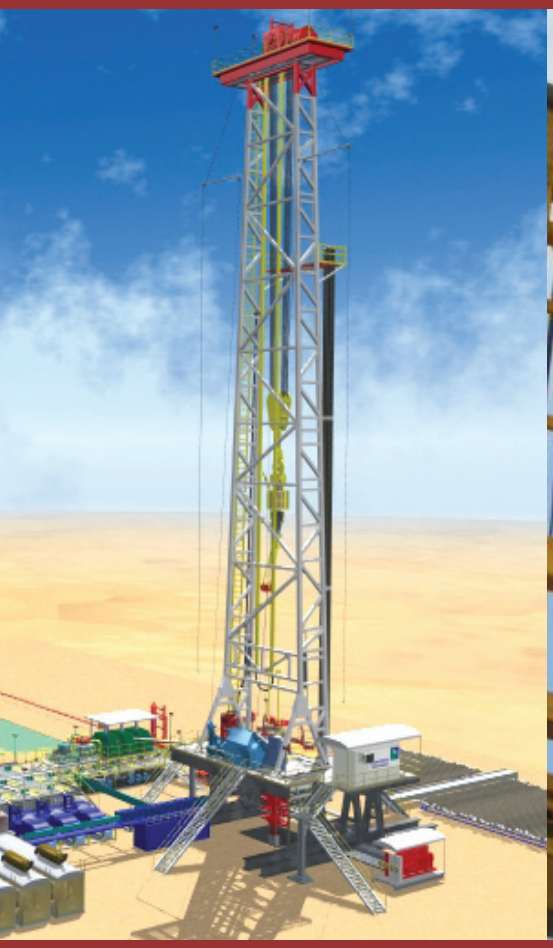
ارامكو السعودية
Saudi Aramco

Instructor Guide

# INTRODUCTION TO DRILLING OPERATIONS



**Module 4.4**
Define the function of the Drilling Line

**D&WO HR Training & Competency Development Division**
**Published by T&D**
**August 2014**

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Trainee Handbook

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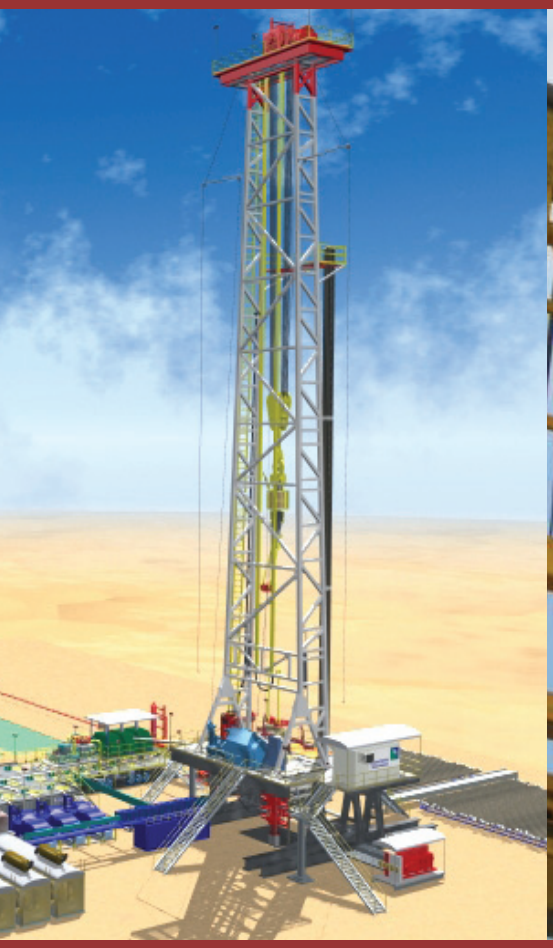

**Module 4.4**
Define the function of the Drilling Line

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## Unit 4: State Hoisting System Operating Requirements on a Rotary Drilling Rig

## Module 4.4
## Define the function of the Drilling Line

### INSTRUCTOR GUIDE

## Unit 4: State Hoisting System Operating Requirements on a Rotary Drilling Rig

## Module 4.4
## Define the function of the Drilling Line

### TRAINEE HANDBOOK

| Item | Action | Aid | Time |
|---|---|---|---|
| PREPARATION | Before class, prepare the classroom.<br>Distribute trainee handbooks. | Instructor Guide.<br>Trainee Handbooks. | |
| INTRODUCTION | Identify and explain the module objectives.<br><br>Explain new words. | Information Sheets.<br><br>Glossary.<br>Oil Industry Terms e-Glossary. | 1 hr. |
| OBJECTIVE 4.4.1 | State the factors affecting the service life of the drilling line.<br><br>Show PETEX video "Care and Handling of Wire Rope & Slings on Drilling Line".<br><br>Have trainees complete the exercise. | Information Sheets, part I.<br><br>PETEX Video 56-1099.<br><br>Exercise A. | 2 hr. |
| OBJECTIVE 4.4.2 | List steps for slipping and cutting the drilling line.<br><br>Have trainees complete the exercise. | Information Sheets, part II.<br><br>Exercise B. | 3 hr. |
| OBJECTIVE 4.4.3 | State the reasons and methods for reeving the drilling line.<br><br>Have trainees complete the exercise. | Information Sheets, part III.<br><br>Exercise C. | 3 hr. |
| RIG VISIT | Review rigman responsibilities in relation to the drilling line. | Information Sheets | 4 hr. |
| REVIEW | Review objectives. | Information Sheets. | 1 hr. |
| WRITTEN TEST | Administer the written test. Score and record the results.<br><br>Counsel trainees whose performance is unsatisfactory and provide remedial training as required. | Test Sheets.<br>Test Answer Key. | 2 hr. |
| | Estimated time for a class of 8 trainees. | | 16 hr. |

## USING THIS MODULE

This module familiarizes the trainees with the function and operation of the drilling line. Use the Saudi Aramco Oil Industry Terms e-Glossary and other online resources to explain new terms or concepts.

The key objectives to emphasize in this module are:

- function of the drilling line
- factors that will affect how quickly the drilling line will wear
- purpose and procedure for slipping and cutting
- purpose and procedure for reeving the drilling line

## RIG VISIT

Use the training rig as much as possible to show trainees the physical parts discussed in the module and their function. Also use practical demonstrations in place of lectures wherever possible. The information sheets are best seen as reference material for your trainees to review information on the equipment that they have been learning about.

## KEY TO EXERCISES

### EXERCISE A

1. a. derrick height
   b. sheave size
   c. line tension
   d. drawworks drum type
   e. deadline tie-down anchor size and location
   f. handling and care
   g. drilling job type

2. a. drum size

   b. working condition of the drum

   c. drum design

3. Cut and slip the drilling line to remove the birdcage.

4. Freeing a stuck pipe.

5. a. prevent rust and corrosion.

   b. reduce friction wear.

6. a. size

   b. location

## EXERCISE B

1. Ton-miles.

2. To shift critical points of wear.

3. a. Extreme stuck pipe operation.

   b. Visual inspection shows significant wear.

4. Top of the crown block and bottom of traveling block sheaves.

5. Wraps of non-working drilling line that will always remain on the drum, even when the traveling block is fully lowered.

6. The main difference is either cutting first or slipping first.

## EXERCISE C

1. Reeving is threading the drilling line through the blocks' sheaves.

2. a. After drilling line cutoff.

   b. Rigging up.

   c. Gaining mechanical lifting advantage.

3. 8 individual lines.

4. Small fleet angle.

5. Dead wraps prevent loads from being placed on the drilling line where the line is attached to the drum, which is a weak point.

6. Use the air hoist line to pull tension on the drilling line while reeling line onto the drum.

| Date | Reason |
| --- | --- |
| August 2014 | First Printing |

## Enabling Objectives

*You will, correctly and without help, be able to:*

4.4.1
State the factors affecting the service life of the drilling line.

4.4.2
List steps for slipping and cutting the drilling line.

4.4.3
State the reasons and methods for reeving the drilling line.

### *Terminal Objective*

*Define the function of the drilling line.*

## INTRODUCTION

As you have learned, the drilling line raises and lowers the traveling block. The drawworks reels out or reels in the drilling line to lower and raise the traveling block. The drilling line supports the weight of the drill string as well as the traveling block and hook assembly. With continued use, the line will eventually wear, and must then be replaced.

The drilling line is the most expensive item on the rig that needs to be replaced often. It may last less than one year or for several years. Many factors affect how long it remains in service. The rig crew can control some of these factors to extend the life of the drilling line.

In this module, you will learn about the factors that affect the drilling line service life. You will also learn about the reasons and procedures for slipping, cutting, and threading the drilling line.

**PART I** **OBJECTIVE 4.4.1**

### State the Factors Affecting the Service Life of the Drilling Line

Many factors influence how long the drilling line can be used for. These factors are:

- ❑ derrick height
- ❑ sheave size
- ❑ line tension
- ❑ drawworks drum type
- ❑ deadline tie-down anchor
- ❑ handling and care
- ❑ drilling job type

## DERRICK HEIGHT

Derrick height determines the total length of line to string up. Derrick height also determines the amount to keep on the supply reel (the reserve) for a slip-and-cutoff program.

*A slip-and-cutoff program involves unreeling (slipping) a length of new line off the supply reel, and reeling it onto the drawworks drum. The used part of the line is then cut off and discarded.*

Short derricks tend to wear a line faster than tall ones because the stress points are closer. The highest stress points are where the line is forced onto a reel, such as the drawworks, crown block, and traveling block. A slip and cut will need to be performed more often in a short derrick than in a tall one.

## SHEAVE SIZE

As you learned, the size of the crown block and the traveling block sheaves affects drilling line wear. Also, the size of the sheave grooves and tread diameter affect line wear.

### Sheave Groove Size

If a sheave groove is too large (see figure 1), the wire rope moves back and forth in the groove. This movement makes the line flatten against the bottom of the groove and causes it to wear out. If the sheave groove is too small, the wire rope rubs the sides of the grooves.

