foot of its length. The main points to watch for are external wear and cutting, internal wear between the strands, and deterioration of the fibers.

1.2.0 Fiber Lines

Fiber lines are made from either natural or synthetic fibers. The natural fibers come from plants and include manila, ***sisal***, and hemp. The synthetic fibers include nylon, ***polypropylene***, and the polyesters. The strength of these lines depends on their size, the fiber used, and the type of stranding.

1.2.1 Uncoiling Line

New line is coiled, bound, and wrapped. The protective covering should not be removed until the line is to be used. This covering will protect the line during stowage and prevent tangling. To open, strip off the outer wrapping and look inside the coil for the end of the line. This should be at the bottom of the coil. If not, turn the coil over so that the end will be at the bottom, as shown in *Figure 2-1*. Pull the end of the line up through the center of the coil. As the line comes up through the coil, it will unwind in a counterclockwise direction.

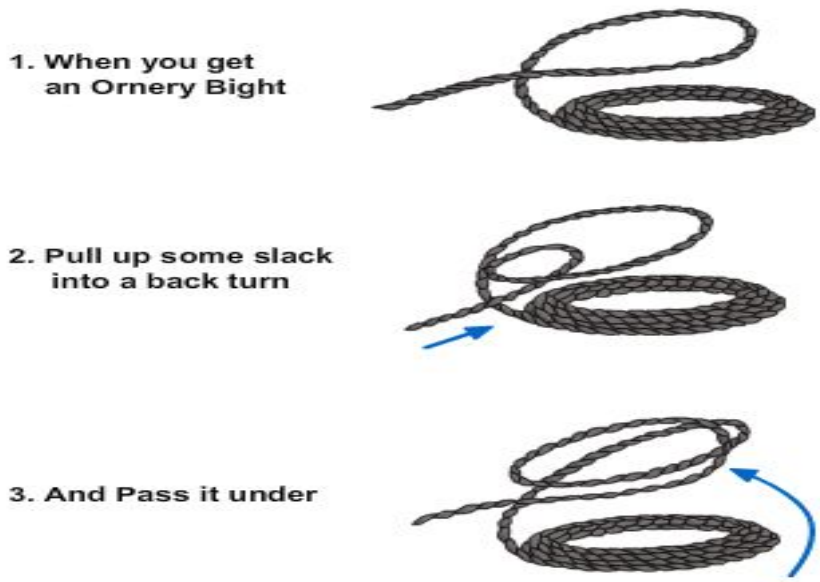

Figure 2-1 – Uncoiling line from a shipping reel.

1.2.2 Whipping Line

The term whipping refers to the process of securing the ends of a line to prevent the strands from unraveling and the yarns from separating or fraying. Whippings are made from fine twine and will not increase the size of the line enough to prevent it from fitting the blocks or openings

Make a loop in the end of the twine and place the loop at the end of the line, as shown in the figure. Wind the standing part around the line covering the loop of the whipping. Leave a small loop uncovered, as shown. Pass the remainder of the standing end up through the small loop and pull the dead end of the twine, thus pulling the small loop and the standing end back towards the end of the line underneath the whipping. Pull the dead end of the twine until the loop with the standing end reaches a point midway underneath the whipping. Trim both ends of the twine close up against the loops of the whipping. Before cutting a line, place two whippings on the line 1 or 2 inches apart and make the cut between the whippings. This will prevent the ends from unraveling after they are cut.

1.2.3 Stowing Line

Before stowing a fiber line, you must take certain precautions to safeguard the line against deterioration. **NEVER** stow a wet line. Always dry the line well before placing it in stowage. Refer to *Figure 2-2*.

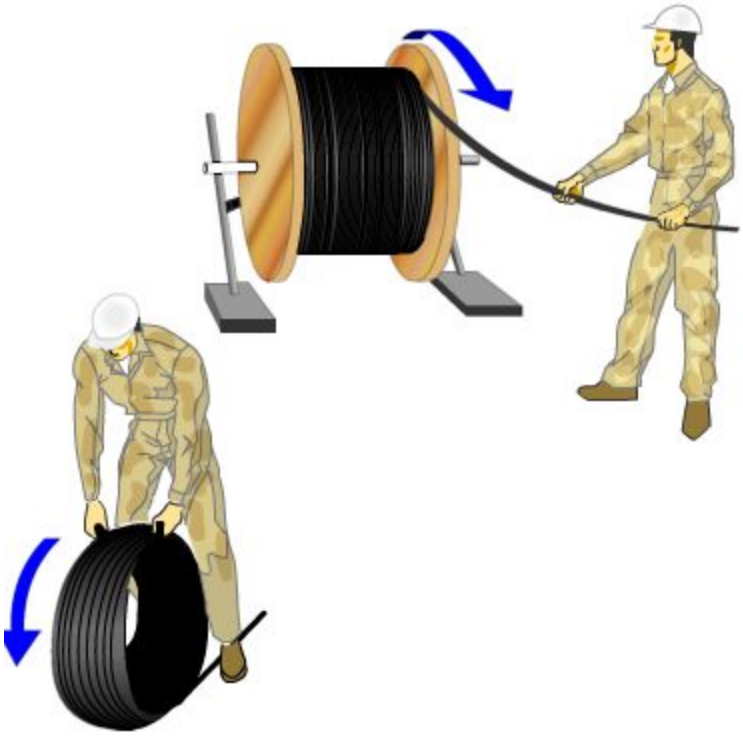

Figure 2-2 – Stowing a line.

After a line has been used, you should coil it down in a clockwise direction (assuming it is a right-hand lay). Should the line be kinked from excessive turns, remove the kinks by the procedure known as "thorough footing." You do this by coiling the line down counterclockwise and then pulling the bottom end of the coil up and out the middle of the coil. If the line is free of kinks as it leaves the coil, make it up in the correct manner. If it is still kinked, repeat the process before making up the line for stowage.

Choose your stowage space for line carefully. Line deteriorates rapidly if exposed to prolonged dampness. Furthermore, it is important for the stowage area to be dry, unheated, and well ventilated. To permit proper air circulation, you should either place the line in loose coils on a wood grating platform about 6 inches (15 cm) above the floor or hang the line in loose coils on a wooden peg.

You should **NEVER** expose a line to lime, acids, or other chemicals, or even stow it in a room containing chemicals. Even the vapors may severely damage line. As a final precaution, avoid continually exposing line to sunlight. Excessive sunlight will also damage the line.

1.2.4 Strength of Fiber Line

Overloading a line poses a serious threat to the safety of personnel, not to mention the heavy losses likely to result through damage to material. To avoid overloading, you must know the strength of the line you are working with. This involves three factors: breaking strength, safe working load, and safety factor.

Breaking Strength (**BS**). Refers to the tension at which the line will part when a load is applied. Line manufacturers have determined breaking strength through tests and have set up tables to provide this information.

Safe Working Load. Briefly defined, the "safe working load" (**SWL**) of a line is the load that can be applied without causing any kind of damage to the line. Note that the SWL is considerably less than the BS. A wide margin of difference between BS and SWL is necessary to allow for such factors as additional strain imposed on the line by jerky movements in hoisting or bending over sheaves in a pulley block.

Safety Factor. Safety factor of a line is the ratio between the BS and the SWL. Usually, a safety factor of 4 is acceptable, but this is not always the case. In other words, the safety factor will vary, depending on such things as the condition of the line and circumstances under which it is to be used. While the safety factor should NEVER be less than 3, it often should be well above 4 (possibly as high as 8 or 10). For best, average, or unfavorable conditions, the safety factor indicated below may often be suitable.

BEST conditions (new line): 4

AVERAGE conditions (line used but in good condition): 6

UNFAVORABLE conditions (frequently used line, such as running rigging): 8

Table 2-1 lists some of the properties of manila and sisal line, including strength. The table shows that the minimum BS is considerably greater than the safe working capacity. The difference is caused by the application of a safety factor. The SWL of line is obtained by dividing the BS by a factor of safety (**FS**). A new 1-inch diameter # 1 manila line has a BS of 9,000 pounds, as indicated in Table 2-l. To determine the SWL of the line, you would divide its BS by a minimum standard safety factor of 4. The result is an SWL of 2,250 pounds. A safety factor is always used because the BS of line becomes reduced after use and exposure to weather conditions. In addition, a safety factor is required because of shock loading, knots, sharp bends, and other stresses that the line may encounter during its use.

If tables are not available, the SWL may be closely approximated by a rule of thumb. The rule of thumb for the SWL, in tons, for fiber line is equal to the square of the line diameter in inches (SWL = D^2). The SWL, in tons, of a 1/2-inch-diameter fiber line would be 1/2 inch squared or 1/4 ton. The rule of thumb allows a safety factor of approximately 4.

Table 2-1 – Properties of manila and sisal line.

Nominal diameter (inches)	Circumference (inches)	Lb per ft	No. 1 Manila		Sisal	
			Breaking Strength (pounds)	Safe load (pounds) F.S. = 4	Breaking Strength (pounds)	Sale load (pounds) F.S. = 4
1/4	3/4	.020	600	150	480	120
3/8	1 1/8	.040	1,350	325	1,080	260
1/2	1 1/2	.75	2,650	660	2,120	520
5/8	2	.133	4,400	1,100	3,520	880
3/4	2 1/4	.167	5,400	1,350	4,320	1,080
7/8	2 3/4	.186	7,700	1,920	6,160	1,540
1	3	.270	9,000	2,250	7,200	1,800
1 1/8	3 1/2	.360	12,000	3,000	9,600	2,400
1 1/4	3 3/4	.418	13,500	3,380	10,800	2,700
1 1/2	4 1/2	.600	18,500	4,650	14,800	3,700
1 3/4	5 1/2	.895	26,500	6,625	21,200	5,300
2	6	1.08	31,000	7,750	24,800	6,200
2 1/2	7 1/2	1.35	46,500	11,620	37,200	9,300
3	9	2.42	64,000	16,000	51,200	12,800

1.3.0 Synthetic Fiber Lines

Synthetic-fiber lines, such as nylon and polyester, have rapidly gained wide use by the US Navy. They are lighter in weight, more flexible, less bulky, and easier to handle and stow easier than manila lines. Also, they are highly resistant to mildew, rot, and fungus. Synthetic lines are stronger than natural-fiber line; for example, nylon is about three times stronger than manila. When nylon line is wet or frozen, the loss of strength is relatively small. Nylon line will hold a load, even though several strands may be frayed. Ordinarily, the line can be made reusable by cutting away the chafed or frayed section and splicing the good line together.

Tables 2-2 and *2-3* list the approximate safe working loads of new fiber lines with a safety factor of 5.

Table 2-2 – Safe working load of fiber line.

APPROXIMATE SAFE WORKING LOADS OF NEW FIBER LINES – POUNDS

Three Strand Line

Safety Factor = 5

Nominal Line Diameter (inches)	Manila	Nylon	Polypropylene	Polyester	Polyethylene
3/16	100	200	150	200	150
1/4	120	300	250	300	250
5/16	200	500	400	500	350
3/8	270	700	500	700	500
1/2	530	1,250	830	1,200	800
5/8	880	2,000	1,300	1,900	1,050
3/4	1,080	2,800	1,700	2,400	1,500
7/8	1,540	3,800	2,200	3,400	2,100
1	1,800	4,800	2,900	4,200	2,500
1 1/8	2,400	6,300	3,750	5,600	3,300
1 1/4	2,700	7,200	4,200	6,300	3,700
1 1/2	3,700	10,200	6,000	8,900	5,300
1 5/8	4,500	12,400	7,300	10,800	6,500
1 3/4	5,300	15,000	8,700	12,900	7,900
2	6,200	17,900	10,400	15,200	9,500

Table 2-3 – Safe working load of braided synthetic fiber line.

APPROXIMATE SAFE WORKING LOADS OF NEW BRAIDED SYNTHETIC FIBER LINES (LBS) SAFETY FACTOR = 5			
Nominal Line Diameter (inches)	Nylon Cover Nylon Core	Nylon Cover Polypropylene Core	Polyester Cover Polypropylene Core
1/4	420	-----	380
5/16	640	-----	540
3/8	880	680	740
7/16	1200	1000	1060
1/2	1500	1480	1380
9/16	2100	1720	-----
5/8	2400	2100	2400
¾	3500	3200	2860
7/8	4800	4150	3800
1	5700	4800	5600
1 1/8	8000	7000	-----
1 1/4	8800	8000	-----
1 1/2	12800	12400	-----
1 5/8	16000	14000	-----
1 3/4	19400	18000	-----
2	23600	20000	-----

NOTE

These are for reference only. Check the manufacturer's ratings before determining the SWLs, as they may differ from the tables.

You may not always have a chart available to tell you the safe working load for a particular size of line. There is a rule of thumb that will adequately serve your needs on such an occasion. The formulas below are examples of synthetic fiber lines used for rigging, not slings.

For nylon or polyester line, change the line diameter into eighths of an inch, square the numerator, and multiply by 60.

Example: 1/2-inch nylon line = 4/8-inch diameter

SWL = 4 x 4 x 60 = 960 lb

For polypropylene line, multiply the diameter by 40, and for ***polyethylene***, by 35.

Remember that the strength of a line decreases with age, use, and exposure to excessive heat, boiling water, or sharp bends. Especially with used line, you should give these and other factors affecting strength careful consideration and make proper adjustment in the breaking strength and SWL of the line.

1.4.0 Wire Rope

During the course of a career, Construction Electricians often need to hoist or move heavy objects. Wire rope is used for heavy-duty work. In the following paragraphs, we will discuss the characteristics, construction, and usage of many types of wire rope as well as the safe working load, use of attachments and fittings, and procedures for the care and handling of wire rope.

1.4.1 Construction

Wire rope consists of three parts: wires, strands, and core (*Figure 2-3*). In the manufacturing of wire rope, a number of WIRES are laid together to form the STRAND. Then a number of STRANDS are laid together around a CORE to form the wire ROPE.

The basic unit of wire-rope construction is the individual wire, which may be made of steel, iron, or other metal in various sizes. The number of wires to a strand will vary, depending on the purpose for which the wire rope is intended. Wire rope is designated by the number of strands per rope and the number of wires per strand. Thus a 1/2-inch, 6 by 19 wire

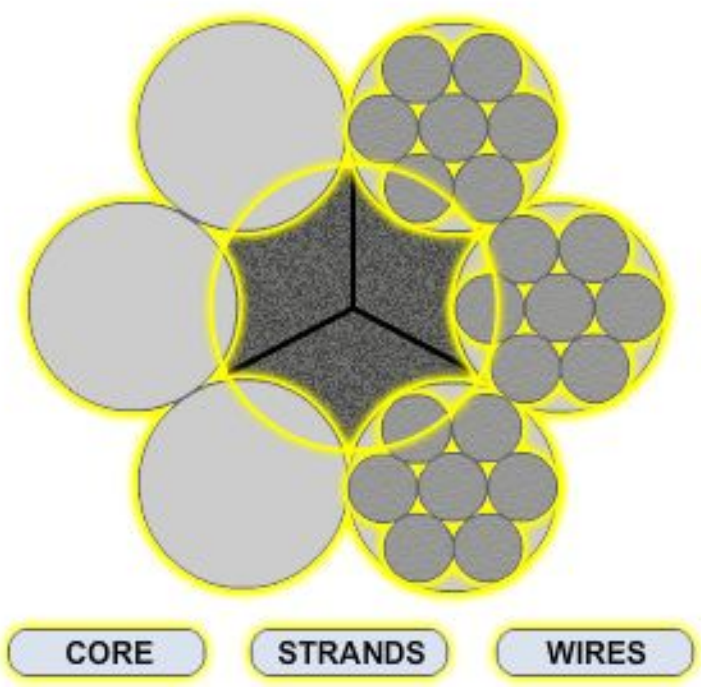

Figure 2-3 – Parts of a wire rope.

rope will have six strands with 19 wires per strand; but it will have the same outside diameter as a 1/2-inch, 6 by 37 wire rope, which will have six strands with 37 wires of much smaller size per strand.