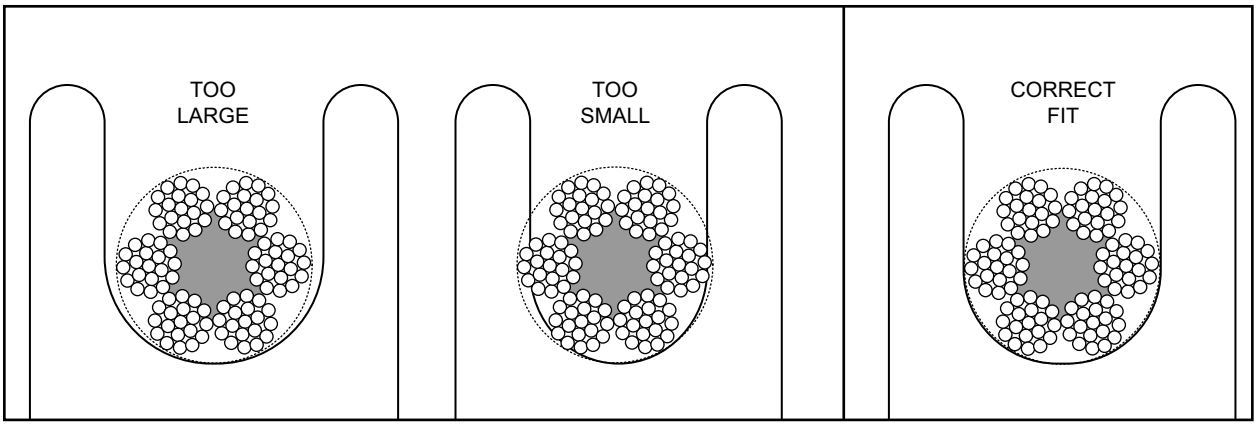


**Figure 1**
**Wire Rope in Sheave Groove**

A groove of the correct size will eventually wear to a larger size as the line moves through it. When grooves wear beyond recommended tolerance, they damage the line.

## Tread Diameter

Proper tread diameter (sheave size) is also important. The larger the sheave's diameter, the more contact it has with the drilling line. Larger diameters also minimize the bending angle and wear on the line. Thicker ropes require a larger diameter sheave. If the sheave is too small the rope bends too much, causing it to wear out quickly or even to break.

There are tables that show different rope diameters and the recommended sheave diameter, and a minimum sheave diameter for each rope size. These recommendations apply to both crown block and traveling block sheaves.

## LINE TENSION

Sudden stress is the most damaging factor to a drilling line. When installing a new line or slipping and cutting an existing line, the rig crew must keep tension on the line as the driller ***spools*** the line onto the drawworks drum. Tension will keep the line tight as it wraps on to the drum. If the ***wraps*** are loose, the line can slip and jerk.

The jerks cause stress on the line and may damage it. One way to keep tension on the line is to attach the air hoist line to the drilling line. When the driller spools the drilling line onto the drum, the air hoist operator holds tension on the drilling line with the air hoist line.

## DRAWWORKS DRUM TYPE

The size, the design, and the condition of the drawworks drum affect the rate of wear on the line.

### Drum Size

A small-diameter drum requires more wraps than a large drum. This means a small drum has more crossover (turnback) points which increase wear. Crossover causes wear spots on the rope, which shortens its life.

Crossover happens as drilling line spools onto the drum. The line wraps around the drum from one end of the drum to the other. When it reaches the end, the line continues back the other way, wrapping around the previous layer of drilling line. Each time the line starts back the other way, it crosses over, and causes wear spots on the rope.

### Drum Design

Drums can be designed to reduce wear from scrubbing. Scrubbing wear at the drum is often severe at the crossover points. The line scrubs against the flange and part of the line on the drum. Some drums have turnback rollers on each side of the drawworks, as in figure 2, to reduce scrubbing.


**Figure 2**
**Turnback Rollers**

Turnback rollers are small metal cylinders attached to the drawworks, just above the drum flanges on each side of the drawworks. When the drilling line nears the flange, it contacts the rollers instead of the flange. The rollers hold the line off the flange to prevent scrubbing.

Also, most rigs use line guides on the fastline between the drum and the crown to reduce vibration and fastline whip. The line guides reduce wear and increase the service life of the rope (see figure 3).

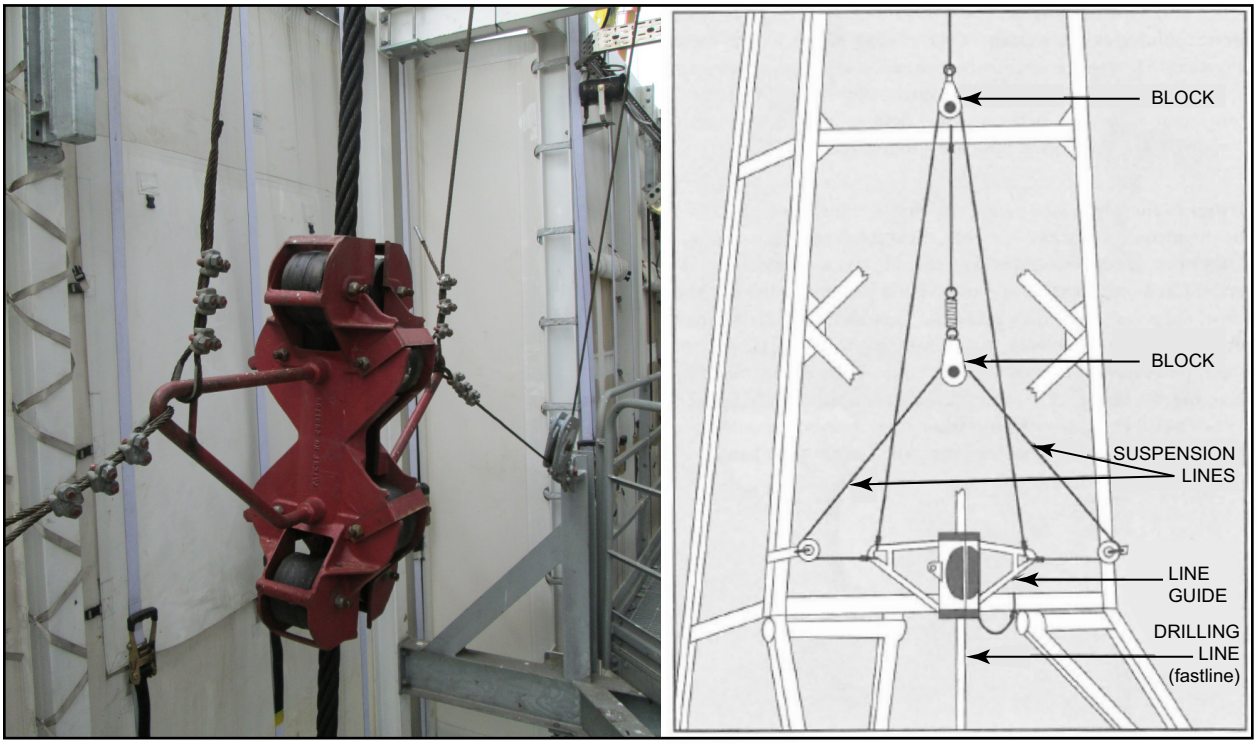


**Figure 3**
**Line Guides Reduce Vibration and Fastline Whip**

Virtually all drawworks drums have a grooved surface. Grooved drums make the drilling line spool evenly and tightly over the length of the drum.

## Condition

The condition of the drawworks can affect the wear of the drilling line. For example, if the clutch slips on the drawworks drum, it will not firmly engage the drum and start it evenly and smoothly. The clutch partly engages, and then partly disengages (slips). Every time the clutch slips, it jerks on the drilling line. Each jerk stresses the line and shortens its life.

## DEADLINE TIE-DOWN ANCHOR

The size and the location of the deadline tie-down ***anchor*** affect the life of the drilling line.

### Size of Tie-Down Anchor

To attach the deadline to the anchor, the line must be looped around the anchor and clamped firmly. If the anchor is too small for the size of the line, the line's strands have to bend too much to fit around the anchor. A bent drilling line does not last long.

### Location of the Tie-Down Anchor

The anchor should be located where there is no need to bend or twist the deadline to reach the anchor. Bending or twisting the line stresses it and can cause early failure.

## HANDLING AND CARE

The way rig crew moves, uses, and lubricates a drilling line can make a big difference in its service life.

### Moving the Supply Reel

New drilling line is provided on a supply reel, as shown in figure 4. The reel is usually covered to protect the rope against mud, corrosive water, and windborne abrasives. A crowbar is used on the reel flange only, not on the wire itself. When lifting a reel, the sling is put through the center hole of the reel to protect against crushing. The reel should not be rolled where the line may pick up dirt or sand.