Wire rope that is made up of a large number of small wires is flexible. The small wires are, however, easily broken, so the wire rope does not resist external abrasion. Wire rope that is made up of a smaller number of larger wires is more resistant to external abrasion but is less flexible.

The **CORE**, the element around which the strands are laid to form the wire rope, may be of hard fiber, such as manila, hemp, plastic, paper, or sisal. Also, a wire strand core may be used. Each type of core serves the same basic purpose; to support the strands laid around it.

A **FIBER CORE** offers the advantage of increased flexibility. Also, it serves as a cushion to reduce the effects of sudden strain and acts as a reservoir for the oil to lubricate the wires and strands to reduce friction between them. Wire rope with a fiber core is used in places where flexibility of the wire rope is important.

A **WIRE-STRAND CORE** not only resists heat better than a fiber core but it also adds about 15 percent to the strength of the wire rope. On the other hand, the wire strand makes the wire rope less flexible than a fiber core would.

An **INDEPENDENT WIRE-ROPE CORE** is a separate wire rope over which the main strands of the wire rope are laid. It usually consists of six seven-wire strands laid around either a fiber core or a wire-strand core. This core strengthens the wire rope more, provides support against crushing, and supplies maximum resistance to heat.

Wire rope may be made by either of two methods. If the strands or wires are shaped to conform to the curvature of the finished wire rope before laying up, the wire rope is termed preformed. If they are not shaped before fabrication, the wire rope is termed non-preformed. When cut, preformed wire rope tends not to unlay, and it is more flexible than non-preformed wire rope. With non-preformed wire rope, twisting produces a stress in the wires; and, when it is cut or broken, the stress causes the strands to unlay. In non-preformed wire rope, unlaying is rapid and almost instantaneous, which could cause serious injury to someone not familiar with it.

The main types of wire rope used by the US Navy are 6, 7, 12, 19, 24, or 37 wires in each strand. Usually, the wire rope has six strands laid around a fiber or steel center.

Two common types of wire rope, 6 x 19 and 6 x 37 wire rope, are shown in *Figure 2-4*. The 6 x 19 type of wire rope, having six strands with 19 wires in each strand, is commonly used for rough hoisting and skidding work where abrasion is likely to occur. The 6 x 37 wire

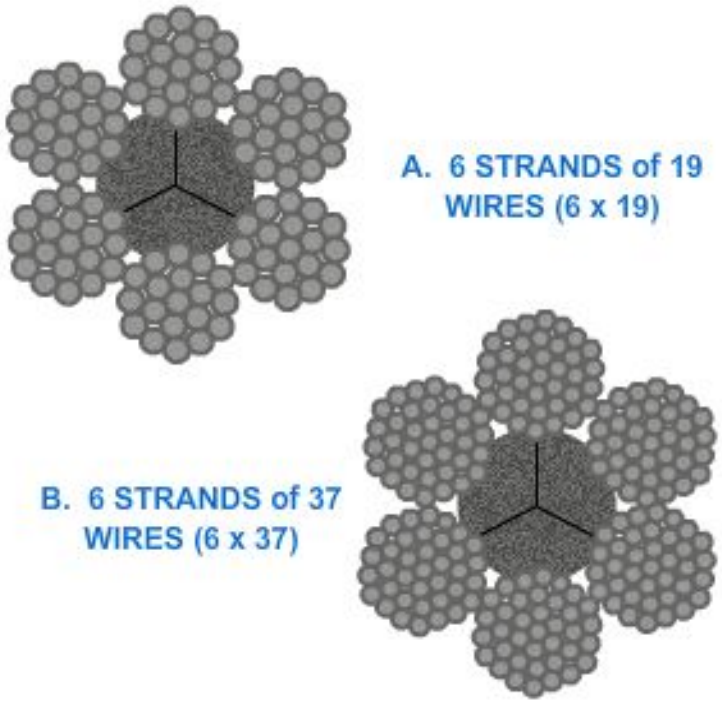

Figure 2-4 – Two types of wire rope.

rope, having six strands with 37 wires in each strand, is the most flexible of the standard six-strand wire ropes. For that reason, it is particularly suitable when you are going to use small sheaves and drums, such as are used on cranes and similar machinery.

1.4.2 Grades of Wire Rope

Wire rope is made in a number of different grades, three of which are mild-plow steel, plow steel, and improved-plow steel.

MILD-PLOW STEEL wire rope is tough and pliable. It can stand up under repeated strain and stress, and it has a tensile strength of 200,000 to 220,000 pounds per square inch (**psi**).

PLOW STEEL wire rope is unusually tough and strong. This steel has a tensile strength (resistance to lengthwise stress) of 220,000 to 240,000 psi. This wire rope is suitable for hauling, hoisting, and logging.

IMPROVED-PLOW STEEL wire rope is one of the best grades of wire rope available, and most, if not all, of the wire rope you will use in your work will probably be made of this material. It is stronger, tougher, and more resistant to wear than either plow steel or mild-plow steel. Each square inch of improved-plow steel can stand a strain of 240,000 to 260,000 psi.

1.4.3 Measuring Wire Rope

The size of wire rope is designated by its diameter. The true diameter of a wire rope is considered as being the diameter of the circle that will just enclose all of its strands. Both the correct and incorrect methods of measuring wire rope are shown in *Figure 2-5*. Note, in particular, that the CORRECT WAY is to measure from the top of one strand to the top of the strand directly opposite it. Use ***calipers*** to take the measurement; if calipers are not available, an adjustable wrench will do.

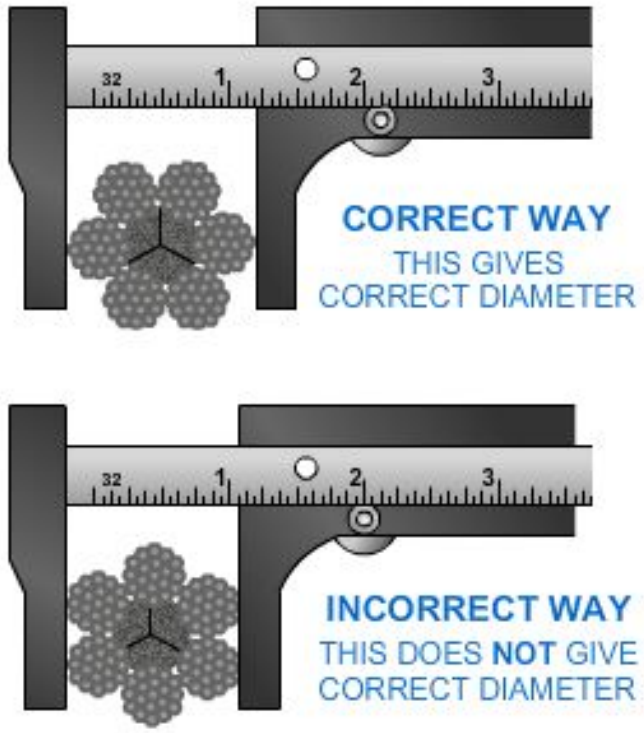

Figure 2-5 – Correct and incorrect methods of measuring wire rope.

To ensure an accurate measurement of the diameter of a wire rope, always measure the wire rope at three places on a six-stranded, and four places on an eight stranded wire rope. Use the average of the three measurements as the diameter of the wire rope.

1.4.4 Safe Working Load

The term SWL, as used in reference to wire rope, means the load that you can apply and still obtain the most efficient service and also prolong the life of the wire rope. Most manufacturers provide tables that show the safe working load for their wire rope under various conditions. In the absence of these tables, you may apply the following rule of thumb formula to obtain the SWL:

$$SWL \text{ (in tons)} = D^2 \times 8$$

This particular formula provides an ample margin of safety to account for such variables as the number, size, and location of sheaves and drums on which the wire rope runs and such dynamic stresses as the speed of operation and the acceleration and deceleration of the load, all of which can affect the endurance and breaking strength of the wire rope. Remember this formula is a general computation, and you should also consider the overall condition of the wire rope.

In the above formula, D represents the diameter of the rope in inches. Suppose you want to find the SWL of a 1/2-inch-diameter wire rope. Using the formula above, you would solve the problem as follows:

$$SWL = (1/2)^2 \times 8$$

$$SWL = 2 \text{ tons}$$

1.5.0 Wire Rope Attachments

Wire rope can be attached to other wire ropes, chains, ***pad eyes***, or equipment by splicing, which is permanent, or by any of a number of wire-rope attachments. These include sockets and wire-rope clips. In general, these attachments permit the wire rope to be used with greater flexibility than would be possible with a more permanent splice. The attachments allow the same wire rope to be made up in a variety of different arrangements.

1.5.1 Clips

A temporary eye splice may be put in wire rope by using clips. A single clip (*Figure 2-6*) consists of three parts: U-bolt, saddle, and nuts. The correct and incorrect methods of applying these clips to wire rope are shown in *Figure 2-6*; the second incorrect method shown is the most common. Notice that the correct way is to apply the clips so that the U-bolts bear against the bitter end; that is, the short end of the wire rope. If the clips are attached incorrectly, the result will be distortion or mashed spots on the live end of the wire rope. After a wire rope is under strain, tighten the clips again. On

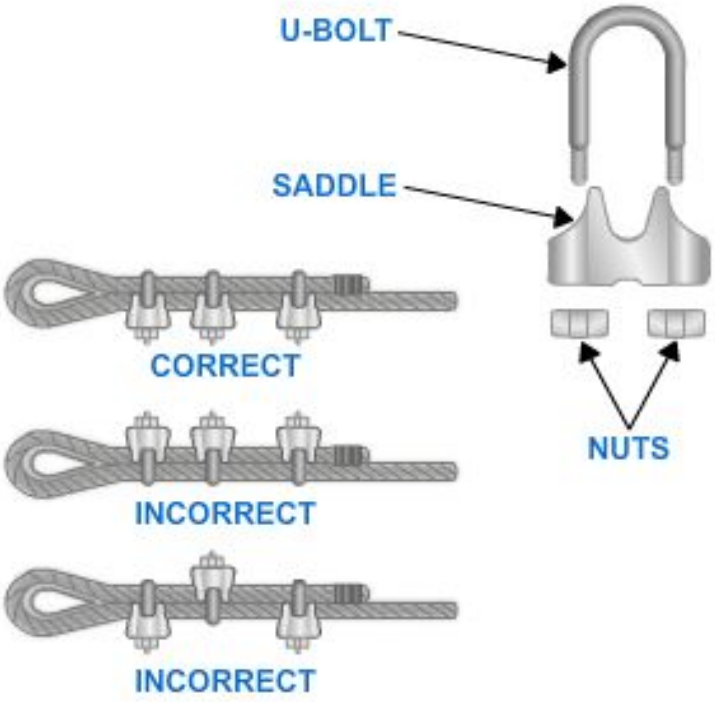

Figure 2-6 – Use of wire rope clips.

operating wire ropes, tighten the clips daily and inspect the wire ropes carefully at points where there are clips. Pay particular attention to the wire at the clip farthest from the eye, as vibration and whipping are heaviest here and fatigue breaks are likely to occur.

To obtain maximum strength in the temporary eye splice, use the correct size and number of wire clips. The size is stamped on the saddle between the two holes. A rule of thumb for determining the number of clips required for various sizes of wire rope is to multiply the diameter of the wire rope by 3 and add 1. Stated as a formula, this means

3D + 1 = number of clips.

For example, if the wire rope has a diameter of 1 inch, determine the number of clips as follows:

(3 x 1) + 1 = 4 clips

In case the answer contains a fraction, then use the next largest whole number. For example, suppose you want to find the number of clips for a wire rope 1/2 inch in diameter. Using the formula, the answer would be 2 1/2 clips. You simply use the next whole number to get the correct answer.

You should space the clips properly to provide a good hold on the wire rope. You can determine the correct distance between the clips by multiplying 6 times the diameter of the wire rope. Where D is equal to the diameter, 6 x D = DISTANCE BETWEEN CLIPS. Here, as in determining the number of clips, if the answer contains a fraction, use the next whole number.

You should inspect and tighten wire-rope clips at regular intervals. Also, after comparatively long use, remove the clips and examine the wire rope for broken wires. If any are present, remove the damaged part and make a new attachment.

1.5.2 Knots

Although wire-rope fittings are stronger and safer and make wire rope last longer, you may have to use knots in emergencies. Use knots secured with clips (*Figure 2-7*). *Figure 2-7* also shows the proper way to join two wire ropes.

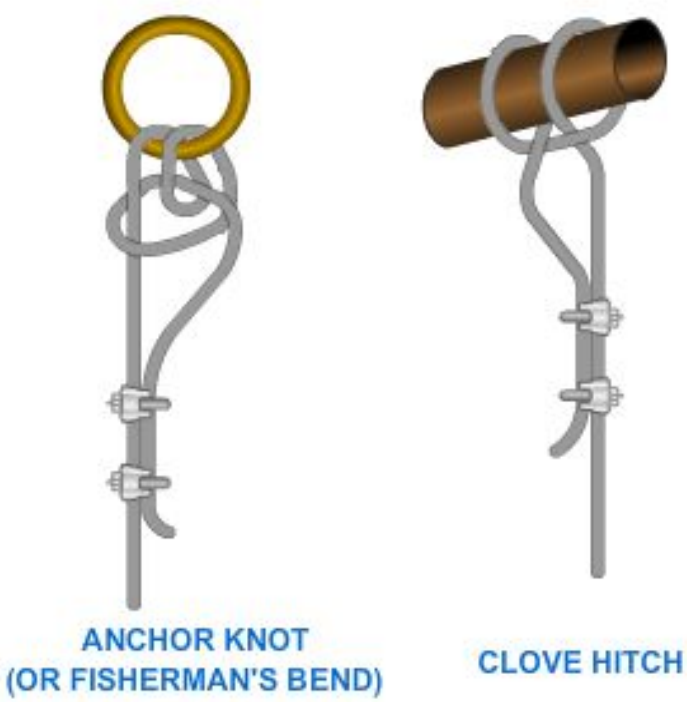

Figure 2-7 – Wire rope bends and couplings.

1.5.3 Fittings

Fittings are attached to the ends of wire rope so that the wire rope can be easily connected to other wire ropes, chains, pad eyes, or heavy equipment. *Figure 2-8* shows some standard fittings. The type of fitting used depends on the job. For instance, to hoist a bundle of conduit from ground level, use two wire rope slings made using a ***thimble*** in the wire rope and then attaching a shackle to the thimble. A thimble in an eye splice reduces abrasive wear on the wire rope (*Figure 2-8, View 2)*.