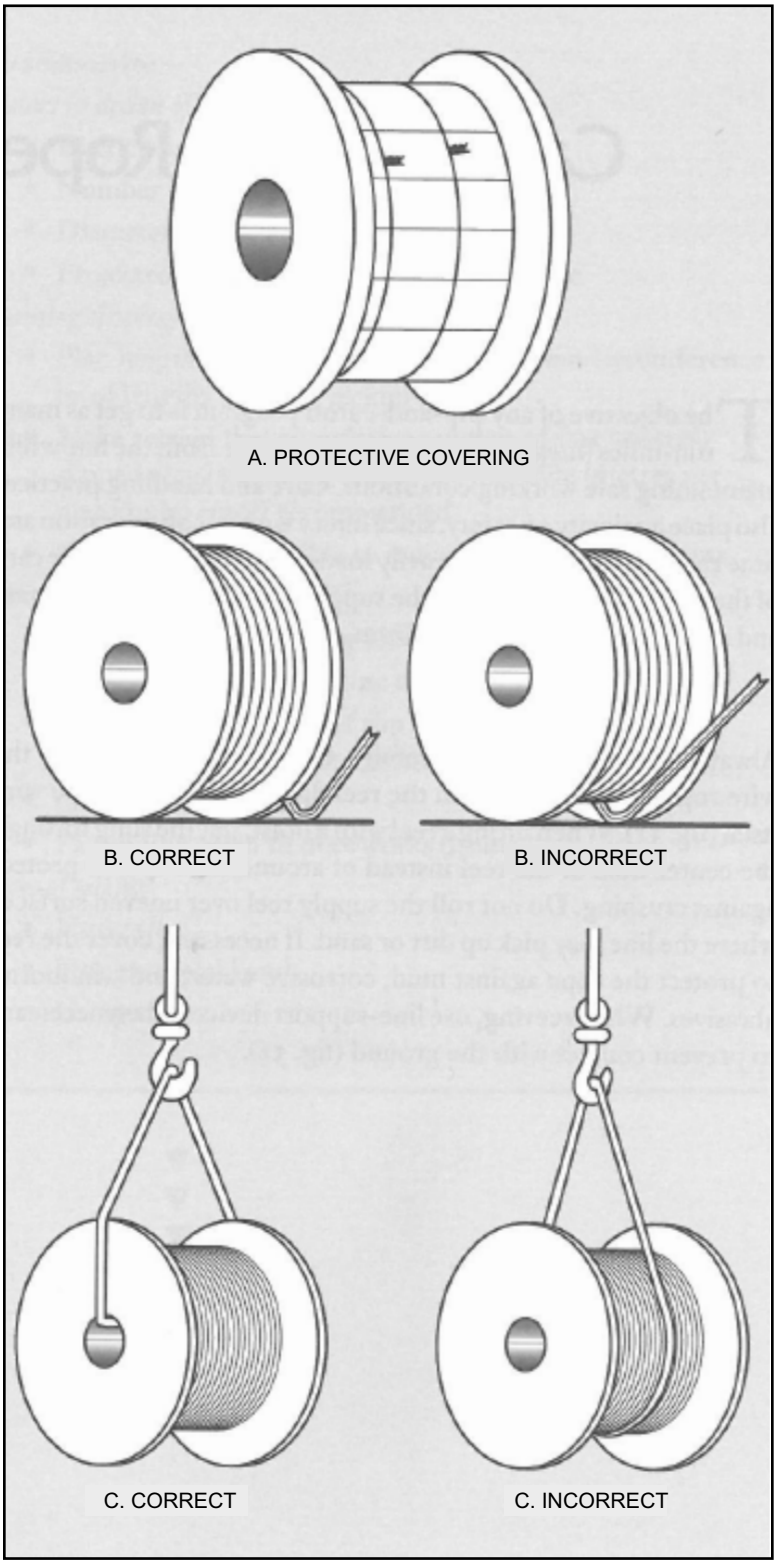


**Figure 4**
**Moving the Supply Reel**

When reeving, the pneumatic motor may be used if so equipped, or line-support devices. This prevents contact with the ground, as shown in figure 5.

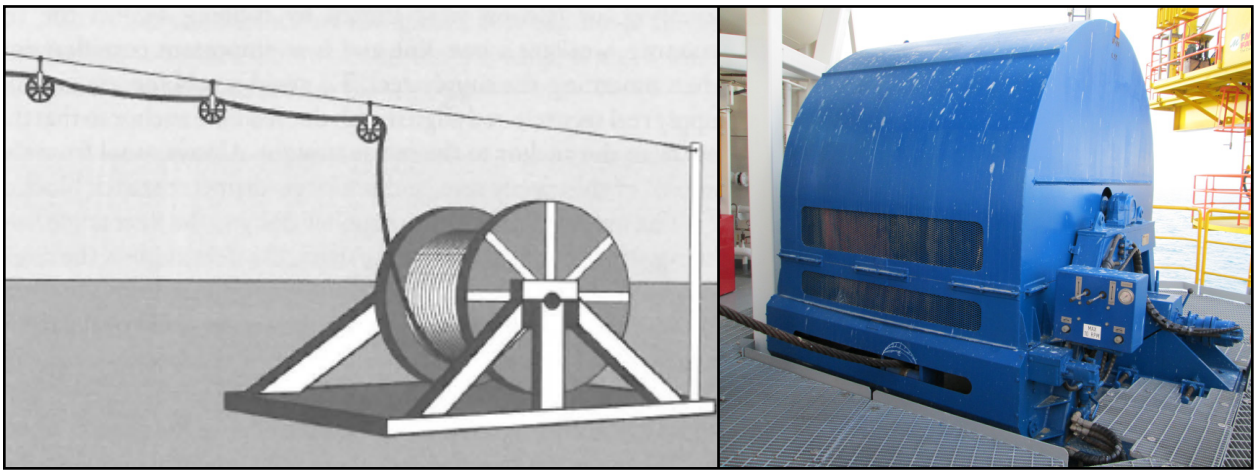

**Figure 5**
**Line Support Setup and Modern Motor Operated Supply Reel**

## Use and Misuse of Drilling Line

Careful drilling practices can minimize stress on the line. Moving the line too fast when hoisting the traveling block is a major cause of line wear. To avoid such wear the driller should allow the traveling block to gradually slowdown in the last feet of its travel. The line then spools tighter on the drum and is less likely to kink or get crushed.

Drillers should raise and lower the blocks as smoothly as possible instead of dropping and bouncing them. Smooth operation results in better drum spooling and less wear. Sudden releases sometimes cause the wire to unravel or birdcage (see figure 6). Birdcaged wire means that the line is unsafe and that it should be immediately cut and slipped to remove the birdcage.

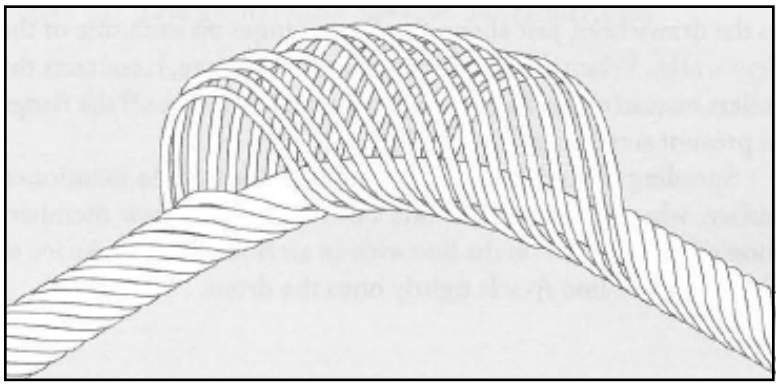

**Figure 6**
**Birdcaged Wire Rope**

## Drilling Line Lubrication

Proper lubrication lengthens the service life of wire rope. Lubrication prevents rust and corrosion and reduces friction wear. Factory lubricated rope may never require field lubrication. However, if the lubricant applied by the manufacturer has worn off for any reason, then field lubrication is necessary.

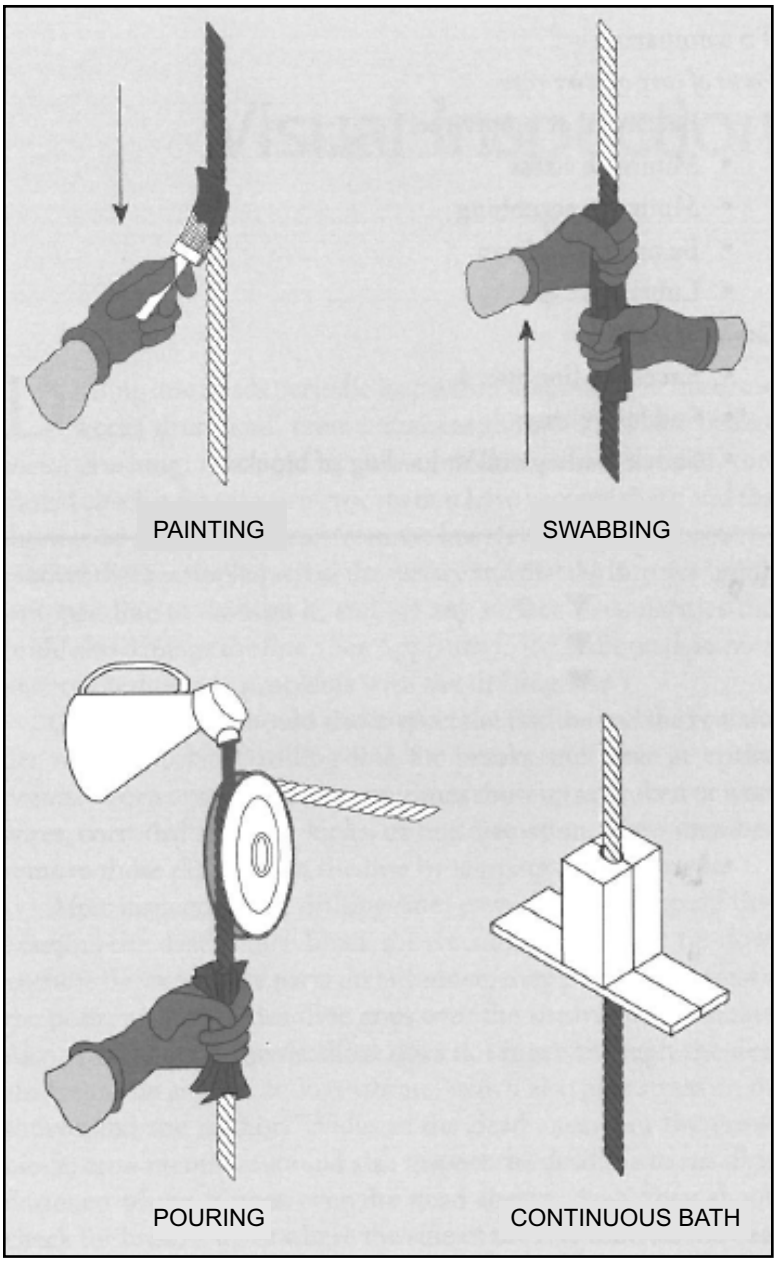


**Figure 7**
**Field Lubrication**

The rope should be cleaned before greasing it. Cleaning is done with a brush, rather than a solvent, to remove any grit or sand clinging to the rope. A solvent may damage the rope. A good grade lubricant is applied by painting, swabbing, or pouring; or a continuous bath (see figure 7). When swabbing or pouring lubricant, rigmen should wear gloves due to broken wire and sharp ends.

## DRILLING JOB TYPE

Drilling conditions, the depth of the well, the size of the drill pipe, and the number of drill collars vary from job to job. Also, operations such as drill string testing, retrieving stuck pipe, and running casing, put a lot of wear on the drilling line. In short, the more round trips on a particular job, the faster the drilling line will wear.

### Stuck Pipe

Attempts to free a drill string that has become stuck downhole can be the most damaging to the drilling line. The operation to unstick drill pipe causes extreme strain and wear on the line. After such an operation, the rig crew must fully inspect the mast and line. Workers must slip the drilling line to remove the critical wear points and damaged line.

## SUMMARY

In this section, you have learned that there are many factors that affect the service life of the drilling line. Rig crew should be aware of them and watch out for signs of wear.