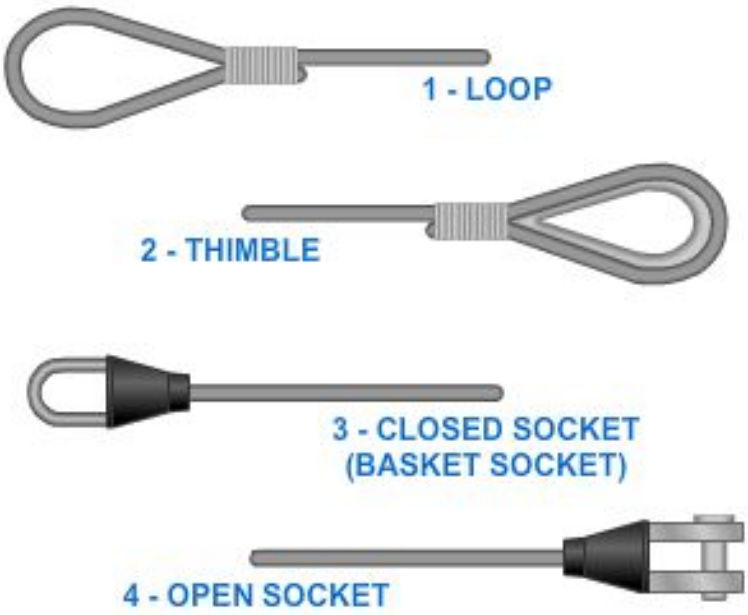

Figure 2-8 – Wire rope fittings.

1.5.4 Hooks and Shackles

Hooks and shackles (*Figure 2-9*) provide a useful means of hauling the lifting loads without tying directly to the object with a line, wire rope, or chain. They can be attached to wire rope, fiber line, blocks, or chains. Shackles should be used for loads too heavy for hooks to handle.

When hooks fail because of overloading, they usually straighten out and lose or drop their load. When a hook has been bent by overloading, do NOT straighten it and put it back into service. Cut it in half with a cutting torch and discard it.

Hooks should be given a visual inspection at the beginning of each workday and before lifting a full rated load. If you are not sure whether a hook is strong enough to lift the load, use a shackle.

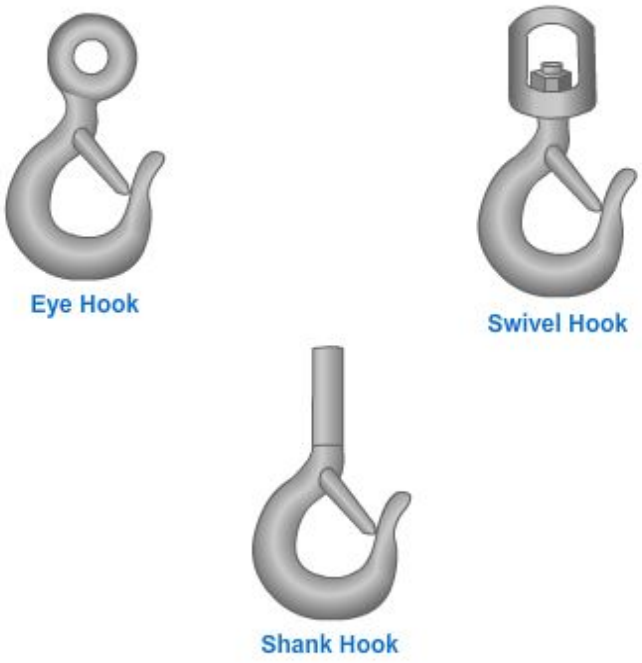

Figure 2-9 – Hooks and shackles.

You should use hooks that close and lock where there is danger of catching on an obstruction. This applies particularly to hoisting buckets, or cages, and your own self. Slings may be constructed of fiber line, wire rope, or chain.

1.5.5 Fiber Line and Wire Rope Slings

Fiber line slings offer the advantage of flexibility and protection of finished material. At the same time, fiber line slings are not as strong as wire rope or chain slings. In addition, fiber line slings are more likely to be damaged in the event of sharp edges on the material being hoisted than are wire rope or chain slings.

Three types of fiber line and wire rope slings commonly used for lifting a load are the endless, single leg, and bridle slings.

An endless sling usually referred to as a sling, can be made by splicing together the ends of a piece of fiber line or wire rope to form an endless loop.

An endless sling is easy to handle, and you can use it in several different ways to lift loads. Frequently, it is used as a choker hitch (*Figure 2-10*). To form a choker hitch, cast

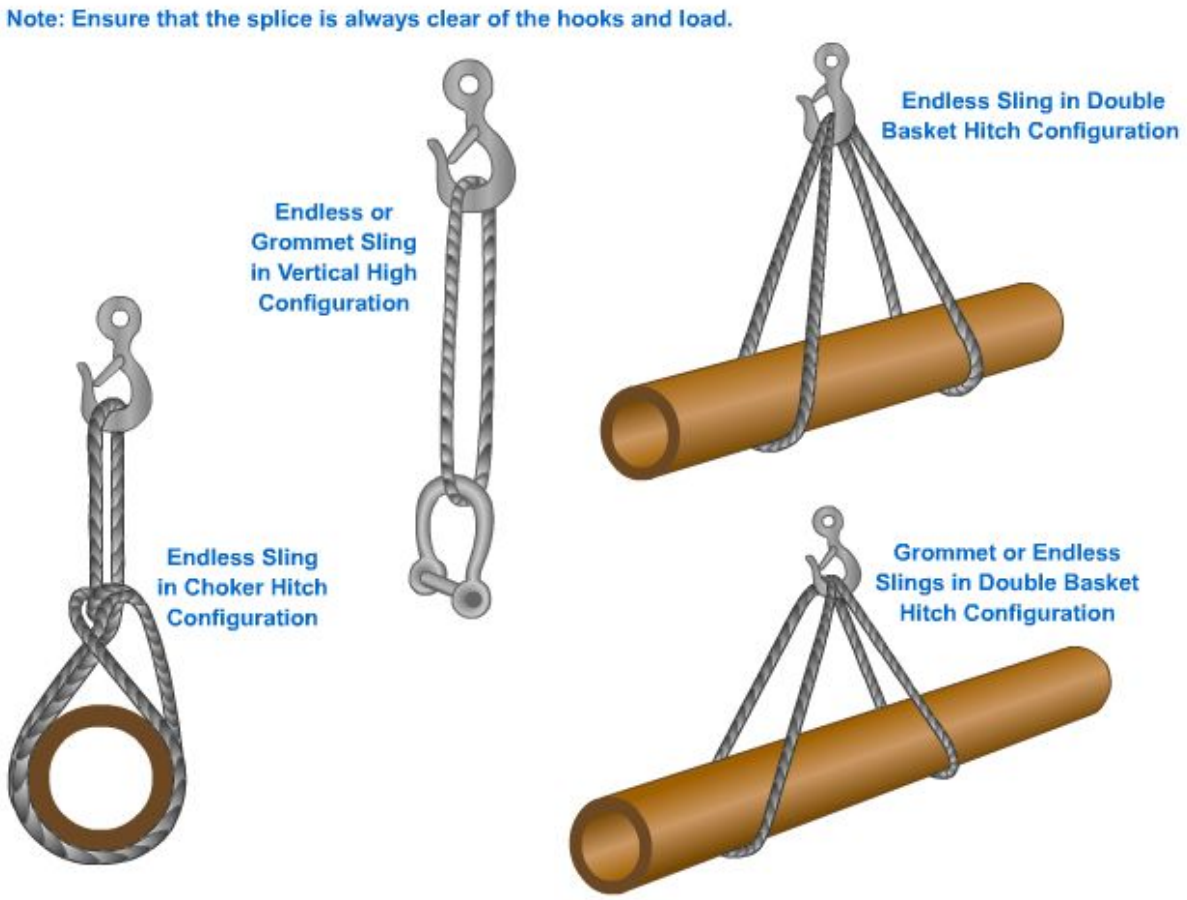

Figure 2-10 – Choker hitch formed from an endless sling.

the sling under the load to be lifted and insert one loop through the other and over the hoisting hook.

A single leg sling commonly referred to as a strap, can be constructed by forming a spliced eye in each end of a piece of fiber line or wire rope. Sometimes the ends of a piece of wire rope are spliced into eyes around thimbles, and one eye is fastened to a hook with a shackle. With this arrangement, the shackle and hook are removable.

A single-leg sling may be used as a choker hitch (*Figure 2-11*) in hoisting by passing one eye through the other eye and over the hoisting hook.

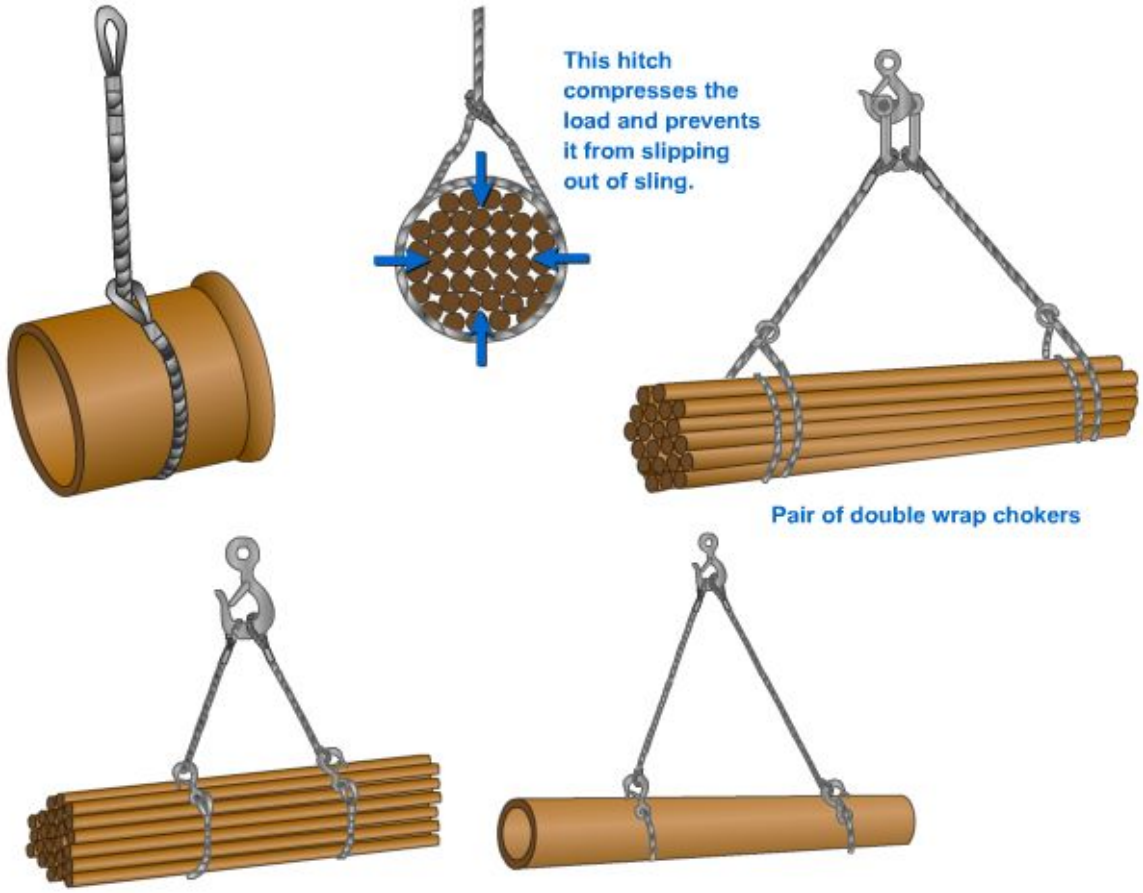

Figure 2-11 – Choker hitch formed by a single leg sling.

You can use single-leg slings to make various types of bridles. Two types are shown in *Figure 2-12*. You can use two or more single slings for a given combination. Also, if an individual sling is not long enough for the job at hand, you can combine two of the single slings to form a longer sling.

It is advantageous to have matched sets of slings (that is, two or more of equal length) so that when it is necessary to use more than one to hoist a load, the strain will be equal and the load will come up evenly. You should mark slings that are of equal length for ease of identification. Painting the eyes of equal-length slings the same color is one way of doing this.

In lifting heavy loads, always make a special effort to ensure that the bottoms of the sling legs are fastened to the load in a manner that will prevent damage to the load. Many pieces of equipment have eyes fastened to them during the process of manufacture to aid in lifting. With some loads, though, fastening a hook to the eye on one end of each sling leg provides an adequate means for securing the sling to the load.

Chafing gear (protective pads) must be used when a sling is exposed to sharp edges at the comers of a load. Pieces of round wood, heavy bagging or old rubber tires are excellent materials to use as padding.

You can use single-leg slings to make various types of ***bridles***. Two types are shown in *Figure 2-12*. You can use two or more single slings for a given combination. Also, if an individual sling is not long enough for the job at hand, you can combine two of the single slings to form a longer single sling.

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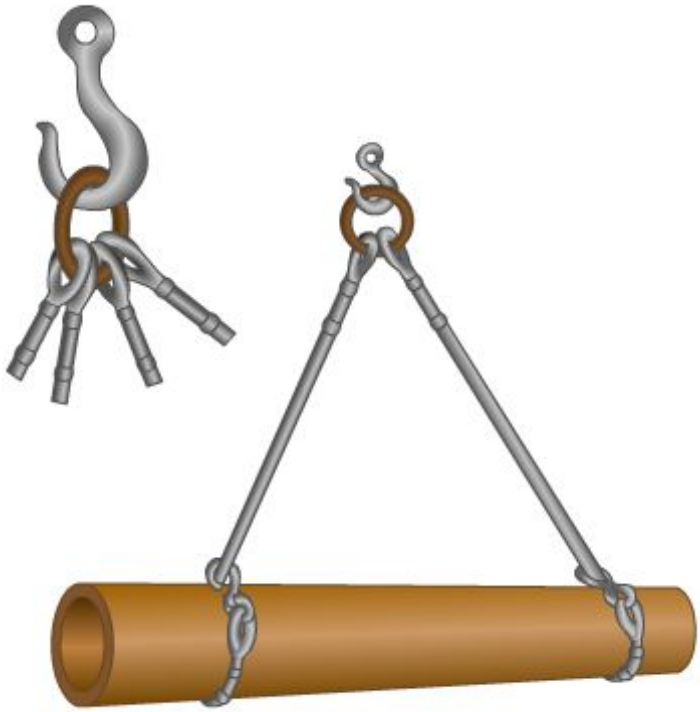

Figure 2-12 – Bridles.

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Chafing gear (protective pads) must be used when a sling is exposed to sharp edges at the comers of a load. Pieces of round wood, heavy bagging or old rubber tires are excellent materials to use as padding.

1.5.6 Chain Slings

Chain slings are frequently used in hoisting and moving heavy steel items, such as rails, pipes, wide flange beams, and angles. They are also desirable for slinging hot loads and in handling loads with sharp edges that might cut wire rope.

Steel-length chain slings are available with variable type ends and lengths. Types include a 1/2-inch (12.7-mm) size sling, obtainable in either 12- or 20-foot (3.6-m or 6-m) lengths. This is a one-leg type of sling with a center swivel, equipped with a grab hook on one end and a pelican hook on the other. There is also available a 3/4 inch (19.05 mm) chain sling, 22 feet (6.6 m) long, with a grab hook on one end and a cinch (100-mm) link on the other.

Before doing any lifting with a chain sling, first place ***dunnage*** between the chain and the load to provide a gripping surface. In handling rails or a number of lengths of pipe, make a round turn and place the hook around the chain as shown in *Figure 2-13.*

In using chain slings, you must exercise care to avoid twisting or kinking the chain while it is under stress. This condition might cause failure of the chain, even in handling a light load. Before lifting, make sure that the chain is free from twists and kinks. Make sure, also, that the load is properly seated in the hook (not on the point) and that the chain is

free from nicks or other damage. Avoid sudden jerks in lifting or lowering the load, and always consider the angle of lift when using a sling chain bridle.

Store chains in a clean, dry place where they will not be exposed to the weather. Before storage, it is a good idea to apply a light coat of lubricant to prevent rust.