## EXERCISE A

***Directions:*** *Answer the following questions.*

1. What are seven (7) factors that affect the service life of a drilling line?

   a. _____

   b. _____

   c. _____

   d. _____

   e. _____

   f. _____

   g. _____

2. What three (3) drum factors that can affect the service life of a drilling line?

   a. _____

   b. _____

   c. _____

3. What should be done if there is a birdcage in the drilling line?

   _____

   _____

4. Which operation could be the most damaging to a drilling line?

_____

_____

5. What are two (2) reasons for lubricating a drilling line?

a. _____

b. _____

6. What two (2) deadline tie-down anchor factors that can affect the service life of a drilling line?

a. _____

b. _____

**PART II** **OBJECTIVE 4.4.2**

List Steps for Slipping and Cutting the Drilling Line

The drilling line is expensive. Measuring and recording its service life helps to get the most use out of the line. The toolpusher and driller use the measurements in a systematic way to know when to slip and cut the line. They slip the line past the high stress points in the hoisting system where it gets more wear. This distributes the wear to unworn parts of the line and increases the life of the line.

In this part you will learn about:

- measuring drilling line service life
- slip and cut off programs
- drilling line inspection

## MEASURING DRILLING LINE SERVICE LIFE

The toolpusher and driller record line use in ton-miles. When the hoisting line has moved 1 ton over a distance of 1 mile, the line will have given 1 ton-mile of service. The driller and toolpusher calculate the ton-miles of work performed by the drilling line using mathematical formulas. Drillers record these measurements to keep track of the drilling line wear.

# SLIP-AND-CUTOFF PROGRAMS

A slip-and-cutoff program helps guide the driller and toolpusher, so that they know when the drilling line should be replaced. A program includes information about:

- ❑ visual inspection
- ❑ critical wear point locations
- ❑ planning the slip-and-cutoff
- ❑ cutting
- ❑ slip-and-cutoff procedures

## Visual Inspection

The limitations on ton-miles of service that a line actually provides may vary from the recommended slip-and-cutoff program. This depends on the type of equipment used and the degree of wear on the line. For this reason, visual inspection is an important part of monitoring service life.

By looking at the condition of the line, the driller or toolpusher can tell if the line needs attention. For example, when the line is kinked or stretched by an unusually heavy strain. Visual checks are the only reliable way to determine whether the slip-and-cutoff schedule needs adjustment. Visual inspection by experienced hands always takes priority over any scheduled procedures.

Visual inspection is good for spotting obvious marks of severe stress. However, you cannot easily see regular high stress marks on the drilling line. In a working line, higher-than-normal wear occurs in a few specific spots.

Critical points of wear should be shifted, or slipped, frequently. Otherwise, the line will wear out completely in these areas but wear very little elsewhere. Without a program that systematically removes worn line, the line would eventually break at the weak points.

Following a precise slip-and-cutoff program schedule gets the most service from a line. The program determines when and how long, to pull (slip) new line from the supply reel to evenly distribute the wear on the line.

Working from their service records and manufacturer guidelines, the driller and toolpusher develop slip-and-cutoff programs to extend the service life of the drilling line. Slip-and-cutoff programs are calculated based on many factors, as listed in table 1.

| SLIP-AND-CUTOFF CALCULATION FACTORS |
| --- |
| Derrick height |
| Number and size of lines strung |
| Sheaves diameter |
| Ton-miles of service between cuts |
| Ton-mile per foot cut |

**Table 1**

The driller and toolpusher usually slip and cut the line when the line service reaches a predetermined figure; for example, 1,000 ton-miles. However, unscheduled slipping and cutoff is often required after extreme stuck pipe operations or when an inspection shows significant wear.

## Critical Wear Points Locations

Critical wear points are locations where the load exerts the most strain on the line. This includes where the line moves over and through the blocks, and on and off the drawworks drum. Wear areas include the pickup points on the blocks coming out of and going into the hole. Also, crossover (turnback) points at the drum flanges (see figure 8). These pickup points absorb stress when the drill string is picked up off the slips.

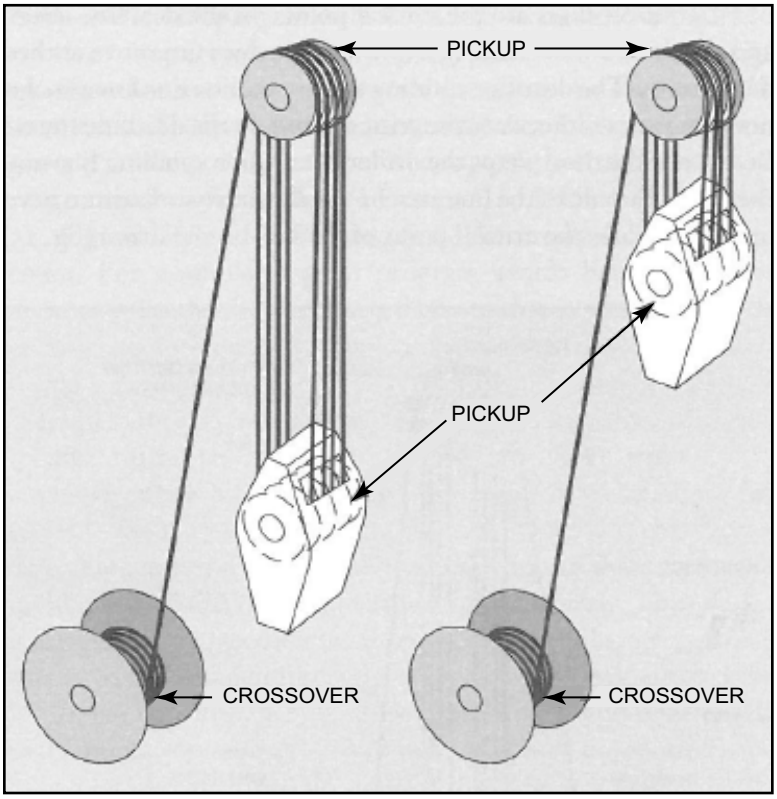


**Figure 8**
**Critical Wear Points**

Most critical points shift, depending on whether the load is coming out of the hole or going into it. Two examples of critical points that do not shift are the critical points on the deadline sheave and the drawworks drum.

*Dead wraps are wraps of nonworking drilling line that always remain on the drum, even when the traveling block is fully lowered.*

The drilling line does not move at these dead points. Once the drilling line is fixed to the drawworks drum, the first 7 to 10 wraps that are reeled on to the drum are never used. These 'dead wraps' never move off the drum nor does the critical point of the line on the drum (figure 9).

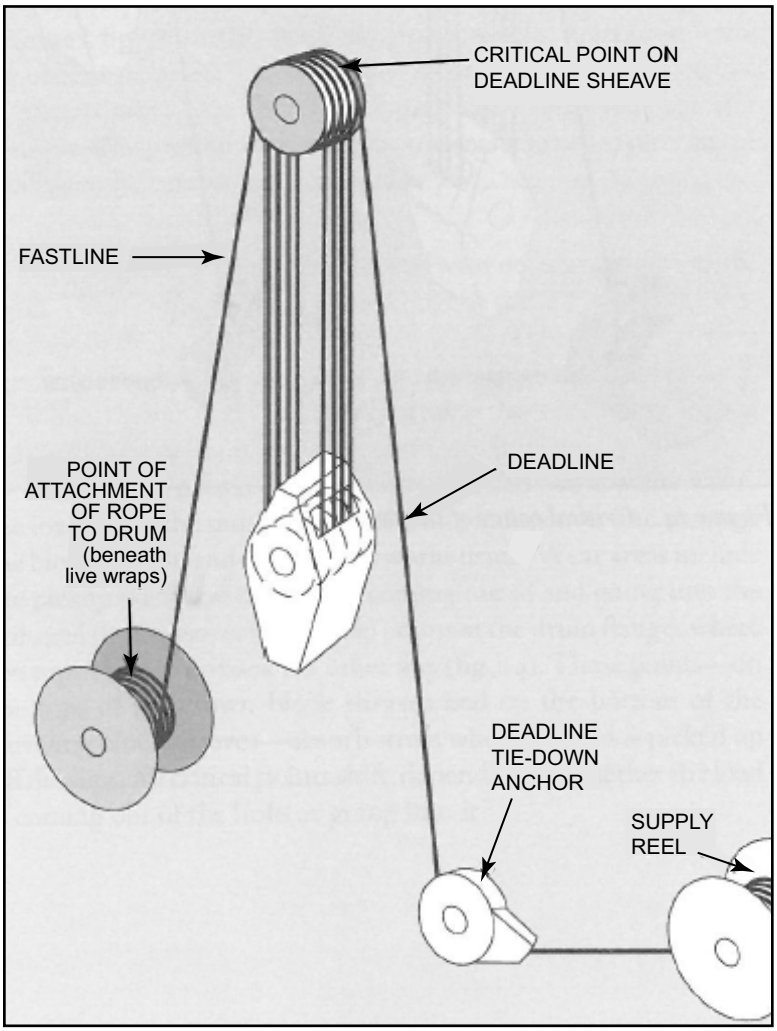


**Figure 9**
**Nonmoving Critical Points**

## Planning the Slip-and-Cutoff

A slip-and-cutoff program is calculated to meet each rig's specifications. A program for one rig does not work for another. These programs follow a number of general guidelines, as listed in table 2.

| SLIP-AND-CUTOFF PROGRAM GUIDELINES |
| --- |
| Never slip the drilling line a distance that is a multiple of the drum's circumference, or a multiple of the distance between the side of the drawworks drum and the pickup point. If you do, you would move the rope from one critical wear point to another, instead of placing relatively unworn line at the wear points.<br><br>A multiple of a number is any other number that divides evenly into the original number. For example, 64 feet is a multiple of 8 feet, because $^{64}/_{8}$ = 8. |
| The number of feet slipped must equal the number of feet per ton-mile of cutoff recommended by the program. For example, if the program indicates cutting off 80 feet for every 800 ton-miles, or 10 ton-miles per foot cut, then 20 feet should be slipped for every 200 ton-miles, and so on. |
| Cut off before slipping line from the supply reel to avoid contaminating the new line with dirt. |
| Slip the fewest feet possible to move all critical wear points. This ensures that no one point is exposed to a high wear point twice. |

**Table 2**

## Cutting

Before cutting the line, rigmen seize, or wrap, the rope at both sides of the intended cut. This stops the individual strands from springing apart, and possibly causing injury. Depending on the type of rope, they may use wire, a metal band, or tape for seizing.

Tape used for seizing rope must be pre-formed by the manufacturer. None pre-formed tape is more likely to jump or fray while being cut and cannot hold the strands. Injuries could result from using the incorrect pre-formed tape.

Rigmen may use one of a number of seizing procedures. The steps listed in table 3 are for a recommended seizing procedure using wire (see figure 10).

| STEP | SEIZING WITH WIRE |
|---|---|
| 1 | Wind the seizing wire around the rope several times by hand. Keep the wraps together, and keep a lot of tension on the seizing wire. |
| 2 | Twist the ends of the wrapping wire together counterclockwise by hand so that the twisted portion is near the middle of the seizing. |
| 3 | Using proper cutters, tighten the twist just enough to take up the slack. Do not tighten the seizing further by twisting. |
| 4 | Tighten the seizing further by prying the twist away from the rope with the cutters. This causes the seizing rope to tighten firmly at the bottom of the twist. |
| 5 | Repeat the prying and tightening as often as necessary to secure a finished seizing. |
| 6 | Cut the ends of the seizing wire and tap them flat against the body of the rope. After two such seizings, one on each side of the cut, place the rope in the cutter and cut between the two seizings. |

**Table 3**

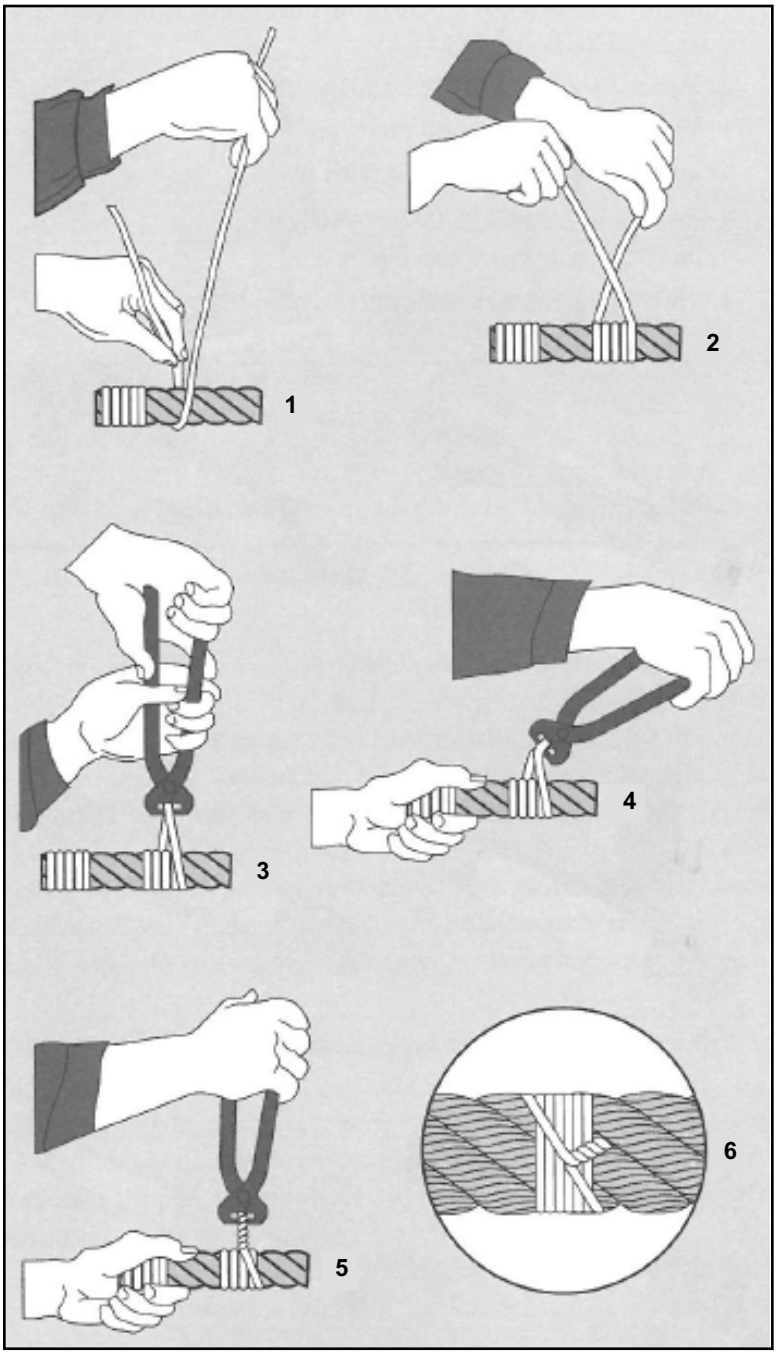


**Figure 10**
**Seizing Using Wire**

Another common seizing method, listed in table 4, is using a metal band (see figure 11).

| STEP | SEIZING WITH A METAL BAND |
|---|---|
| 1 | Lay the rope across the band. |
| 2 | Bend the band around the rope. |
| 3 | Crimp the edges together with pliers. |
| 4 | Secure the crimp by compressing it. |
| 5 | Tap the crimp with the pliers. |
| 6 | Make two seizings and cut the rope between them. |

**Table 4**

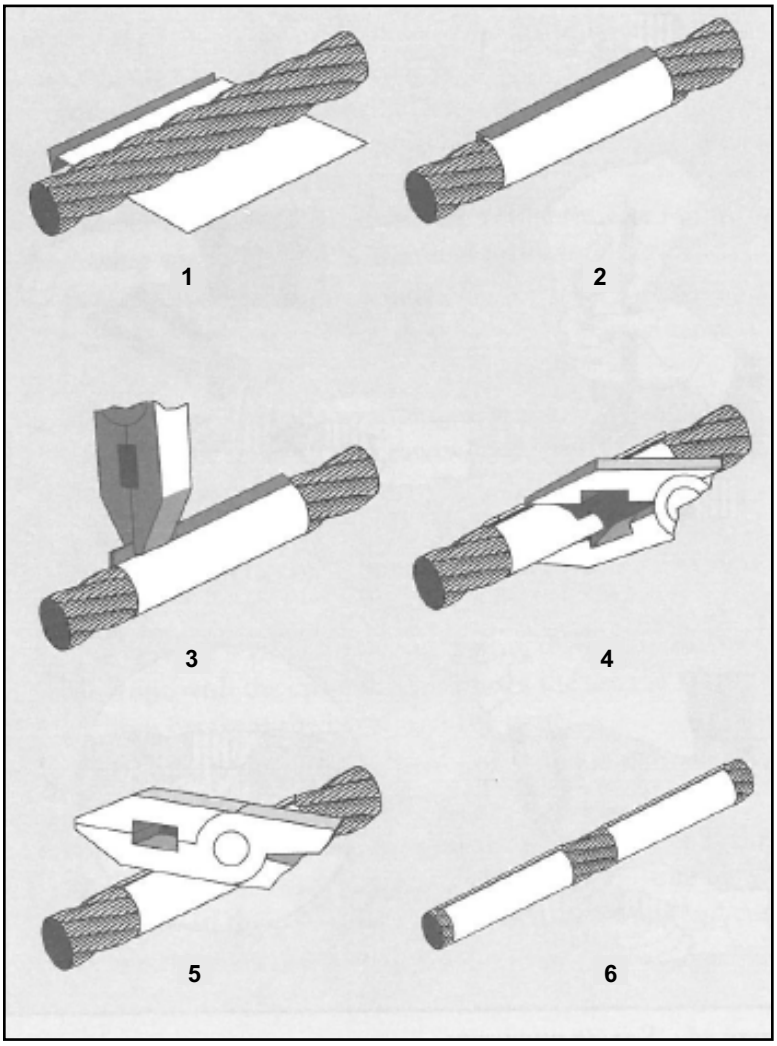


**Figure 11**
**Seizing Using Metal Bands**

There are two types of wire-rope cutters available: a hydraulic type and a mechanical type that is hit with a sledgehammer to make the cut (see figure 12).

> ***CAUTION***
> ***Never use oxyacetylene or electrical welding equipment to cut wire rope.***

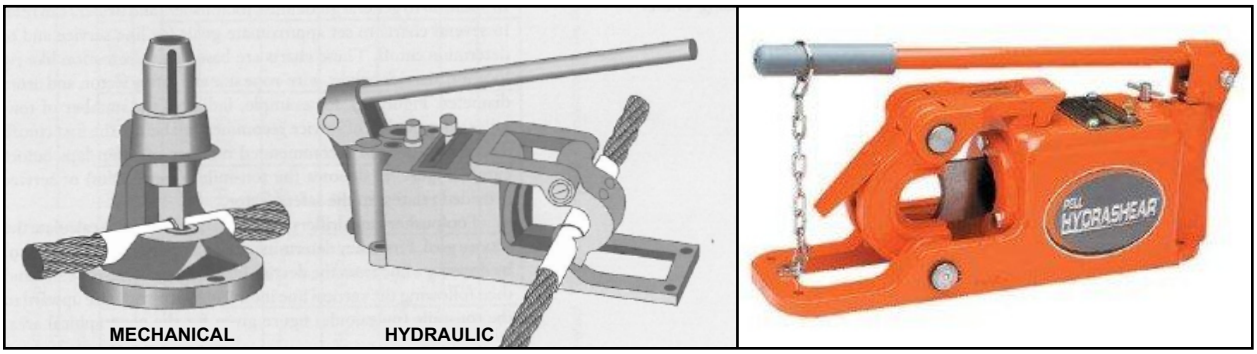


**Figure 12**
**Wire Rope Cutters**

Rigmen must pay strict attention to safety when cutting wire rope. The traveling block must be suspended on a hangline before they begin cutting. They must wear safety goggles and gloves when cutting the rope. Make sure that the rope is securely seized and will not spring and injure someone during cutting.

## Procedures for Slip and Cutoff

The personnel normally required for this task are the driller, assistant driller, and two or three rigmen.

The safety precautions that must be followed with drilling line slip and cutoff are listed in table 5.

| SLIP-AND-CUT SAFETY PRECAUTIONS |
| --- |
| The drill floor must be cleared of all personnel when work on the traveling block is carried out. |
| A safety harness must be worn by all persons working on the traveling block. |
| The traveling block must be hung from a load rated padeye under the crown header beams. Never hang from the mast brace. |
| Slip-and-cut when the bit is at the casing shoe (under normal circumstances). This ensures that the maximum amount of pipe will be in the hole should the well start to flow. |
| Do not perform cutting or slipping of the drilling line if the pipe is out of the hole on a live well (no BOP), or if the pipe is in an open hole (hole may collapse). |

**Table 5**

There are two slip and cut procedures:

- ❑ cutoff then slip procedure
- ❑ slip then cutoff procedure

The driller must decide which procedure to follow. "Cutoff then slip" is recommended as it keeps the new drilling line clean. Rigmen perform these procedures under the supervision of the driller while the other team members are doing their part. The general steps listed in tables 6 and 7 refer to the rigmen part of the procedure.