Makeshift repairs, such as fastening links of a chain together with bolts or wire, should never be permitted. When links become worn or damaged cut them out of the chain; then fasten the two adjacent links together with a connecting link. After the connecting link is closed and welded, it will be as strong as the other links. For cutting small-size chain links, use bolt cutters. For cutting large-size links, use a hacksaw or oxyacetylene torch.

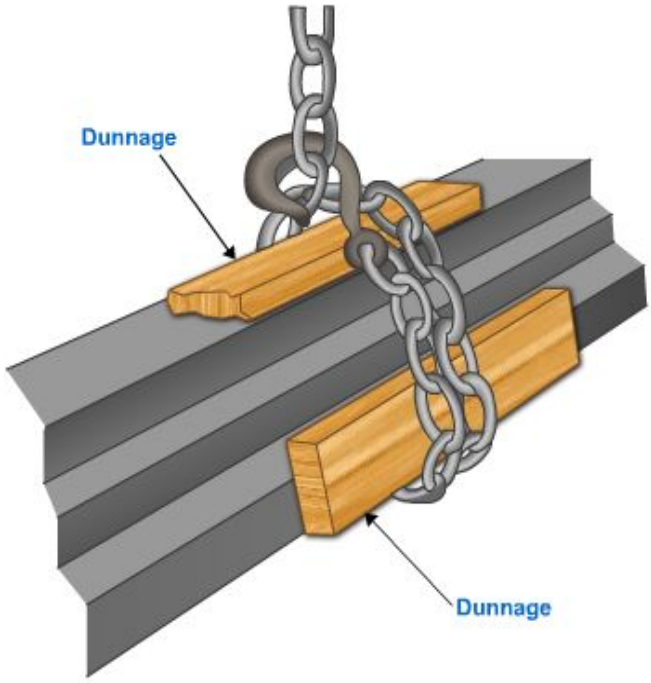

Figure 2-13 – Chain sling.

1.5.7 Inspection of Slings

Slings must be inspected frequently and removed from service whenever defects are detected. Bear in mind that a defective sling may cause serious injury to personnel or extensive damage to equipment in case of failure under load.

You should check fiber line slings carefully for signs of deterioration caused by exposure to the weather. You should also check closely to determine whether any of the fibers have been broken or cut by sharp-edged objects.

Broken wires are a major defect to look for when inspecting wire rope slings. When four percent of the total numbers of wires in the rope are found to have nicks, or cuts, they should be replaced. However, if a chain shows evidence of stretching or distortion of more than five percent in any five-link section, make sure the entire chain is discarded.

The least sign of binding at the juncture points of links indicates collapse in the sides of the link caused by stretching. Such a condition is dangerous, and the chain should be removed from service.

1.5.8 Spreaders and Pallets

When hoisting with slings, you may often need to use spreader bars to prevent crushing and damaging the load. Spreader bars are short bars or pipes that have eyes fastened to each end. By setting spreader bars in the sling legs above the top of the load (*Figure 2-14*), you change the angle of the sling leg and avoid crushing the load, particularly the upper portion.

The use of cargo pallets in combination with slings is a big advantage on jobs that involve the hoisting and moving of small-lot items (*Figure 2-15*). You may need to use

spreader bars when hoisting pallets to avoid damaging the pallets and load. The pallet provides a small platform or board on which a number of items can be placed and moved as a unit rather than piece by piece. Palletizing obviously is quicker and easier than moving each individual item separately.

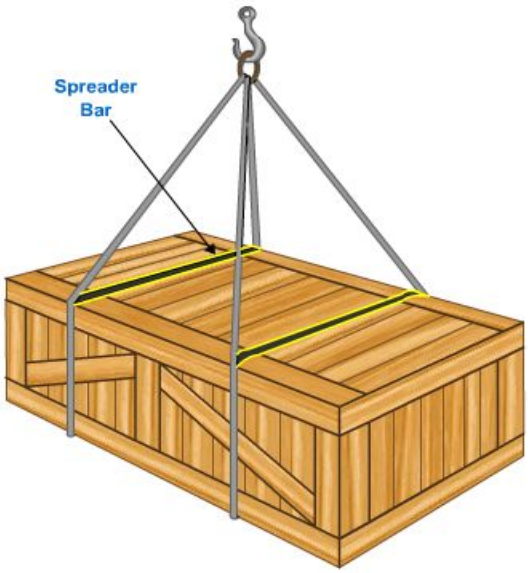

Figure 2-14 – Use of spreader bars in a sling.

Figure 2-15 – Cargo pallets in combination with slings.

Test your Knowledge (Select the Correct Response)

1. Which of the following is NOT considered a grade of wire rope?

   A. Mild Plow Steel
   B. Harden Plow Steel
   C. Plow Steel
   D. Improved Plow Steel

2.0.0 MOVING MATERIALS and EQUIPMENT

The safe movement of equipment and materials does not just happen. It takes knowledgeable people to communicate, control, and rig movements. Personnel safety, undamaged materials/ equipment, and operational efficiency are the responsibility of all personnel involved.

2.1.0 Signaling

CEs are frequently required to act as signalmen for crane or hoist operators and for the positioning of equipment. There are a number of precautions and procedures that should be observed in these operations.

Whenever the operator's view is obstructed so that he cannot see the path of travel of any part of the equipment, load, or components, a competent signalman is required to be stationed in such a position that he or she can be easily seen by the operator and where the signalman has a full view of the intended path of travel of the equipment, load, or components, yet where he or she will be clear of the intended path of travel. The signalman should assist the operator by watching the load when it is out of view of

the operator and communicating with the operator by the use of prearranged visual signals (See Appendix I) or a suitable communication system.

The signalman must do the following:

- Be fully qualified by experience with the operation.
- Wear high visibility gloves.
- Use hand signals only when conditions are such that the signals are clearly visible to the operator.
- Be made responsible for keeping the public and all unauthorized personnel outside the operating radius of the crane or the path of the equipment.
- Direct the load so that it never passes over anyone.

When the signalman desires to give the operator any instructions other than those provided by the established signal system, the operator should be instructed to stop all motion FIRST.

Hand signals can be used effectively when the distance between the operator and the signalman is not great, but two-way radios should be used when the distance or atmospheric conditions prevent clear visibility. Adequate lighting and signaling arrangements must be available during night work, and the equipment must not be operated when either is inadequate.

2.2.0 Procedures and Precautions for Lifting Operations

The most important rigging precaution is to determine the weight of all loads before attempting to lift them, to make ample allowances for unknown factors, and to determine the available capacity of the equipment being used. In cases where the assessment of load weight is difficult, safe load indicators or weighing devices should be fitted. This chapter also includes a section dealing with the estimation of load weights.

It is equally important to rig the load so that it is stable. Unless the center of gravity of the load is below the hook, the load will shift.

The safety of personnel involved in rigging and hoisting operations largely depends upon care and common sense. Remember these safe practices.

Know the SWL of the equipment and tackle being used. NEVER exceed this limit.

Determine the load weight before rigging it.

Examine all hardware, equipment, tackle, and slings before using them and survey defective components. Discarded equipment may be used by someone not aware of the hazards or defects.

Never carry out any rigging or hoisting operations when the weather conditions are such that hazards to personnel, property, or the public are created. You must carefully examine the size and shape of the loads being lifted to determine if a hazard exists during high wind speeds. Avoid handling loads that have large wind catching surfaces that could cause loss of control of the load during high or gusty winds. The wind can critically affect the loading and load landing operation and the safety of the personnel involved. See *Figure 2-16* to see affects of wind on a load.

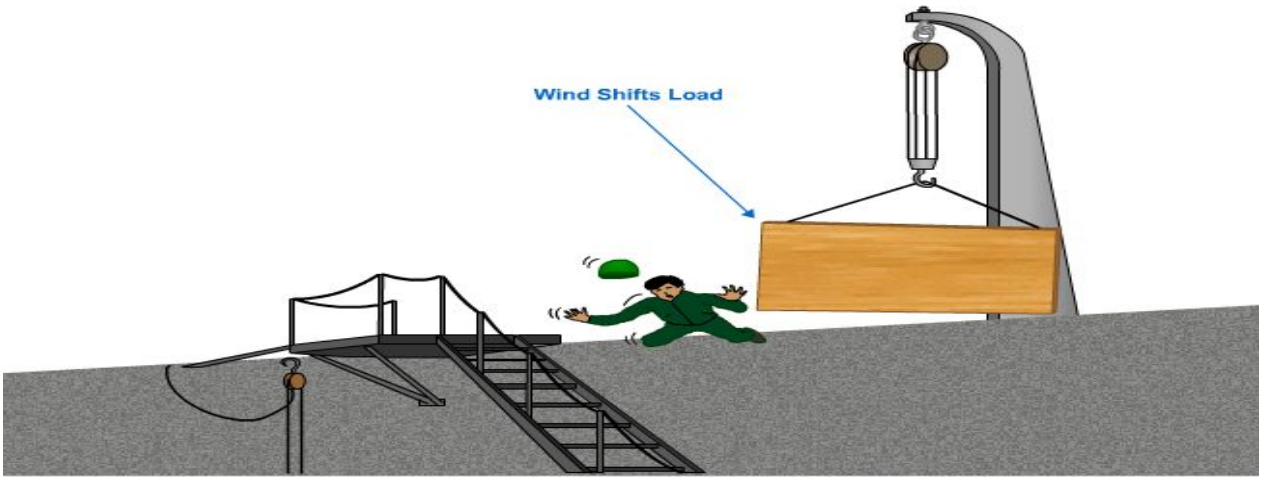

Figure 2-16 – Wind effects on load.

The primary killer of riggers and those persons handling loads is electrocution caused by the contact of the boom, load line, or load of a crane with electric power lines. When working with or around cranes that are within a boom's length of any power line, you must ensure that the power to that section of line is secured. If for some reason this cannot be accomplished, a component signalman must be stationed at all times within view of the operator to warn him or her when any part of the machine or its load is approaching the minimum safe distance from the power line (*Figure 2-17*). You must also exercise caution when working near overhead lines that long spans, as they tend to swing laterally because of the wind, and accidental contact could occur.

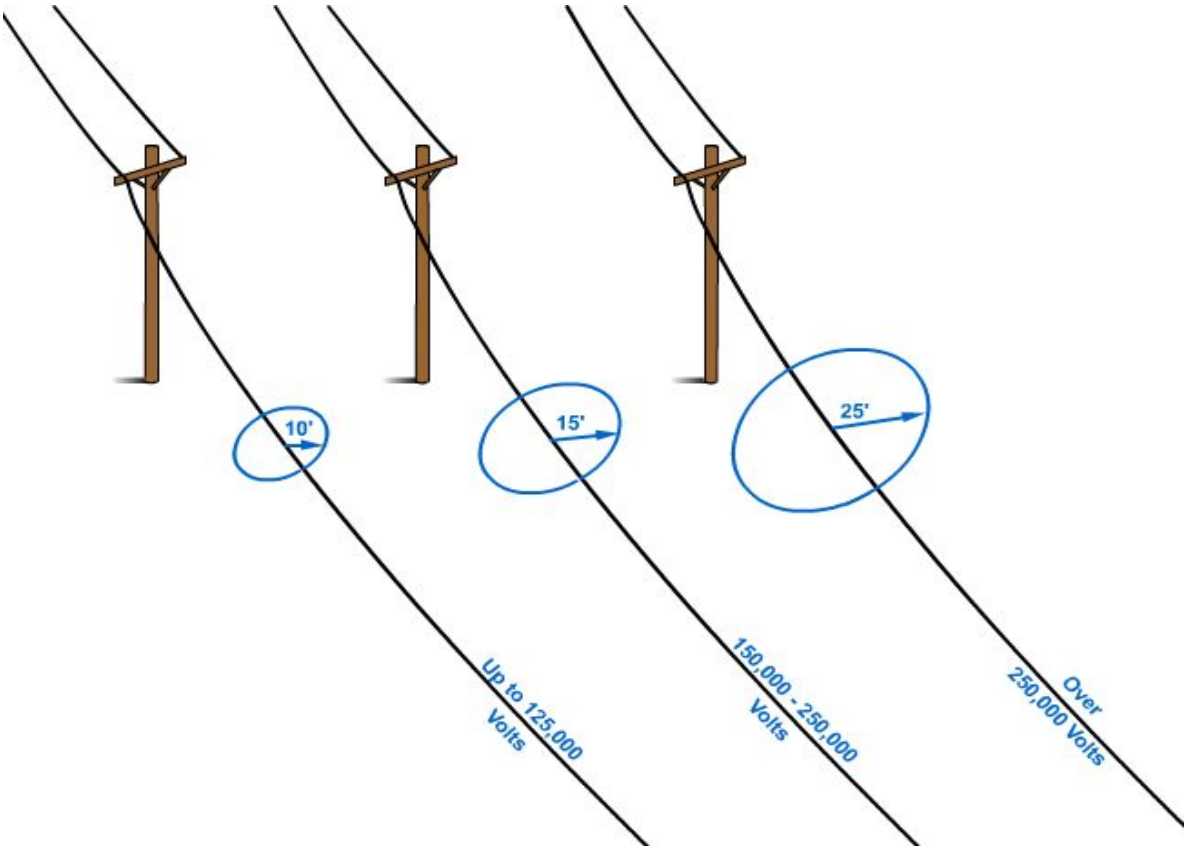

Figure 2-17 – Minimum safe distance for working around energized conductors.

The SWLs of hoisting equipment apply only to freely suspended loads on plumb hoist lines. If the hoist line is not plumb at all times when handling loads, then additional side loads will endanger the stability of the equipment. In circumstances such as this, structural failures can result without any warning. See *Figure 2-18* for incorrect lifting procedure.

Never use kinked or damaged slings or hoist wire ropes. To provide maximum operating efficiency and safety, you should give all slings and fittings through periodic inspections as well as daily inspections for signs of wear and abrasion, broken wires, worn or cracked fittings, loose seizing and splices, kinking, crushing, flattening, and corrosion. Special care should be taken in inspecting the areas around thimbles and fittings.

When using choker hitches, do not force the eye down towards the load once tension is applied. Wire rope damage is the invariable result. See *Figure 2-19* for proper position of choker hitches.

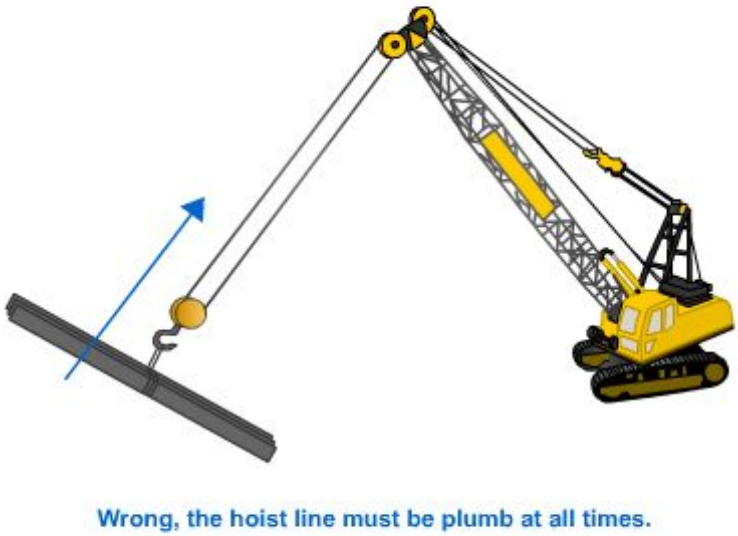

Figure 2-18 – Incorrect lifting procedures.