## *Cutoff then Slip Procedure*

| CUTOFF THEN SLIP | |
|---|---|
| STEP | CUTTING OFF THE DRILLING LINE |
| 1 | Tie the traveling block to the derrick. |
| 2 | Refer to wire line cut-off instructions and count layers to be cut off from drilling line along the drum from the fast line and mark with paint. Also mark the drum. Request the driller to engage reverse drive on the drawworks. |
| 3 | Guide the wire off the drum and feed the loop down the V-door until all the wire is off the drum. |
| 4 | Pull the dead man clamp out of the side of the drawworks drum (see figure 13). Remove the dead man clamp. |
| 5 | Pull the wire end out of the V-door, along the catwalk, until the paint mark on the drilling line is accessible for cutting. |
| 6 | Verify with a steel line measure that the cutoff length is correct. Make two seizings with wire or bands and cut the drilling line at the paint mark. |
| 7 | Install the dead man clamp with all clamp bolts correctly and evenly torqued to the correct value. Install the dead man on the drum flange (figure 13). |
| SLIPPING THE DRILLING LINE | |
| 8 | Loosen the nuts on the deadline anchor clamp(s) to enable the drilling line to slip through. Make sure all keeper bolts are in place on the anchor to prevent the line from coming off. |
| 9 | Use the spool drive system for rotating the drilling line spool to feed the correct length of drilling line. Feed at the same rate that the drawworks is spooling the drilling line onto the drum. If a spool drive system is not available, use line support devices. |
| 10 | Tighten the deadline anchor clamp(s) bolts in an alternating pattern and to the specified torque. |

**Table 6**

## *Slip then Cutoff Procedure*

| SLIP THEN CUTOFF | |
|---|---|
| STEP | SLIPPING THE DRILLING LINE |
| 1 | Tie the traveling block to the derrick. |
| 2 | Loosen the nuts on the deadline anchor clamp(s). Make sure all keeper bolts are in place on the anchor to prevent the line from coming off. |
| 3 | Use the spool drive system for rotating the drilling line spool to feed the correct length of drilling line. Feed at the same rate that the drawworks is spooling the drilling line onto the drum. If a spool drive system is not available, use line support devices. |
| 4 | Tighten the deadline anchor clamp(s) bolts in an alternating pattern and to the specified torque. |
| 5 | Slip the line off the drawworks. |
| 6 | Pull the dead man clamp out of the side of the drawworks drum (figure 13). Remove the dead man clamp. |
| 7 | Pull the wire end out of the V-door, along the catwalk. Measure the required length to be cut and mark the drilling line. |
| CUTTING OFF THE DRILLING LINE | |
| 8 | Make two seizings with wire or bands and cut the drilling line at the mark. |
| 9 | Install the dead man clamp. Ensure that all clamp bolts are correctly and evenly torqued to the correct value. Install the dead man on the drum. |
| 10 | Guide the line onto the drum side by side in the drum grooves. |

**Table 7**

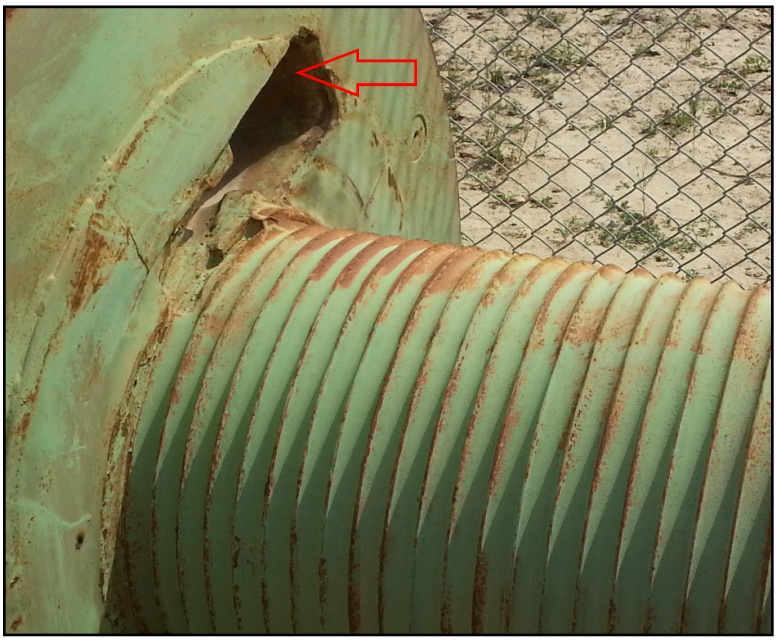

**Figure 13**
**Dead Man Clamp Location on the Drum Flange**

## DRILLING LINE INSPECTION

Rigmen conduct periodic inspections of the drilling line. The inspection includes the checks listed in table 8.

| LOCATION | CHECK FOR: |
|---|---|
| Drawworks drum | Broken wires, crushing, and signs of cutting. |
| | Worn grooves that have become sharp and that shave away small bits of steel from the line. |
| | Corrugated grooves, grooves that are rippled across the surface and that dig into the tightly wrapped line to damage it. |
| | Any surface irregularities that could damage the line. |
| Fastline and the remainder of the working drilling line | Breaks and wear at critical points.<br><br>Reduction in the drilling line's diameter. |
| Dead crown block sheave and the deadline tie-down anchor | No flattening of the deadline where it goes over the dead sheave. |
| | Broken wires where the side of the line touches the dead sheave groove. |
| | Deadline tie-down anchor clamps are tight enough to keep the line from slipping through the anchor, but not so tight that they crush the line. |

**Table 8**

*The dead crown block sheave and the deadline tie-down anchor do not move, but they vibrate. This puts stress on the sheave and the anchor.*

## SUMMARY

In this part, you learned that slipping and cutting a line is the process by which old sections of the drilling line are replaced before they break. This is done following a slip-and-cutoff program.

Rigmen assist the other members of the rig crew in slipping and cutting operations. They periodically inspect the drilling line for signs of wear, or any indicators that the drilling line needs to be slipped and cut.

## EXERCISE B

***Directions:*** *Answer the following questions.*

1. What is the measurement unit for drilling line use?

   _____

2. What is the purpose of slipping a drilling line?

   _____

3. What two conditions may cause unscheduled slipping and cutoff of a drilling line?

   a. _____

   b. _____

4. Where are the critical wear areas when a drilling line is lifting a load?

   _____

   _____

5. What are dead wraps on the drawworks drum?

   _____

   _____

6. What is the main difference between the two drilling line slip and cut procedures?

   _____

   _____

**PART III** **OBJECTIVE 4.4.3**

State the Reasons and Methods for Reeving the Drilling Line

Stringing or threading the line through the sheaves is called reeving. In this part you will learn about:

- reasons for reeving
- reeving planning factors
- drum spooling

## REASONS FOR REEVING

Reeving is planned and performed for any of the following reasons:

- after line cutoff
- rigging up
- mechanical lifting advantage

### After Line Cutoff

New drilling line is reeved through the blocks sheaves to replace worn parts cutoff from the drilling line.

### Rigging Up

Some large derricks have to be disassembled at rig move and reassembled at the new location. The traveling block is removed from such derricks and transported separately. The drilling line is pulled from the blocks and reeved at the new site.

## Mechanical Lifting Advantage

Mechanical lifting advantage increases with the number of lines strung between the crown and the traveling blocks. For example, reeving the line between the traveling block and the crown block six times gives the line a lifting strength equal to twelve lines.

## REEVING PLANNING FACTORS

Before reeving starts, the job is planned by the toolpusher, driller, and rigman assigned to work in the derrick. They consider the following factors that determine the reeving plan:

- ❑ reeving pattern
- ❑ number of lines
- ❑ location of the deadline tie-down anchor
- ❑ position of the equipment
- ❑ fleet angle

## Reeving Pattern

*The V-door is the opening in the rig floor, at the top of the pipe ramp, directly opposite the drawworks.*

There are two reeving patterns; from right to left or from left to right in relation to the V-door and the supply reel.

A right hand reeving pattern is reeving the line from the supply reel, which is to the right of the V-door, to the right-hand sheaves first, as you stand on the rig floor facing the V-door.

A left-hand reeving pattern is reeving the line from the supply reel, which is to the left of the V-door, to the left hand sheaves first, as you stand facing the V-door.

Left-hand reeving is the most common reeving pattern. You reeve the line from the supply reel through the deadline tie-down anchor, and pass it alternately over a sheave in the crown block first, and then through a sheave in the traveling block. From the crown block, the drilling line is attached to the drawworks drum as in figure 14. In figure 14, the sheaves numbered from 1 to 7 are the crown block sheaves. The sheaves labeled from A to F are on the traveling block.