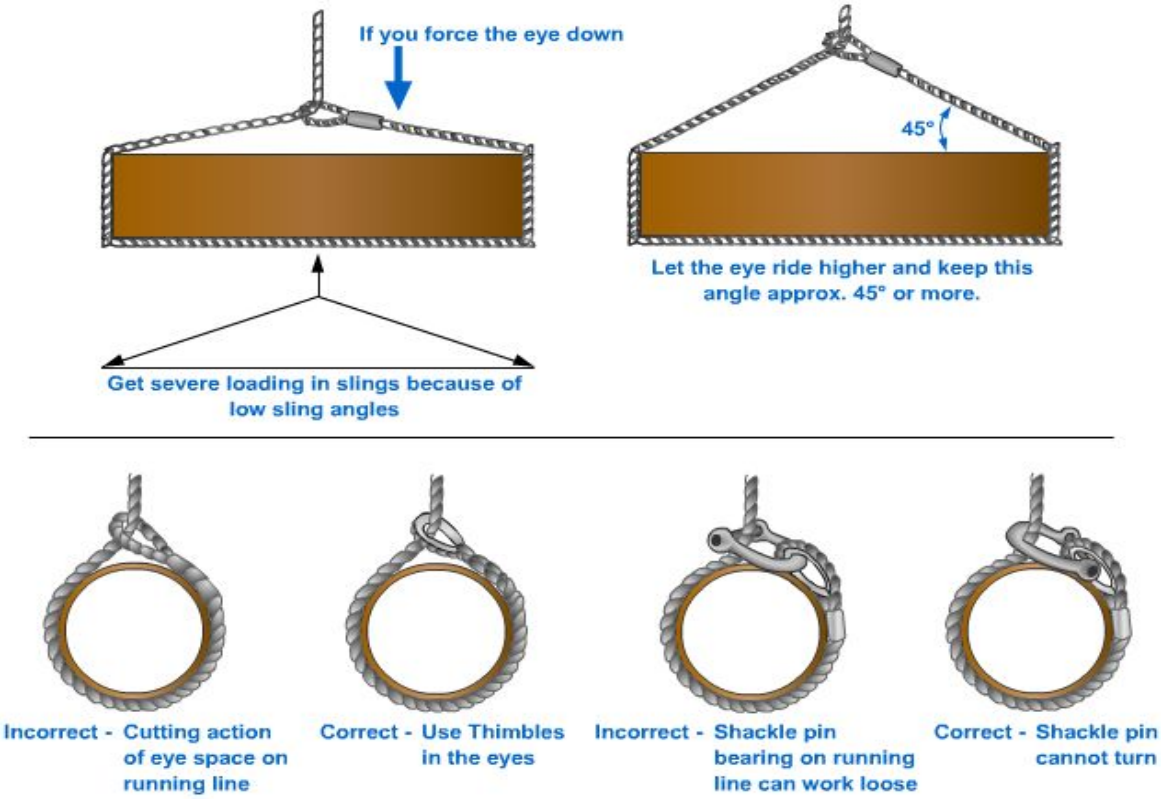

Figure 2-19 – Proper position of choker hitches for lifting.

Whenever two or more wire rope eyes must be placed over a hook, install a shackle on the hook and hook the wire rope eyes to the shackle. This will prevent the spread of the slings legs from opening up the hook and also prevent the eyes from damaging each other when under load. See *Figure 2-20* for shackle use with two or more wire ropes.

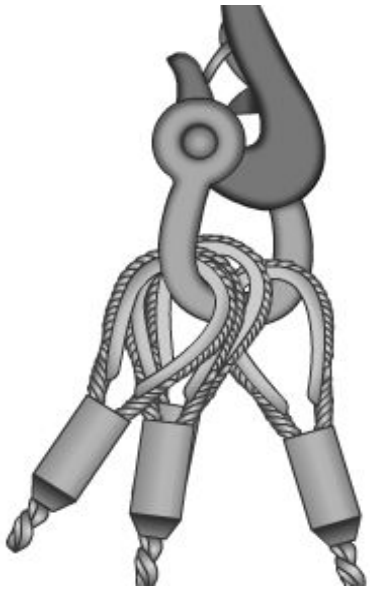

Figure 2-20 – Shackle use with two or more wire ropes.

The following procedures and precautions should be observed whenever loads are to be handled:

Rig all loads to prevent the dislodgement of any part. Suspended loads should be securely slung and properly balanced before they are set in motion.

Keep the load under control at all times. Where necessary by the rotation, use one or more guide wire ropes or tag lines to prevent the rotation or uncontrolled motion. See *Figure 2-21* for use of tag lines to control a load.

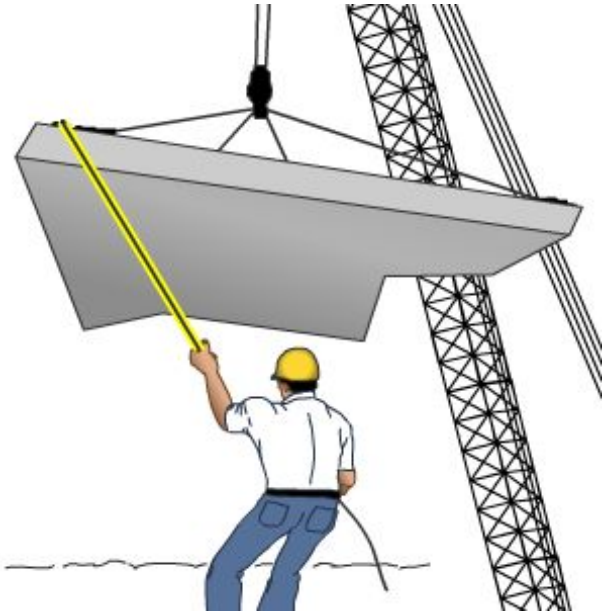

Figure 2-21 – Using tag lines to control load.

Land all loads safely and block them properly before unhooking and unslinging them. See *Figure 2-22* to see a properly blocked load.

Never wrap the hoist wire rope around the load. Attach the load to the hook by slings or other rigging devices that are adequate for the load being lifted.

Bring the load line over the center of gravity of load before starting lift.

Load and secure materials and equipment being hoisted to prevent any movement that could create a hazard in transit.

Keep hands away from pinch points as the slack is being taken up.

Wear gloves when handling wire rope.

Make sure that all personnel stand clear while loads are being lifted and lowered or while the slings are being drawn from beneath the load. The hooks may catch under the load and suddenly fly free.

Before making a lift, check to see that the sling is properly attached to the load.

Never, under any circumstances, ride on the load that is being lifted.

Never allow the load to be carried over the heads of any personnel.

Never make temporary repairs to a sling. Procedures for proper repairs to a damaged sling should be established and followed.

Remove or secure all loose pieces of material from the load before it is moved.

Make sure that the load is free before lifting and that all sling legs are taking the load.

Test your Knowledge

2. Whenever two or more wire rope eyes must be placed over a hook, what piece of equipment is used?

   A. Shackle
   B. Guide
   C. Pallet Hook
   D. Sling

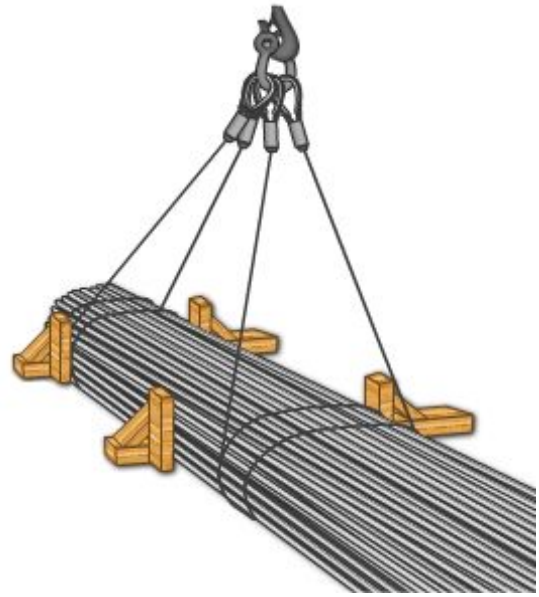

Figure 2-22 – Before loads are unhooked, they must be properly blocked.

3.0.0 HAZARDOUS MATERIAL

Hazardous Material Control and Management (**HMC&M**), OPNAVINST 4110.2 dated 20 June 1989, establishes uniform policy, guidance, and requirements for the life-cycle control of hazardous material acquired and used by the Navy.

This instruction, unless otherwise specified applies to all Navy organizations and shore activities involved in the planning, procurement, acquisition, stowage, distribution, requisition, use, or other disposition of hazardous material (including disposal of used hazardous materials and hazardous wastes in the United States and its territories). Navy shore activity requirements in foreign countries are to comply with the requirements of host nation Status of Forces agreements if they are more restrictive than U.S. regulations. Where host national requirements are less stringent, conform to U.S. occupational Safety and Health Administration (**OSHA**) and Environmental; Protection Agency (**EPA**) laws and regulations to the extent feasible.

The Department of Defense (**DOD**) established the Hazardous Material Information System (**HMIS**) to acquire, stow, and disseminate manufacturer's data on hazardous material (**HM**). The system provides a means to share and communicate information on HM procured by a single DOD activity with all other commands, activities, and units within DOD.

3.1.0 Hazardous Waste and the Seabee

As you read the above paragraphs, you may have been inclined to think that the message and warnings could not possibly apply to you at your level. If this is what you thought, you were definitely wrong. It is true that the above instructions, along with a few others, give us the rules and regulations we must follow in regard to hazardous material, but they were also written for your protection. You, as a DOD employee, are ensured that the information on hazardous materials you may come in contact with will be available to you. This information is to be made available by means of comprehensive hazard communication programs, which are to include container labeling and other forms of warning, Material Safety Data Sheets (**MSDS**), and training.

As a member of today's Navy, you must be aware of the importance of hazardous material, used hazardous material and hazardous waste. You also must recognize the hazards of hazardous material, used hazardous material and hazardous waste to personnel and the environment. You must pay particular attention to OPNAVINST 4110.2 and OPNAVINST 5100.23C on the use, stowage, and disposal of hazardous material in your workplace.

3.2.0 Material Safety Data Sheets (MSDS)

To comply with the OSHA Hazard Communication Standard, 29 CFR 1910.1200, manufacturers of chemical products must use an MSDS, OSHA Form 174, or an equivalent form containing the identical data elements to inform the users of the chemical, physical, and hazardous properties of their product. The completed form identifies key information about the product; name, address, and emergency contact for the manufacture; the identity of hazardous ingredients; physical/chemical characteristics; fire and explosion hazard data; reactivity data; health hazard data; precautions for safe handling and use; and control measures (*Figure 2-23*). All data submitted must comply with the provisions of FED-STD 313C (NOTAL).

You must be aware of any chemical hazards that are used in your work spaces or on the jobsite. An MSDS must be available in the workplace or posted conspicuously on all hazardous materials. The MSDS must be provided by the supply department and also by suppliers of any hazardous material issued or purchased. The MSDS must contain all the information you will need to work, stow, and dispose of hazardous material safely. In addition, the MSDS will identify any personnel protective clothing or equipment needed, as well as first aid or medical treatment required in case of exposure.

MATERIAL SAFETY DATA SHEET

PRODUCT IDENTIFICATION

EPA Registration No. 63120-3 Contract No: SPM450-03-D-0758
NSN: 6840-01-345-0237, Insect Repellent, Clothing Application, Kit
Military Specification: MIL-DTL-44410B Department of Defense Formula

SECTION I - GENERAL INFORMATION

CAGE CODE: 0NR20
MANUFACTURER: Hilton Head Laboratories, Inc.
182B Sea island Parkway, PMB #558
Beaufort, SC 29907

EMERGENCY TELEPHONE NO.
(800) 424-9300

INFORMATION: Same

EPA Est. No. 62828-SC-001
DATE OF LATEST REVISION: 04/01/06 PREPARED BY: Nancy S. Ball

SECTION II - HAZARDOUS INGREDIENTS

CHEMICAL NAME	CAS No.	Percent	Exposure Limits in Air	ACGIH (TLV) OSHA (PEL)
Permethrin*	52645-53-1	40.00	NE	NE
Related Compounds	NA	3.48	NE	NE
Petroleum Distillates	64742-47-8	48.00	NE	NE

* (3-phenoxyphenyl)-methyl (K) cis-trans-3-(2,2-dichloroethenyl)-2,2-dimethyl-cyclopropanecarboxylate; cis/trans isomers ratio: min 35% (K) cis and max. 65% (K) trans.

SECTION III - PHYSICAL/CHEMICAL CHARACTERISTICS

Melting Point: NA
Boiling Point: NE
Vapor Pressure: NE
Vapor Density: NE
Appearance: Amber, Sl Viscous Liquid
Solubility (Oil): Soluble
Solubility (Water): Emulsifiable
Shelf Life: >2 years

Flashpoint: 115EF (46EC) TCC
Evaporation Rate: 50%
Odor: Aromatic
Sp. Gravity @ 20E C: 1.010
lbs/Gal: 8.41
Color: (G-H) 12
Percent Volatile: NE

SECTION IV - FIRE AND EXPLOSION HAZARD DATA

Flash Point (Method Used): 115E F (TCC)
Flammable Limits: No information found
Extinguishing Media: Foam, Carbon Dioxide, Dry Chemical, Water, Fog
Special Firefighting Procedures: Isolate fire area. Evacuate downwind residents and all areas where fire seriously threatens the product containers. Wear full protective clothing including rubber boots, neoprene gloves, and self-contained breathing apparatus. Attempt to keep drums cool. Do not breathe or contact smoke or vapors.
Unusual Fire/Explosion Hazards: None

SECTION V - REACTIVITY DATA

Stability: Stable
Conditions to Avoid: None
Hazardous Polymerization: Will not occur
Incompatibility: Strong oxidizing agents
Hazardous Decomposition or Byproducts: None known
Conditions to Avoid: Do not store when temperature exceeds 130EF

SECTION VI - HEALTH HAZARD DATA

ROUTE OF EXPOSURE	SYMPTOMS	HEALTH EFFECTS	FIRST AID; EMERGENCY PROCEDURES
INHALATION	NONE	Acute: NE Chronic: NE	Remove person to well ventilated area. Apply artificial respiration if indicated.
EYES	Non-Irritating	Acute: NE Chronic: NE	Flush eyes with plenty of water. Contact a physician if irritation persists.
SKIN	Moderately irritating Not absorbed	Acute: NE Chronic: NE	Wash affected areas with soap and water.

ROUTE OF EXPOSURE	SYMPTOMS	HEALTH EFFECTS	FIRST AID; EMERGENCY PROCEDURES
SWALLOWED	None	Acute: NE Chronic: NE	Contact a physician or Poison Control Center immediately. Do not induce vomiting unless directed by a physician. Vomiting may cause aspiration pneumonia.

Chemicals listed as carcinogens or potential carcinogens:
Nat'l Toxicology Program: None IARC Monographs: None OSHA: None

SECTION VII - SPILL, LEAK AND DISPOSAL

Spillage or Leakage Procedures: Steps to be taken in case material is spilled or released; Faulty or leaking container: Keep people away. Open all windows and doors and ventilate area thoroughly. Allow to discharge safely, avoiding breathing vapors. Soak up residues with an absorbent material.
Preparing Wastes for Disposal (container types, neutralization): Do not contaminate water, food, or mess gear by storage or disposal. Recap empty permethrin container, place in plastic bag and put in trash. Dispose of absorbents in trash.
NOTE: Dispose of all Wastes in Accordance with Federal, State and Local Regulations.