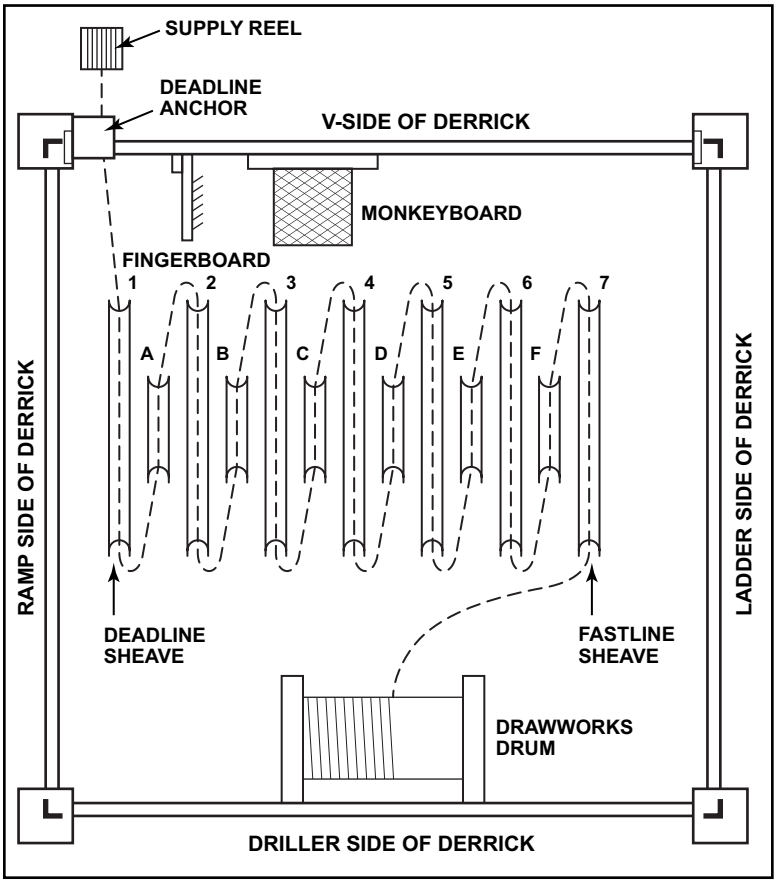


**Figure 14**
**Left-Hand Reeving Pattern**

The best reeving pattern is the one that puts as little stress as possible on the rig substructure, the derrick, and the drilling line. This means that the block moves as straight up and down as possible, and hangs directly over the hole. It also means that the drilling line moves through the blocks sheaves smoothly, without rubbing against the guards.

## Number of Lines

As noted earlier, the more lines reeved the more weight the system can support. On rigs drilling deep holes, the blocks are large and have more sheaves than rigs drilling shallow holes. Deep wells require more drill pipe. Therefore, the blocks and line must be able to support heavier loads.

## Location of the Deadline Tie-Down Anchor

It is best to set the deadline tie-down anchor as directly below the crown block as possible. If the anchor is too far to one side of the crown block, the deadline pulls the derrick to the side. This puts additional stress on the deadline.

## Position of the Equipment

The position of equipment and space availability can affect a reeving plan. Another factor is the layout of the rig floor. Layout considerations also include the location of the deadline and the catwalk.

The height and location of the monkey board is a factor as is the location of the derrick V-door. The reeving pattern is also affected by the way the

manufacturer arranges the sheaves in the crown block, and the fleet angle.

## Fleet Angle

The fastline is parallel to the fast sheave's groove only when the line is at one point on the drawworks drum, usually the center (figure 15).

*The fast sheave is the first sheave in the crown block over which the drilling line from the drawworks (fastline) runs.*

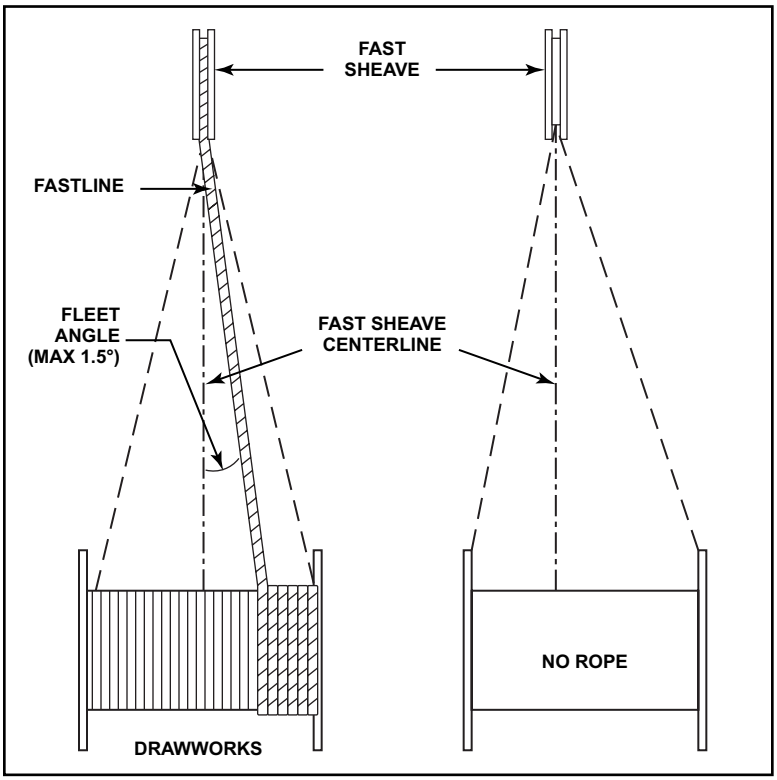


**Figure 15**
**Fleet Angle**

When the rope moves from this center point on the drum to either end, an angle is created, called the fleet angle. Any fleet angle increases wear on the side of the rope and the fast sheave. Keeping the fleet angle as small as possible reduces this wear.

A large fleet angle also causes the line to spool poorly at either side of the drum. Poor spooling increases wear on the line and can cause it to kink, thus damaging it.

Some fleet angle is unavoidable. To minimize fleet angle, the drawworks is positioned so that the drum's center is directly below the fast sheave. The fleet angle should be no more than 1.5 degrees from center.

## REEVING METHODS

There are several reeving methods. In cases where the line is reeved before raising the derrick, crew members lay the blocks on the catwalk in order to string them. In upright derricks one of the following reeving procedures may be used:

- ❑ reeving using old line
- ❑ reeving using catline

Tables 9 and 10 list the general steps for the two procedures.

| REEVING USING OLD LINE | |
|---|---|
| STEP | TASK |
| 1 | Immobilize the traveling block. Suspend it as straight as possible in the derrick with a strong line from the derrick's structure. |
| 2 | Remove the old line from the deadline anchor. |
| 3 | Attach the new line to the old line with a swivel stringing grip. (This is a special clamp that connects the two ends of the ropes to a swivel so each line is free to rotate. The swivel prevents any twists in the old line from being transferred to the new line.) |
| 4 | Ensure that the supply reel is properly aligned with the deadline anchor. The new line should come off the reel straight to the anchor and up to the first crown block sheave. |
| 5 | Ensure that the new rope does not rub against the substructure or the rig floor. |

**Table 9**
**Part 1 of 2**

| REEVING USING OLD LINE | |
|---|---|
| STEP | TASK |
| 6 | Operate the supply reel built-in tensioning equipment as the driller engages the drawworks drum to take in drilling line. The tensioning equipment keeps tension on the line so that any changes in pulling speed do not allow the line to go slack and then be jerked hard and possibly damaged. |
| 7 | Temporarily, but firmly, secure the new line on a derrick strong point near the drawworks as soon as the new rope appears at the drawworks drum. Firmly securing the new line prevents it from running back through the blocks after removing the swivel grip. |
| 8 | With the new line firmly secured, remove the swivel grip from the connection between the old and the new ropes. |
| 9 | Pull the old line from the drawworks drum and wind it onto a storage reel. |
| 10 | Attach the new line to the drawworks drum socket. |
| 11 | The driller winds the required number of dead wraps onto the drum. (Dead wraps are the first wraps spooled onto the drum. The number of dead wraps is specified by the drawworks manufacturer. Dead wraps do not move off the drum.) The driller finishes the last dead wrap with the fastline at the minimum fleet angle (figure 15). |
| 12 | Place the other end of the new line in the deadline tie-down anchor (figure 16). Tie down the new line by firmly clamping it to the anchor. Replace the clamp cover to protect the clamps from dirt and debris. |
| 13 | The driller spools in drilling line until the weight of the traveling block is supported by the line. |
| 14 | Untie the line suspending the block from the derrick. |
| 15 | The driller and rig crew lower the traveling block through the V-door far enough to unreel the line on the drawworks drum so that it can be reeled again tightly. |
| 16 | Attach an air hoist line onto the block as the driller begins to reel in the drilling line. Use the air hoist to maintain enough tension on the drilling line for proper wrapping. |

**Table 9**
**Part 2 of 2**

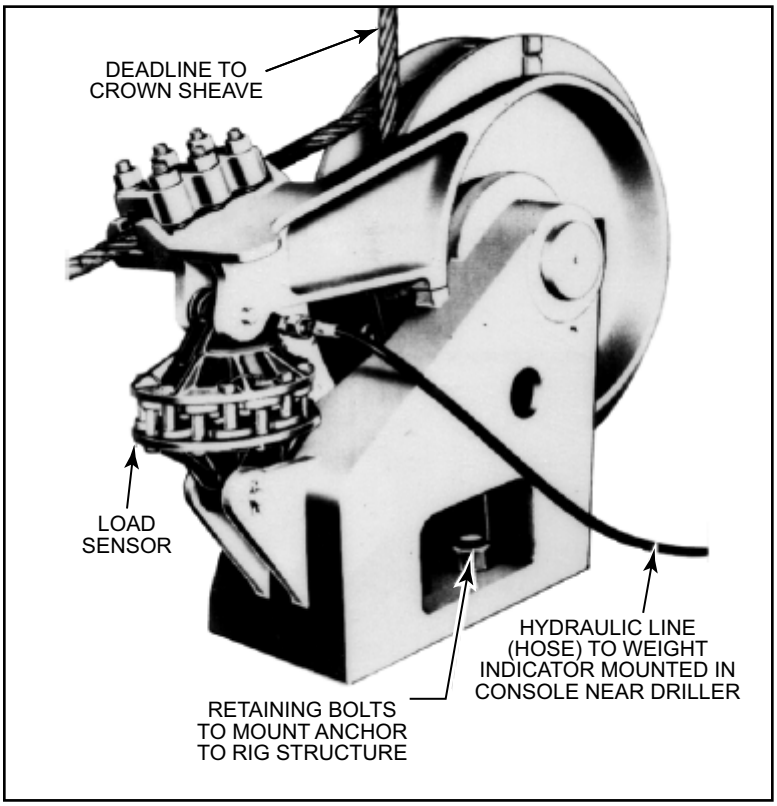


**Figure 16**
**Deadline Tie-Down Anchor**

The driller runs the new line with a light load for a period after it has been installed to break it in slowly to working conditions.