SECTION VII - CONTROL MEASURES

RESPIRATORY PROTECTION: Normal (Mechanical) Exhaust
EYE PROTECTION: OSHA - approved safety glasses or goggles
PROTECTIVE CLOTHING: Rubber or impervious gloves
OTHER PRECAUTIONS: See SECTION VII
HYGIENIC PRACTICES: Wash hands before eating and smoking.
OTHER HANDLING AND STORAGE REQUIREMENTS: Do not use or store near heat or open flame. Do not store below 32EF.

SECTION IX - TRANSPORTATION

SHIPPING NAME: FLAMMABLE LIQUID, N.O.S. (Permethrin and petroleum distillates).
IDENTIFICATION NUMBER: UN1993
HAZARD CLASS: III
REPORTABLE QUANTITY: Limited Quantities, Combustible, Not Regulated
LABELS REQUIRED: None
UNIT CONTAINER 1 box containing 12 kits (24 9 ml bottles)
DISPOSAL METHODS: See SECTION VII

SECTION X - LABELING

Labeling; Precautionary Statements: *KEEP OUT OF REACH OF CHILDREN.* Do not apply to skin. For Military Field Uniform Treatment Only. Keep away from food, mess gear, and water supplies. Thoroughly wash mess gear if contaminated by this product. Avoid breathing vapors or contact with face, eyes or skin. Wash thoroughly after handling fluid, container or wet treated uniform and before eating and smoking. Wear protective gloves when mixing to prevent accidental exposure to concentrated permethrin should spillage occur.

SECTION XI - REGULATOR INFORMATION

TSCA (Toxic Substances Control Act) Regulations, 40 CFR 710: This product is a pesticide and is exempt from TSCA regulation.
CERCLA and SARA Regulations (40 CFR 355, 370, 372): This product does not contain any chemicals subject to the reporting requirements of SARA Section 313

NE = None (not) Established NA = Not Applicable

THE INFORMATION CONTAINED HEREIN IS BELIEVED TO BE ACCURATE WHETHER ORIGINATING WITH THE MANUFACTURER OR NOT. THE MANUFACTURER PROVIDES NO WARRANTY EITHER EXPRESSED OR IMPLIED, AND ASSUMES NO RESPONSIBILITY FOR THE ACCURACY OR COMPLETENESS OF THE DATA. RECIPIENTS ARE ADVISED TO CONFIRM ANY DATA, IN ADVANCE OR NEED, THAT IT IS CURRENT, APPLICABLE AND SUITABLE TO THEIR CIRCUMSTANCES.

Material Safety Data Sheet
Insect Repellent, Clothing Application, Kit
NSN: 6840-01-345-0237

Figure 2-23 – Material Safety Data Sheet.

3.3.0 Labeled Hazardous Material and Hazardous Waste Containers

Each container of material possessing hazardous ingredients should be properly labeled by the manufacturer, importer, and or shipper(s) to warn personnel of the potential dangers of the material. In the event warning labels are inadvertently removed or damaged in shipping before receipt by shore activities, commercial suppliers should be required to provide OSHA Hazard Communication (**HAZCOM**) compliant replacement labels. Activities are not required to put DOD or other hazardous material warning labels on new stocks because the manufacturer is responsible for placing a warning label on it that conforms with the HAZCOM standard.

OSHA labeling requirements are provided in reference 29 CFR 1910.1200 for workplace use of hazardous material. This OSHA standard requires that containers of hazardous material be labeled, tagged, or marked with the identity of the hazardous chemical(s); appropriate hazard warnings; and the name and address of the chemical manufacturer, importer, or other responsible party. Further information on hazardous material labeling can be found in DODINST 6050.5.

3.4.0 Hazardous Material Label

Labeling and marking of hazardous material containers are a function of the manufacturer, importer, or distributor. Your supply department should not accept improperly or incompletely labeled hazardous material. They should refuse to accept it and return it. However, if you need to relabel a container because the original label becomes damaged, unreadable, or is missing, use the DoD Hazardous Chemical Warning Label in *Figure 2-24*. These are the only approved labels to be used to identify hazardous material (according to The movement of equipment/material done at a DODINST 6050.5) and can be filled in using the DoD battalion level will involve personnel throughout the HMIS CD-ROM.

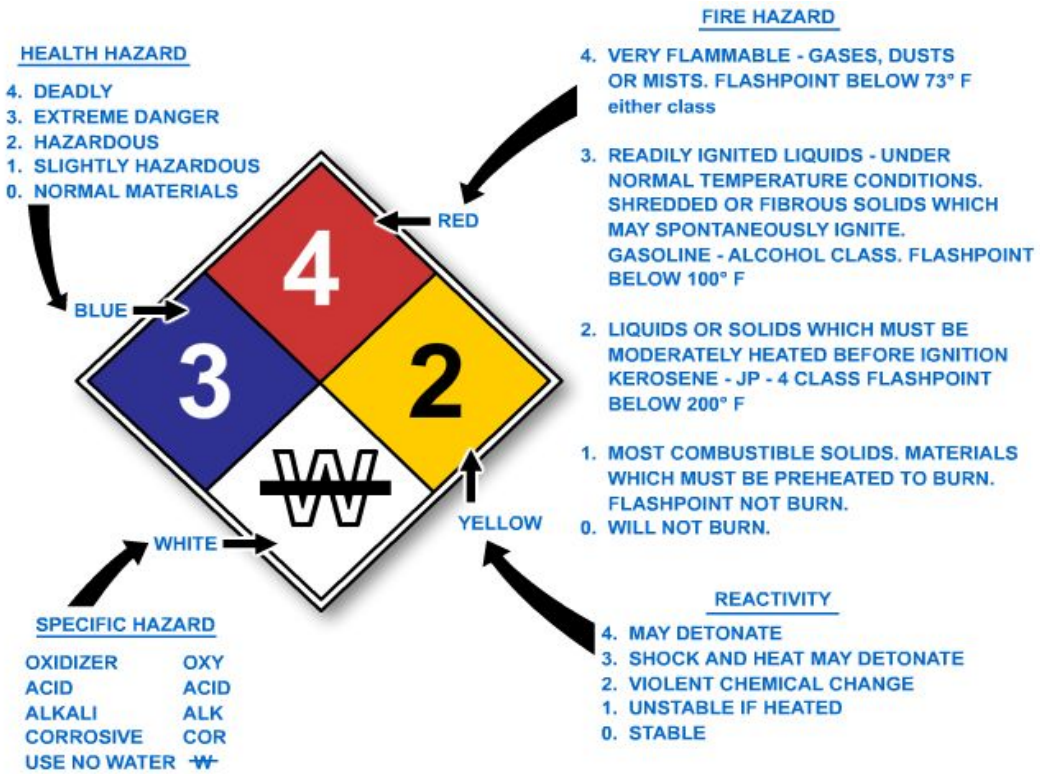

Figure 2-24 – Hazardous chemical warning label.

4.0.0 TOOL and TOOL KITS

Some tool kits are groups of tools assembled for specific purposes, like bending conduit or pulling wire or cable. Other kits include tools for general electrical construction work. The kits for general work include toolboxes. Enough toolboxes are supplied in the kit for one crew of Construction Electricians.

The Naval Facilities Expeditionary Logistics Center (NFELC*)* determines the contents of the kits. NFELC is located at the Construction Battalion Center (CBC), Port Hueneme, California. Kit contents may change as new tools become available and as the need for a particular assembly is pointed out to NFELC by Construction Electricians in the field

4.1.0 Tool Kit Inventories

The requirements associated with tool kit accountability sometimes vary from one activity to another. You are responsible for tools checked out to you from the central tool room (**CTR**). Tools are not only expensive but are essential equipment for those who use them in constructing a quality project. The proper tools must be available when and where they are needed. The only way to be certain the right tools are available when needed is to keep track of them at all times.

Kits from CTR should be maintained at 100 percent of kit assembly allowance. Damaged and worn tools should be returned to CTR for replacement in kind. Tools requiring routine maintenance, such as power tools, should be turned in for repair and reissue.

4.2.0 Tool Stowage and Security

The crew leader must plan ahead for tool stowage and security. When there is no secure place to stow tools at the jobsite, you may need to make arrangements to haul them back to the camp each day. “Gang” boxes are sometimes used to secure all the tools of a crew at a jobsite. These are large lockable boxes constructed of wood or steel and are sometimes equipped with wheels. Even though these boxes may have sloped roofs and be waterproofed, they should be placed on high ground in case of local flooding. Once you have considered storage and security of tools, you need to decide how to keep up with them through the workday.

You are responsible for the security and safe operation of your tools. Crew members may want to carry their toolboxes to the jobsite or leave them in the gang box or secure area. Toolboxes are best kept locked. Tools used daily may be kept in a pouch. For safety and tool-security reasons, you should be especially careful not to leave small hand tools lying around.

4.3.0 Electrician Hand Tools

Tools enable you to perform your job in a quick, easy and safe manner. In order for tools to serve their intended purpose you must understand their function and keep them in good condition.

4.3.1 Drills

You are probably familiar with electric drills, as they are by far the most common type of drill for household use. As an electrician you will use electric drills where electricity is readily available; however there will be times where electricity will not be available and you will be required to use either a hydraulic drill or a brace and bit.

4.3.1.1 Brace and Bit

In a work situation where electricity is not available, the brace and bit shown in *Figure 2-25* will prove to be a very useful tool. It is made up of a brace, which houses a chuck and is hand-tightened to hold the bit and a ratchet action feature that facilitates drilling in tight places.

The ratcheted brace consists of a round handle for holding the brace steady, a crank arm with handle grip, a ratchet box, and a chuck for holding the bits. The ratchet box has a knurled ring for making three adjustments: fixed, ratchet clockwise and ratchet counter-clockwise. The ratchet feature is handy when a full swing of the handle is not possible.

Figure 2-25 – Brace.

The bits commonly used in the brace are called “auger bits.” As seen in *Figure 2-26*, the auger bit’s end is not round, but is specially shaped to fit the brace’s chuck. The tip of the bit (used for drilling) has a screw point. This point makes the bit self-feeding, and very little pressure is needed for the bit to dig into the wood. The bits are about 18 inches long and range from 1/4 inch to 1 inch in diameter.

The bits are numbered in sixteenth-inch increments. A number 11 bit is 11/16th of an inch in diameter. Most bolts on a utility pole are 5/8 inch in diameter so a number 11 bit would be used to give a 1/16-inch clearance around the bolt shaft.

Figure 2-26 – Auger bit.

The brace should be kept clean and the moving parts lightly oiled. If the bit becomes dull, it is normally sharpened with a file or replaced. The brace and bit should be stored in a dry location when not in use and the bit stored in its case after each use.

4.3.1.2 Electric

Electric drills (*Figure 2-27*) are also used for drilling holes, where electricity is available. One prime consideration when using a portable electric drill is to ensure the drill is able to handle the workload. The bit used in this drill is a twist bit. This bit has a smooth shank and is locked in the chuck of the drill with a key. It is worthy to note that there are two popular size chucks used on these drills: 3/8 and 1/2 inch. These sizes indicate to the user the maximum diameter bit the drill can accommodate. For example, a 3/8 inch drill will accept a maximum bit size of 3/8 inch in diameter.

When drilling a large hole in metal, a technique called step drilling should be used. This involves starting the hole with a smaller sized drill bit than that of the final hole required. The drill bit is then gradually increased in size (or steps) until the desired hole size is obtained. Remember never to exert more pressure than is necessary when drilling, as this may break the bit. Sometimes when drilling smaller holes in metal, the bit will have a tendency to move from the point where you started to drill. In this case, a center punch can be used to establish the starting point.

The electric drill should be kept in a dry place. The bit should be removed after each use and stored in its container. The air vents on this drill should be kept clear of debris to avoid overheating the drill. Never remove the grounding pin on the plug (the third prong) where one is provided, as this is for the safety of the user. Some drills have double insulated cases, and as a result, only a two-prong male plug is needed.

Figure 2-27 – Electric drill.

4.3.1.3 Hydraulic

The hydraulic drill shown in *Figure 2-28* works off of hydraulic pressure that is supplied by the hydraulic system of a special purpose truck used within the career field. It comes with a pair of hydraulic hoses, which are attached to a truck's accessory hydraulic ports. One hose is used to supply the drill with fluid while the other acts as the return.

Hydraulic pressure is supplied to the drill with the use of controls located on the truck. The user should ensure that the lines are tangle free before attempting to use the drill. The drill is activated with the use of a trigger just like an electric drill, and may have a reversible feature to reverse the bit rotation.

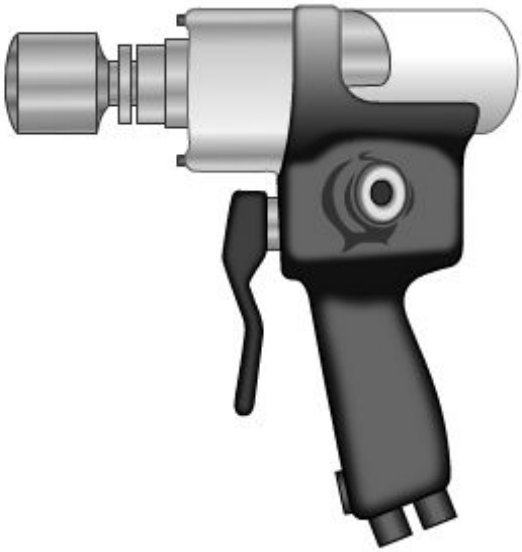

Figure 2-28 – Hydraulic drill.

The hydraulic drill is nearly maintenance free; however there are some general maintenance guidelines that apply. If the lines (hoses) that supply the drill become damaged, they should be replaced with identical lines.

The drill should also be kept in a clean, dry place. Most of the problems that occur with this type of drill are associated with the hydraulic pressure supplied by the vehicle's hydraulic system. The manufacturer's manual of that particular unit or vehicle should then be referenced.

4.3.2 Fuse Puller

The fuse puller is used for removing or installing cartridge-type fuses. (See *Figure 2-29*) It is constructed of a laminated fiber that has a high insulating value. Fuse pullers will vary in length from 5 to 20 inches.

Before using a fuse puller, you should ensure that the power to the equipment is turned off. The fuse puller has a set of jaws on each end, each sized to fit a certain range of cartridge fuses. The fuse is gripped with the jaws of the puller and the fuse extracted with a firm pull.

Fuse pullers should be kept clean and properly stored when not in use. An occasional drop of oil at the pivot point will keep free movement of the puller.

Figure 2-29 – Fuse pullers.

4.3.3 Hack Saw

Electricians use hack saws to cut metal or plastic raceways. A typical hack saw as shown in *Figure 2-30* is made up of a frame that accommodates a cutting blade. The handle makes up a part of the frame, and the frame can be adjusted to facilitate various lengths of blades (depending on the manufacturer). The blade of the hack saw is classed according to the amount of cutting teeth found in one inch of the blade. The three different sizes are 18, 24 and 32 teeth per inch. A rule of thumb for blade selection is to keep two teeth in contact with the work at all times. So the thicker the item, the fewer teeth are required; the thinner the item the more teeth required. The blades should be installed with the teeth facing away from the handle; therefore, force should always be applied on the downward stroke (away from you). You should keep your hand away from the blade while cutting. Any burrs and sharp edges left as a result of cutting should be filed or reamed smooth.

Figure 2-30 – Hack saw.

If the frame of the hack saw is damaged to a point where it cannot accommodate the blade, or if the handle of the frame is damaged, the saw should be replaced. Blades should be replaced when teeth are missing or when they become too dull to cut. The frame should outlast the blade if it is not abused. Light oil should be used to keep the hack saw frame and blade from rusting, and blades should be kept clean by brushing out debris.

4.3.4 Hammers

There are three types of hammers commonly used by the electrician. They are the claw, sledge (engineer) and ball peen hammer. The size of the hammer is determined by the weight of the head. Heads vary in weight and should be selected according to their intended use. For example, you would not want to use a 2-pound sledgehammer to drive a small nail, or a 16 ounce claw hammer to breakup a concrete slab.

When using a hammer, you should hold it near the end of the handle. Your grip should be just tight enough to control the stroke and keep the handle from slipping out of your hand. The blow should be delivered with the wrist, and the face of the hammer should strike the object squarely. On larger hammers, two hands may be required.

4.3.4.1 Claw

The claw hammer shown in *Figure 2-31* is used for driving and pulling nails and staples. Although it has claws, it should not be used to pull large nails, as too much leverage applied may break the handle. Never strike a claw hammer against a steel punch or hardened steel object.

4.3.4.2 Sledge

Sledgehammers are used where more force is needed to accomplish a job. For example, a sledgehammer would be the tool of choice when a hole is needed to be placed in a concrete wall or when a wall needs to be totally demolished. See *Figure 2-32* for example of a sledgehammer.

Figure 2-31 – Claw hammer.

Figure 2-32 – Sledgehammer.

4.3.4.3 Ball Peen

The ball peen hammer is used to drive chisels and punches. The rounded portion is used to shape metal, and flatten rivets. See *Figure 2-33* for a example of a Ball Peen hammer.

Hammers should never be used if the face is damaged or the handle is loose, cracked or broken. A wedge is used to tighten a loose handle, while cracked or broken handles will be replaced. A hammer is never be used as a crowbar. Eye protection will always be worn when using any type of hammer.

Figure 2-33 – Ball Peen hammer.

4.3.5 Knives

4.3.5.1 Electrician's Knife

The electrician's knife is one of several knives you will use to remove wire or cable insulation from conductors. The pointed blade is used for cutting and the square blade is used for scraping and cleaning surfaces. See *Figure 2-34* for example of a Electrician's knife.

4.3.5.2 Cable Splicing Knife

The cable-splicing knife consists of a stocky handle and a short curved blade. It is mainly used for splicing high voltage underground cable. Insulation on this high voltage cable is fairly thick and extremely hard; therefore a sturdy blade is necessary. See *Figure 2-35* for an example of an Electrician's knife.

The blades of both knives should be kept sharp and coated with a thin film of oil. The knife blade is sharpened using an oilstone. In order to sharpen a knife blade properly you will want to hold it flat against the stone and push it away from you with the cutting edge first.

Figure 2-34 – Electrician's knife.

Figure 2-35 – Cable splicing knife.

4.3.6 Measuring Tools

Rulers and tape measurers are used where measuring accuracy is important. They can be rigid or flexible and are available in various lengths. Rulers can be made of wood, plastic or metal, whereas tape measurers are commonly made of metal, cloth or fiberglass. Electricians should always use a non-conductive rule when working on or near live circuits. The type, form and size may be dictated by the job or merely by personal preference.

4.3.6.1 Wood Rule

The wood rule in *Figure 2-36* is used extensively by electricians. It is constructed of several sections hinged together so it can be folded into a compact unit and carried in a pouch. The rule must be folded carefully to prevent breaking the sections. The beginning of the rule sometimes has a metallic slide which is used to make depth or inside measurements.

Figure 2-36 – Wood rule.

The wood rule has four sets of graduations. The longest lines represent the inch marks and each inch is divided into equal parts. The 1/4 inch mark and 1/2 inch marks are commonly made longer than the smaller division marks to facilitate counting, but the graduations are usually not numbered individually. A rule is read by the graduation markings. These are indicated by a fraction, which represent part of a whole number. Typically, a rule is divided in quarters, eighths, or sixteenths of an inch. Wood folding rules may be marked in feet or yards.

Care and maintenance of this rule is limited to keeping it clean and away from excessive moisture. It should be kept folded when not in use and dropping it should be avoided. The pivot points should be kept lightly oiled for smooth operation.

4.3.6.2 Tape Measure

The use of the tape measure is similar to that of the wooden rule. The only exception is that tape measures are self-contained in a hand-held housing, where the tape can be stored when not in use. It also has an automatic recoil feature, which allows the tape to be returned to its housing after use. A braking device allows the tape to be held in place while a measurement is taken. The tape measure shown in *Figure 2-37* is made of thin metal and should not be used around exposed energized boxes, circuits or panels, where the potential of electric shock is possible. Care should always be

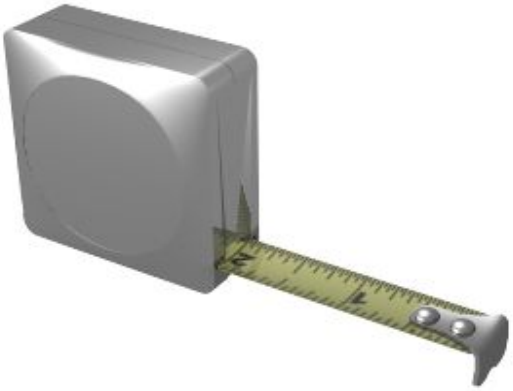

Figure 2-37 – Metal Tape Measure.

taken to avoid stepping on or kinking the tape during its use. Caution is also required during the tape's retraction for storage. The recoil feature retracts the tape at a rapid rate, and if your fingers are not clear of the tape, you may be cut or receive some other type of injury.

Basic care requires that you wipe the tape's surface of moisture and any dirt prior to and during retraction into the storage housing. Maintenance of this rule is limited to keeping it clean and away from excessive moisture. Light oil is used to maintain the steel and recoil system. This oil is applied by completely pulling out the tape from its housing, and locking it in position. The oil is then applied to both surfaces of the tape with a clean rag. Care should be exercised during the cleaning process by wearing leather gloves, as the edge of the tape is somewhat sharp. The tape should be replaced if it becomes difficult to read or damaged. Some manufacturers allow for the tape itself to be replaced while keeping the housing.

4.3.7 Pliers

There are several types of pliers that exist on the market. The most widely used are the diagonal, long nose and multi-slip joint pliers. Though these pliers sometimes come with coated plastic handles, the coating is not intended to provide any electrical insulating value unless otherwise specified. As a general rule, do not use these tools on energized circuits unless you know that the tool in question has been manufactured with the appropriate insulation and is acceptable for energized use.

4.3.7.1 Diagonal

Diagonal pliers (cutters) can be described as heavy-duty scissors. You will use this tool to cut wire. This is accomplished during the installation of new circuits or the removal of old ones. These pliers vary in lengths and have cutting jaws set at a 15-degree angle to the handle. The most common sizes you will encounter are the 6- inch and the 8-inch cutters. See *Figure 2-38* for example of diagonal pliers.

When using these pliers to cut existing circuits, ensure the circuit is de-energized. Care should also be taken to not cut your fingers.

Figure 2-38 – Diagonal pliers.

4.3.7.2 Long Nose

Long nose (also commonly referred to as needle nose) pliers have a tapered jaw with a scored gripping surface on the end and may have cutting edges on the side. These pliers can be used like extended fingers to reach into electrical boxes to retrieve wires or for bending loops on conductors. See *Figure 2-39* for an example of Long nose pliers.

4.3.7.3 Multi - Slip

The multi-slip joint pliers are used for holding round objects such as conduit. Conduit is an electrical pipe used to protect electrical wires. Multi-slip joint pliers should never be used on nuts or bolts as this could round their corners. See *Figure 2-40* for an example of Multi – Slip pliers.

The overall care of pliers is limited to keeping the jaws clean of debris and keeping the joints lightly oiled for free movement. If the jaws become damaged for any reason, the pliers should be replaced. These pliers should never be used as a hammer as this may damage the pivot and result in difficulty opening and closing the jaws.

It cannot be stressed enough that pliers with the side-cutting feature should never be used to cut energized circuits, as this may result in shock, burns and even electrocution.

Figure 2-39 – Long nose pliers.

Figure 2-40 – Multi – slip joint pliers.

4.3.8 Screwdrivers

Screwdrivers are used for installing or removing screws. There are several types of screwdrivers, each having a specific application. The most common types are the common (flat tip), cross-tip and offset. The length of the shank and the width of the tip determine the size of the screwdriver.

4.3.8.1 Common (Flat Tip)

The common (flat tip) screwdriver in *Figure 2-41* is one of the most commonly used screwdrivers, as implied by the name. The shank length may vary from one to twenty inches.

When using this screwdriver, care should be taken to match the tip to the size of the slot on the screw. You should avoid holding the work in your hand; if the screwdriver

Figure 2-41 – Common screwdriver.

slips it could cause injury to your hand. The screwdriver should never be used as a chisel or pry bar, as this could crack the handle, bend the shank or break the tip. Never use pliers or wrenches on a screwdriver unless it was designed for that purpose.

When a screwdriver tip becomes rounded or broken, the best method for restoring it to its original shape is using a bench grinder. When grinding the tip with a grinder, care must be taken not to overheat the metal. Overheating will cause the metal to lose its tempering (hardness) and become soft. Frequently dipping the metal in water during the grinding process will avoid this.

4.3.8.2 Cross Tip

The cross-tip is shaped like a cross and is used to install or remove cross-tip screws. Cross-tip screws have slots that cross at a 90° angle in the center. These screwdrivers are made with four different tips, or point sizes. Cross-tip screwdrivers also vary in shank length from one inch to twenty inches.

Cross-tip screwdrivers are usually referred to as Phillips® screwdrivers. They should only be used with cross-slotted screws. If the tip of the screwdriver is damaged, an angled file can be used to straighten the slot. Be careful when filing, as the tip can become sharp and the integrity of the screwdriver compromised. Often, it is more cost effective to replace the screwdriver rather than attempt to repair it. See *Figure 2-42* for an example of cross-tip screwdriver.

Figure 2-42 – Cross-tip screwdriver.

4.3.8.3 Offset

Offset screwdrivers are used when the working space does not permit the use of a straight shank screwdriver. They are available with common, cross-tip or a combination of both tips. The standard size used by the electrician is four inches long. See *Figure 2-43* for an example of a offset screwdriver.

The care and maintenance of this screwdriver is a combination of those previously discussed for common and cross-tip screwdrivers.

Figure 2-43 – Offset screwdriver.

4.3.9 Stripping Tools

There are a couple of tools made specifically for stripping insulation from cables and conductors. These tools are the cable stripper and wire stripper.

4.3.9.1 Cable Stripper

The cable stripper is used to cut the outer sheath of non-metallic sheathed cable. It should only be used on cables where the conductors run parallel to each other. If it is used on cable where the conductors are twisted inside, the insulation on the individual conductors may become damaged. The handle of the stripper has holes drilled in it to aid in identifying wire sizes.

Before the cable is stripped, you must determine how much of the wire needs to be exposed from it. Once this is determined, the cable is inserted into the stripper and the blade is closed on the sheath where the wires are to be exposed. With the stripper pressed on the cable, it is then pulled to the end of the cable, exposing the wires under the sheath. The sheath can then be removed with a knife or diagonal pliers. See *Figure 2-44* for an example of a cable stripper.

Figure 2-44 – Cable stripper.

In most cases, the cutting blade in the cable stripper is fixed and non-renewable. The stripper must be replaced when the blade becomes too dull to cut the sheath of the cable. The stripper should not be exposed to moisture as rust may occur. Care and maintenance consist of wiping down its surface with light oil and storing it in a dry place.

4.3.9.2 Wire Stripper

There are several types of wire strippers; most are used to strip the insulation from a conductor one wire at a time. They are generally made up of two handles and two moveable jaws with slots that accommodate different-sized wires.

The wire is placed in the appropriate slot and the handles are closed. This cuts the insulation around the wire. The insulation is then pushed/pulled off the end of the wire. Some strippers have indentations between the handles that are used to crimp connectors and terminal ends on wire. *See Figure 2-45* for an example of a wire stripper.

Figure 2-45 – Wire stripper.

Very light lubricating oil should be used on all moving parts. Check and replace the cutting jaws on models where the jaws are replaceable.

4.3.10 Wrenches

Wrenches are used to turn nuts and hold bolts. It is important that the appropriate type of wrench be selected for the type of work you are doing.

4.3.10.1 Adjustable

This wrench must be adjusted to fit the nut or bolt head snugly and torque must be exerted against the fixed jaw. If they are not used in this manner, undue strain is placed on the moveable jaw which may cause it to break. Other consequences of not using this wrench properly are that the wrench may slip off the nut or bolt head which will cause a rounding of the corners; and the possibility of personal injury. The moveable portions of the adjustable wrench should be kept lubricated for free movement and to prevent rust. Never use an adjustable wrench as a hammer or pry bar. See *Figure 2-46* for an example of an adjustable wrench.

Figure 2-46 – Adjustable wrench.

4.3.10.2 Lineman's

This wrench is specifically used by electricians engaged in the installation, maintenance and removal of Overhead distribution systems. It has openings at either end with each opening sub-divided to accommodate two sizes of common line hardware. One wrench, for example, can fit 1/2, 5/8, 11/16 and 3/4-inch nuts and bolts. These four sizes cover most of the hardware found on an average utility pole. An additional capability of the lineman's wrench is the ability to seat pole steps through the use of a hole at the larger end of the wrench. This tool's design enables the electrician to carry a single wrench rather than a handful of assorted tools to facilitate line work. Like the adjustable wrench, the lineman's wrench should never be used as a hammer, in spite of its heavy duty construction and convenience. See *Figure 2-47* for an example of a lineman's wrench.

Figure 2-47 – Lineman's wrench.

The lineman's wrench is practically maintenance free. It should be kept away from moisture to prevent rusting.

4.3.10.3 Pipe

The pipe wrench is used on conduit and fittings. The conduit should always be in contact with the jaws and never allowed to go to the bottom of the jaw opening. Failure to use the wrench as described may cause the wrench to slip and result in personal injury and damage to equipment. To prevent the jaws from slipping, clean them of dirt and grease. The jaw teeth should be sharp, and of higher quality than the pipe. Some wrenches may have replaceable jaws, so they can be replaced if damaged. See *Figure 2-48* for an example of a pipe wrench.

4.3.10.4 Ratchet

The ratchet wrench consists of a steel handle with a hexagonal opening in each end. It comes in various sizes. At one end is stamped “ON”, and on the other side is stamped “OFF”. Putting the wrench over a bolt or nut and moving the handle back and forth will cause the nut to turn clockwise in the “ON” position tightening the nut and bolt. Conversely moving the handle back and forth in the “OFF” position will cause the nut to turn counter-clockwise, loosening it from the bolt. The moving parts should be kept lubricated and clean with a light coating of lubricating oil. See *Figure 2-49* for an example of a ratchet wrenches.

Figure 2-48 – Pipe wrench.

Figure 2-49 – Ratchet wrenches.