The steps listed in table 10 are followed when no old line is available to pull the new one through.

| REEVING USING CATLINE | |
|---|---|
| STEP | TASK |
| 1 | Reeve one end of the catline through the catline sheave located near the crown block. Bring this end of the catline down and firmly attach it to the other end of the catline, which is looped tightly around the friction cathead's spool. This is a continuous loop of catline between the cathead and the catline sheave which will convey the drilling line to the crown block and back down to the traveling block. |
| 2 | Secure the traveling block in an upright position on the rig floor or hang off the traveling block in the derrick. |
| 3 | Take one end of the new drilling line off the supply reel and bring it to the rig floor. Tie this end of the drilling line to the catline at a point about 15 feet from the point where rig crew will attach the drilling line to the drawworks drum. |
| 4 | Use the catline to pull the end of the drilling line up to the dead sheave of the crown block. Untie the drilling line, thread it over the sheave, and tie it again to the catline on the other side of the catline sheave. |
| 5 | Use the catline to pull the end of the drilling line back to the floor. |
| 6 | Thread the drilling line through a traveling block sheave. |
| 7 | Repeat steps 3–6 on successive sheaves in both blocks until reeving is completed. |
| 8 | Attach the drilling line to the drawworks drum socket and take in the proper number of wraps around the drum. At the deadline tie-down anchor, thread and clamp the line to the anchor. Be sure to replace the clamp cover. |
| 9 | Raise the traveling block and take off the supporting line. Finally, unreel the line on the drawworks drum and reel it again tightly. |

**Table 10**

## DRUM SPOOLING

Several types of grooved drawworks drums are available. The design of the groove determines the way that the line spools onto the drum. The grooves guide the wraps and the layers of wraps onto the drum. Guiding the wraps reduces stress and extends the service life of the line.

Grooved drums control the angle of the crossover points. Because the rope changes direction at crossover points, these points are areas of particular line stress and wear. The different spooling patterns feature ways to reduced crossover points stress.

Spooling a new line onto the drawworks drum or re-spooling after a cutoff is the driller's job. The driller has two objectives:

- making dead wraps
- making tight wraps

## Making Dead Wraps

The driller always spools the number of dead wraps recommended by the manufacturer. Dead wraps prevent loads from being placed on the drilling line where the line is attached to the drum, which is a weak point.

The number of wraps to take depends on the design of the drum. Newer drums are more likely to be grooved. Because the grooves guide the line, the wraps in the first layer stay close together. Grooved drums often require no more than ten turns, which may not get a full wrap across the drum's entire width. Grooves ensure that the turns of rope stay close together and prevent additional wraps from damaging the first layer.

## Making Tight Wraps

Tight wraps prevent slack. Slack causes sudden jerks and shock loads on the line when the driller stops or

releases the drawworks drum. To make tight wraps, the driller reels the line onto the drum while using an air hoist line to pull tension on the drilling line.

## SUMMARY

In this part, you have learned that reeving is stringing the drilling line through the sheaves on the crown block and traveling block. This needs to be done after the line has been cut off, or during rig up. The more sheaves there are, the more times the drilling line is strung between the blocks. More sheaves create more mechanical lifting advantage.

You also learned that there are several factors to consider when planning to reeve the drilling line. The reeving pattern, number of lines, location of the deadline anchor, equipment position, and fleet angle all affect the wear on the drilling line.

You went on to learn that the driller spools the drilling line on to the drawworks drum. Drawworks drums usually have grooves on them to help guide the line on. The driller spools on the required number of dead wraps and makes sure that the wraps are kept tight.

## EXERCISE C

***Directions:*** *Answer the following questions.*

1. What is reeving?

   _____

   _____

2. What are three reasons for reeving a drilling line?

   a. _____

   b. _____

   c. _____

3. Reeving the line between the blocks four times will be the equivalent of how many individual lines?

   _____

   _____

4. Which is good for drilling line service life, a large or small fleet angle?

   _____

   _____

5. What is the purpose of dead wraps onto a drawworks drum?

_____

_____

6. What is the best method for making tight wraps on drawworks drum?

_____

_____

## Anchor

To connect something to a solid base or hold something firmly in place.

## Circumference

The length of a line that goes around a circle or other round shape.

## Pry

To raise, move, or open something with a tool.

## Spool

A round object that is made to have something such as thread, wire, or tape wrapped around it.

## Wrap

To wind something around something else. For example, the drilling line wraps around the drawworks drum.

# MAXIMUM: 100

## OBJECTIVE 4.4.1

***Directions:*** *For questions 1 through 6, select the correct answer. (5 points each)*

1. A drilling line will wear out _____ in a short derrick, compared to a tall derrick.

   a. slower
   b. less
   **c. faster**
   d. the same

2. If a sheave groove is too _____ the drilling line will flatten and wear out.

   a. small
   **b. large**
   c. narrow
   d. tight

3. Sudden stress is very _____ to a drilling line.

   a. helpful
   b. necessary
   **c. damaging**
   d. normal

4. Drawworks drums with a _____ diameter will wear the drilling line quicker.

   a. larger
   b. lubricated
   c. grooved
   **d. smaller**

5. A _____ on the fastline between the drum and the crown help to reduce vibration of the fastline.

   **a. line guide**
   b. deadline anchor
   c. turnback roller
   d. supply reel

6. Proper _____ will lengthen the service life of the drilling line.

   a. corrosion
   **b. lubrication**
   c. stretching
   d. stress

## OBJECTIVE 4.4.2

***Directions:*** *For questions 7 through 13, select the correct answer. (5 points each)*

7. The drilling line use is recorded in _____.

   a. ft.-lbs.
   b. meters
   c. tones
   **d. ton-miles**

9. The _____ points on a drilling line are where the load exerts the most strain.

   a. fixed
   **b. critical**
   c. anchor
   d. dead

11. Slipping and cutting should be performed when the drill bit is _____.

   a. at the surface
   **b. at the casing shoe**
   c. in open hole
   d. on bottom

13. Rigmen periodically inspect the drilling line at the drawworks drum, sheaves, and _____.

   **a. deadline anchor**
   b. supply reel
   c. V-door
   d. catwalk

8. A slip-and-cutoff program ensures that drilling line wear is _____.

   **a. distributed**
   b. eliminated
   c. increased
   d. focused

10. The drilling line should be slipped _____ feet to move the highest wear points.

   a. six
   b. twelve
   **c. the fewest**
   d. the most

12. By _____ the wire before cutting, you will help to prevent injury.

   a. lubricating
   b. welding
   c. slipping
   **d. seizing**

## OBJECTIVE 4.4.3

***Directions:*** *For questions 14 through 20, select the correct answer. (5 points each)*

14. The fleet angle is the angle of the fastline between the _____ and the drawworks.

    a. deadline
    b. supply reel
    c. traveling block
    **d. fast sheave**

15. The wraps of drilling line that always stay on the drawworks drum are called the _____ wraps.

    **a. dead**
    b. fast
    c. grooved
    d. tight

16. The methods of reeving on an upright derrick use old line or _____.

    a. new line
    **b. catline**
    c. deadline
    d. wireline

17. Newer drawworks have _____ on the drum to guide the wraps of drilling line.

    a. layers
    b. anchors
    **c. grooves**
    d. sheaves

18. The best reeving pattern is one that puts as little _____ as possible on the rig substructure and drilling line.

    a. lubrication
    **b. stress**
    c. water
    d. wraps

19. A _____ grip connects two ends of drilling line, so that each line is free to rotate.

    a. seizing wrapping
    b. deadline anchor
    c. slipping cutting
    **d. swivel stringing**

20. The driller will reel the line onto the drawworks drum under _____ to ensure that the wraps are tight.

    **a. tension**
    b. water
    c. cover
    d. ground

| Trainee name | | Badge No. | | Date | | Score | |
|---|---|---|---|---|---|---|---|

## MAXIMUM: 100

### OBJECTIVE 4.4.1

***Directions:*** *For questions 1 through 6, select the correct answer. (5 points each)*

1. A drilling line will wear out _____ in a short derrick, compared to a tall derrick.

   a. slower

   b. less

   c. faster

   d. the same

2. If a sheave groove is too _____ the drilling line will flatten and wear out.

   a. small

   b. large

   c. narrow

   d. tight

3. Sudden stress is very _____ to a drilling line.

   a. helpful

   b. necessary

   c. damaging

   d. normal

4. Drawworks drums with a _____ diameter will wear the drilling line quicker.

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5. A _____ on the fastline between the drum and the crown help to reduce vibration of the fastline.

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   b. deadline anchor

   c. turnback roller

   d. supply reel

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   a. corrosion

   b. lubrication

   c. stretching

   d. stress

## OBJECTIVE 4.4.2

***Directions:*** *For questions 7 through 13, select the correct answer. (5 points each)*

7. The drilling line use is recorded in _____.

   a. ft.-lbs.

   b. meters

   c. tones

   d. ton-miles

8. A slip-and-cutoff program ensures that drilling line wear is _____.

   a. distributed

   b. eliminated

   c. increased

   d. focused

9. The _____ points on a drilling line are where the load exerts the most strain.

   a. fixed

   b. critical

   c. anchor

   d. dead

10. The drilling line should be slipped _____ feet to move the highest wear points.

    a. six

    b. twelve

    c. the fewest

    d. the most

11. Slipping and cutting should be performed when the drill bit is _____.

    a. at the surface

    b. at the casing shoe

    c. in open hole

    d. on bottom

12. By _____ the wire before cutting, you will help to prevent injury.

    a. lubricating

    b. welding

    c. slipping

    d. seizing

13. Rigmen periodically inspect the drilling line at the drawworks drum, sheaves, and _____.

    a. deadline anchor

    b. supply reel

    c. V-door

    d. catwalk

## OBJECTIVE 4.4.3

***Directions:*** *For questions 14 through 20, select the correct answer. (5 points each)*

14. The fleet angle is the angle of the fastline between the _____ and the drawworks.

    a. deadline
    b. supply reel
    c. traveling block
    d. fast sheave

15. The wraps of drilling line that always stay on the drawworks drum are called the _____ wraps.

    a. dead
    b. fast
    c. grooved
    d. tight

16. The methods of reeving on an upright derrick use old line or _____.

    a. new line
    b. catline
    c. deadline
    d. wireline

17. Newer drawworks have _____ on the drum to guide the wraps of drilling line.

    a. layers
    b. anchors
    c. grooves
    d. sheaves

18. The best reeving pattern is one that puts as little _____ as possible on the rig substructure and drilling line.

    a. lubrication
    b. stress
    c. water
    d. wraps

19. A _____ grip connects two ends of drilling line, so that each line is free to rotate.

    a. seizing wrapping
    b. deadline anchor
    c. slipping cutting
    d. swivel stringing

20. The driller will reel the line onto the drawworks drum under _____ to ensure that the wraps are tight.

    a. tension
    b. water
    c. cover
    d. ground