Summary

Your knowledge and use of rigging and hoisting equipment is essential for the safe conduct and completion of your job as a Construction Electrician. Equipment movement from embarkation point to job site, job site to structure is an important factor in the safe completion of the mission. It is not only important to know how to use these skills, but also be knowledgeable of the results which may occur. Hazardous material handling and disposal is another intrical aspect of your job, as a Construction Electrician, you need the knowledge and experience when dealing with this material. During your career as a Construction Electrician, you will use a wide range of hand tools to accomplish your job, having knowledge of proper use and care of these tools will lead to a longer shelf life of material, and the safe accomplishment of the job

Review Questions (Select the Correct Response)

1. Safety in the conduct of rigging operations depends primarily on what factor?

   A. Size of line used
   B. Type of slings used
   C. Paygrade of the supervisor
   D. Care and common sense of personnel assigned

2. What is the most important operational check (inspection) made on hoisting and rigging equipment?

   A. Crane operations
   B. Line and rigging
   C. Lifting and load
   D. Load only

3. The strength of rigging lines depends on what factor(s)?

   A. The manufacturer of the line
   B. The size, fiber used, and the type of stranding
   C. Tensile strength tests
   D. Lay and resistance to wear

4. The term “whipping” refers to what factor when applied to a line?

   A. It prevents twisting of the line
   B. It prevents fatigue resistance of the line
   C. It prevents abrasion resistance of the line
   D. It prevents strands from unraveling

5. What precaution should you take before storing a fiber line?

   A. Ensure the line is dry
   B. Use forced rotation to squeeze excess water from the line
   C. Dip the line in oil lubricant to prevent water damage
   D. Check the core strength by performing a sudden strain test

6. Of the following areas, which one should be used for storing a line?

   A. A dry, unheated building that is well ventilated
   B. An air conditioned building
   C. A heated and unventilated building
   D. A building with many windows that allows sunlight to enter

7. Which of the following terms, defines the tension at which the line will part when a load is applied?

   A. Safe Working Load
   B. Breaking Strength
   C. Free Payload Strength
   D. Safety Factor

8. Which of the following terms, means the load can be applied without causing damage?

   A. Safe Working Load
   B. Breaking Strength
   C. Free Payload Strength
   D. Safety Factor

9. Which of the following terms, means that the ratio between the breaking strength and safe working load?

   A. Safe Working Load
   B. Breaking Strength
   C. Free Payload Strength
   D. Safety Factor

10. Synthetic fiber lines are used in the Navy for which of the following reasons?

    A. They are easy to handle
    B. They are highly resistant to mildew, rot, and fungus
    C. They are light weight and strong
    D. Each of the above

11. Wire rope consists of what three parts?

    A. Breech, choker hitch, and becket
    B. Choker hitch, fiber line, and spreader bar
    C. Wire, strands, and core
    D. Strands, breech, and spreader bar

12. **(True or False)** Unlaying of nonperformed wire rope is rapid and could cause serious injury.

    A. True
    B. False

13. Wire rope with what number of (a) strands and (b) wires in each strand is the most flexible?

    A. (a) 6 (b) 19
    B. (a) 6 (b) 37
    C. (a) 8 (b) 38
    D. (a) 8 (b) 41

14. What is the tensile strength of improved steel plow?

A. 180,000 to 200,000 lbs
B. 200,000 to 220,000 lbs
C. 220,000 to 240,000 lbs
D. 240,000 to 260,000 lbs

15. What is the tensile strength of mid plow steel?

A. 180,000 to 200,000 lbs
B. 200,000 to 220,000 lbs
C. 220,000 to 240,000 lbs
D. 240,000 to 260,000 lbs

16. What is the tensile strength of plow steel?

A. 180,000 to 200,000 lbs
B. 200,000 to 220,000 lbs
C. 220,000 to 240,000 lbs
D. 240,000 to 260,000 lbs

17. To ensure an accurate measurement of the diameter of a wire rope, you should measure the wire rope in (a) how many places on a six stranded rope and (b) how many places on an eight stranded rope?

A. (a) Two (b) three
B. (a) Three (b) three
C. (a) Three (b) four
D. (a) Two (b) four

18. The inspection of the wire rope clips at regular intervals should also include what other task?

A. Hitting the clips with a hammer to see if metal flakes fall off
B. Spraying the clips with paint to show they have been inspected
C. Measuring for slippage of clips
D. Removing the clips and examining the wire rope

19. What is the purpose of a wire rope thimble in an eye splice?

A. It reduces abrasive wear on the wire rope
B. It increases the distance between the load and the hoist tip
C. It speeds up the work
D. It is required for hoisting cylindrical objects

20. Shackles should replace hooks during what lifting operations?

A. When lifting a load to an unknown radius
B. When lifting a load where personnel may be working under a load
C. When loads are too heavy for the hooks to handle
D. When lifting the load in a tight area

21. What should be done with a hook that has been bent by overloading?

A. Straighten it and put it back in service
B. Have the safety LCPO approve it for service
C. Weld additional steel on the sides and place out of service
D. Cut it in half and place out of service

22. At what time interval or under what circumstances should you inspect hooks visually?

A. Monthly
B. After every 50 hours of service
C. At the beginning of each work day
D. Only when the hook is used for dragline evolutions

23. What advantage do fiber line slings have over wire rope or chain slings?

A. They are heavier and stronger
B. They resist damage from sharp edges
C. They are more flexible and offer protection to finished materials
D. They require less supporting equipment

24. **(True or False)** An endless sling is frequently used as a choker hitch.

A. True
B. False

25. A single leg sling is also known as

A. Chocker
B. Strap
C. Bridle
D. Grip

26. **(True or False)**Two single slings can be combined to form a longer single sling.

A. True
B. False

27. Why is it important to match sets of slings?

A. So they will withstand heavier loads
B. So a varied mobile lift within small working areas can be accomplished
C. So the load strain will be equal and the load will come up evenly
D. Each of the above

28. **(True or False)**Chafing gear is used to protect slings that are exposed to sharp edges.

A. True
B. False

29. Chain slings are desirable for what type of load?

A. Cold loads
B. Light loads
C. Nonsharp loads
D. Hot and sharp edged loads

30. When using chain slings, you should ensure what material is in place around the load to provide a gripping surface for the chain?

A. Lifting eye
B. A composite covering
C. Dunnage
D. Wire mesh

31. **(True or False)** Bolts and heavy gauge wire may be used to fasten links of chain together.

A. True
B. False

32. Which of the following defects should you look for during a fiber line sling inspection?

A. Deterioration caused by exposure to the weather
B. Broken fibers
C. Cut fibers
D. Each of the above

33. Wire rope slings must be replaced when what percentage of wires are nicked or cut?

A. 1 percent
B. 2 percent
C. 3 percent
D. 4 percent

34. What type of collateral equipment is used to prevent crushing of a load?

A. Stress slings
B. Cargo pallets
C. Spreader bars
D. Rope slings

35. What is the advantage of using cargo pallets?

A. They make the load easier to move
B. They allow single large items to be moved more efficiently
C. Spreader bars do not need to be used
D. Single items may be moved piece by piece

36. Which of the following is NOT a requirement for performance as a competent signalman for a crane or hoist operations?

A. Be fully qualified with the operation
B. Ensure the suspended load never passes over anyone
C. Assist in operating the equipment, as needed
D. Wear high visibility gloves

37. When the signalman desires to give the equipment operator instructions other than those established beforehand, the operator should perform what action first?

A. Stop all motion of the load
B. Have a runner contact the signalman
C. Blow the horn
D. Raise and lower the load about 2 feet in acknowledgement

38. When the distance or atmospheric conditions prevent clear visibility for signaling, what other form of communication should be used?

A. Large Q cards
B. Manual morse
C. A flashing light
D. Two way radio

39. What is the most important rigging precaution?

A. To determine the proper lifting angle
B. To determine whether hand signals being used are adequate
C. To determine the weight of all loads before attempting a lift
D. To determine if the crane can reach the material safely

40. Because gusty wind can affect loading and load landing operations, you should take which of the following precautions?

A. Wrap the load with a wind reducing material
B. Avoid handling loads that have large wind catching surfaces
C. Add additional tie lines
D. Use additional tie down ropes

41. What is the primary cause of death fro riggers on the job?

A. Electrocution
B. Falling equipment
C. Cables that snap

42. What is the minimum safe working distance from an energized conductor of 125,000 volts?

A. 10 feet
B. 15 feet
C. 20 feet
D. 25 feet

43. **(True or False)** Under certain circumstances, it is permissible to ride on a well rigged load.

A. True
B. False

44. OPNAVINST 4110.2 establishes guidance and policy for what subject?

A. Safety precautions and programs
B. Health and physical readiness programs
C. Hazardous material control and management
D. Basic skills for job orientation and OJT programs

45. The requirement to comply with a foreign country's HMJHW regulations (if more restrictive) is found in what document(s)?

A. Host nation Status of Forces agreement
B. United States Navy HM/HW regulations
C. United Nations HM/HW regulations
D. U.S. OSHA and EPA regulations

46. Of the following OPNAV instructions, which ones cover the use, storage, and disposal of HM?

A. OPNAVINST 1306.1 and 5352.1
B. OPNAVINST 4110.2 and 5100.23
C. OPNAVINST 5354.2 and 1160.4
D. OPNAVINST 5700.7 and 6110.1

47. **(True or False)** The MSDS identifies the type of personnel protective clothing and equipment needed in case of exposure.

A. True
B. False

48. Tool kits should be maintained at what maximum percentage of kit assembly allowance?

A. 100 percent
B. 90 percent
C. 80 percent
D. 70 percent

49. On the jobsite, what person is responsible for tool stowage and security?

A. The project safety petty officer
B. The crew members
C. The crew leader
D. The company chief

50. The brace and bit is used during which of the following conditions?

A. Electricity not available
B. Severe weather
C. Stone drilling
D. Sheet metal work

51. What is the proper name given to the type of bit used in a brace?

A. Drill bit
B. Auger bit
C. Chuck key
D. Mills bit

52. The brace and bit is used to drill into what type of material?

A. Metal
B. Stone
C. Wood
D. Plastic

53. What technique is used when drilling a large hole in metal with an electric drill?

A. Snap drilling
B. File drilling
C. Auger drilling
D. Step drilling

54. What tool is used to make a starting point on metal before drilling a small hole?

A. Center punch
B. Awl
C. Screwdriver
D. Chisel

55. What problems are usually associated with the use of the hydraulic drill?

A. Loss of electrical power
B. Loss of hydraulic pressure
C. Loss of pneumatic pressure
D. Loss of compressed air

56. The fuse puller extracts what type of fuse?

A. Box type fuse
B. Plug in type fuse
C. Cartridge type fuse
D. Sidel type fuse

57. What safety precaution will be performed before pulling a fuse?

A. All personnel clear up to 25 feet
B. Fuse puller is oiled
C. LCPO permission
D. Power secured to equipment

58. List the three different sizes of blades used in a hack saw.

A. 18, 24, 32 teeth per inch
B. 16, 20, 34 teeth per inch
C. 18, 24, 34 teeth per inch
D. 16, 24, 32 teeth per inch

59. How should the blade be positioned in the hack saw frame?

A. Teeth facing towards the handle
B. Teeth facing away from handle

60. After using a hack saw, what should be done to eliminate burrs and sharp edges from the material previously cut?

A. Melted away
B. By using a whisk broom
C. Filed smooth
D. Shaking material

61. What three types of hammers are commonly used by electricians?

A. Sledge, Ball peen, and Jewelers
B. Claw, Jewelers, and Sledge
C. Claw, Mallet, and Ball peen
D. Sledge, Ball peen, and Claw

62. What is the ball peen hammer used for?

A. Drive chisels and punches
B. Drive masonry nails
C. Drive conduit staples
D. Drive wood wedges

63. What purpose does the square blade serve when using the electrician's knife?

A. Installing screws
B. Scraping surfaces
C. Stripping insulation
D. Making starting point for electric drill

64. For what purpose is the splicing knife used?

A. Splicing low voltage underground cable
B. Splicing high voltage above ground cable
C. Splicing high voltage underground cable
D. Splicing low voltage above ground cable

65. How many sets of graduations does the wood rule have?

A. One
B. Two
C. Three
D. Four

66. What precaution should be observed when using the tape measure?

A. Kinking of tape
B. Removing excessive oil
C. All increments are legible
D. Tape measure is calibrated

67. **(True or False)** It is accepted practice to use a wrench on a screwdriver when additional force is needed.

A. True
B. False

68. How long is the standard size offset screwdriver?

A. Two inches
B. Three inches
C. Four inches
D. Five inches

69. How is the blade sharpened on the cable stripper?

A. By using whetstone
B. By using a grinding stone
C. By using a coarse file
D. Not sharpened, replacement only

70. What is the purpose of the wire stripper?

A. Strip insulation from a conductor one wire at a time
B. Strip insulation from a high voltage underground cable
C. Strip insulation from a conductor wire rung containing at least three wires
D. Strip insulation from a low voltage rectifier

71. How is the adjustable wrench maintained?

A. Repainted after 10 uses
B. Movable parts lubricated in oil
C. Replaced after 50 uses
D. Movable parts lubricated with silicone

72. How many different sizes of nuts and bolts can the lineman’s wrench accommodate?

A. Two
B. Three
C. Four
D. Five

73. The hole located at the larger end of the lineman's wrench is used for what purpose?

A. Seat pole clamps
B. Start seat poles
C. Start seat clamps
D. Seat pole steps

74. When using the pipe wrench, the conduit should never be allowed to go to the bottom of the jaw opening. Why?

A. Wrench will slip and possibly cause injury
B. Wrench will lock out operation
C. Wrench will fall apart
D. Wrench will not reset

75. What markings are found on the ratchet wrench?

A. Left and Right
B. On and Off
C. Clockwise and counterclockwise
D. Up and Down

Trade Terms Introduced in this Chapter

Abrasion	a wearing, grinding, or rubbing away by friction
Caliper	any of various measuring instruments having two usually adjustable arms, legs, or jaws used especially to measure diameter or thickness
Corrosion	the action, process, or effect of corroding
Dunnage	loose materials used to support and protect cargo
Fatigue	the tendency of a material to break under repeated stress
Kinking	To form a kink
Pad eyes	Device used in assistance of lifting
Polyethylene	a polymer of ethylene ; any of various partially crystalline lightweight thermoplastics that are resistant to chemicals and moisture
Polypropylene	any of various thermoplastic plastics or fibers that are polymers of propylene
Sisal	a strong durable white fiber used especially for hard fiber cordage and line
Thimble	a grooved ring of thin metal used to fit in a spliced loop in a rope as protection from chafing

Additional Resources and References

This chapter is intended to present thorough resources for task training. The following reference works are suggested for further study. This is optional material for continued education rather than for task training.

Tools and Their Uses. NAVEDTRA 14256. June 1992.

Hazard Communication, Code of Federal Regulations, 29 CFR 1910.1200, 1991. Hazardous Material Control and Management, OPNAVINST 4110.2, Office of the Chief of Naval Operation, Washington, DC, 1989.

Naval Construction Force Manual, NAVFAC P-315, Naval Facilities Engineering Command, Washington, D.C., 1985.

Safety and Health Requirements Manual, EM-385-1-1, Department of the Army,U.S. Army Corps of Engineers, Washington, DC, 1992.

Use of Wire Rope Slings and Rigging Hardware in the Naval Construction Force, COMSECOND/COMTHIRDNCBINST 11200.11, Department of the Navy, Naval Construction Battalions, U.S. Pacific Fleet, Pearl Harbor, Hawaii, Naval Construction Battalions, U.S. Atlantic Fleet, Naval Amphibious Base, Little Creek, Norfolk, VA, 1988.

Wire and Fiber Rope and Rigging, Naval Ship's Technical Manual, NAVSEA S9086-UU-STM-000/CH-613, Chapter 613, Commander, Naval Sea System Command, Washington, DC, 1978.

Cranes and Attachments 1, SCBT 540.1, Naval Construction Training Center, Gulfport, MS, 1988.

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