OSHAcademy™
Occupational Safety & Health Training

Well Site Preparation and Drilling Safety

The oil and gas industry employs hundreds of thousands of people and is a vital component of the international economy. However, it can be a very dangerous profession. According to the Bureau of Labor and Industries, from 2003 to 2010, 823 oil and gas extraction workers were killed on the job, which is a fatality rate seven times greater than the rate for all United States industries. This course can be used as a resource in helping to identify oil and gas rig hazards and providing possible solutions.

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OSHAcademy Course 902 Study Guide

Well Site Preparation & Drilling Safety

This study guide is designed to be reviewed off-line as a tool for preparation to successfully complete OSHAcademy Course 902.

Read each module, answer the quiz questions, and submit the quiz questions online through the course webpage. You can print the post-quiz response screen which will contain the correct answers to the questions.

The final exam will consist of questions developed from the course content and module quizzes.

We hope you enjoy the course and if you have any questions, feel free to email or call:

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Course Introduction

The oil and gas well drilling and servicing industry was born in the United States in 1859 when the Drake Well outside Titusville, PA first struck oil. Since then, this industry has evolved to become a vital part of the petroleum industry.

The oil and gas industry employs hundreds of thousands of people and is a vital component of the national economy. More than 450,000 workers were employed in the oil and gas industries in 2011 (Quarterly Census of Employment and Wages). These workers are engaged in many different industrial processes needed to successfully drill and service a well. These processes frequently require the use of specialized equipment and specialized work crews.

From 2003 to 2010, 823 oil and gas extraction workers were killed on the job–a fatality rate seven times greater than the rate for all U.S. industries (Census of Fatal Occupational Injuries). Safety and health hazards and dangerous conditions that can result in fatalities for oil and gas workers include:

- vehicle accidents
- struck-by/caught-in/caught-between
- explosions and fires
- falls
- confined spaces
- chemical exposures

Each drilling and servicing company has its own safety program. This course is not a replacement for those programs nor does it establish any industry consensus standards. Rather, this course can be used as a resource in helping to identify oil and gas rig hazards and providing possible solutions. This course does not purport to identify all hazards and solutions. This course focuses on land based operations.

Which OSHA Rules Apply to Oil and Gas?

Employers must protect the safety and health of workers involved in oil and gas operations according to:

1. OSHA's General Industry Standards (29 CFR 1910)
2. OSHA's Construction Standards (29 CFR 1926)
3. General Duty Clause of the Occupational Safety and Health (OSH) Act

Additional Information

- RP 54. American Petroleum Institute (API) (2007, March). Includes procedures for promotion and maintenance of safe working conditions for employees engaged in rotary drilling operations and well servicing operations, including special services. Applies to rotary drilling rigs, well servicing rigs, and special services as they relate to operations on locations.
- Accident Prevention Guide. International Association of Drilling Contractors (IADC).
- Drilling Technology Series: Petroleum Extension Service (PETEX), University of Texas at Austin.
    - Unit I: The Rig and Its Maintenance
    - Unit II: Normal Drilling Operations
    - Unit III: Non-routine Operations
    - Unit IV: Man, Management and Rig Management

Module 1: Site Preparation Safety

Site preparation for an oil and gas well, in most instances, looks like any other construction site. OSHA uses Safety and Health Regulations for Construction [29 CFR 1926] to assess safety compliance during this phase of the development of a drilling site.

Once the location for the site has been established, the area is prepared for drilling, with the following steps:

1. Site Preparation
    - leveling site
    - excavating and trenching
2. Conductor hole, Rathole and Mousehole
    - conductor hole and pipe
    - rathole
    - mousehole
3. Transporting Equipment
    - transporting equipment by truck
    - unloading at drill site

Leveling the Site

Before well drilling can begin, the company must clear vegetation, level the site, and construct a pad for the drilling rig and other equipment used in preparing the well. The site is leveled (if necessary) with a bulldozer and/or a grader.

Potential Hazards:

- damaging buried pipelines and cables
- unpredictable weather changes creating unexpected hazards

- irritant and toxic plants, pollens, and other entrained materials
- uneven ground causing bulldozers to roll over

Possible Solutions:

- Perform a site line location survey.
- Plan for hazards due to unpredictable changing weather.
- After weather changes, conduct inspections for new hazards.
- Protect employees engaged in site clearing from hazards of irritant and toxic plants. Teach the employees about available first aid treatments. [29 CFR 1926.604(a)(1)]
- Provide rollover guards on all equipment used in site clearing operations. [29 CFR 1926.602]
- Provide overhead and rear canopy guards on rider-operated equipment. [29 CFR 1926.604(a)(2)]

Excavation and Trenching

The scale and duration of excavating and trenching are very minor and site-specific. On some drilling sites, a below-ground-level cellar may be excavated. This is where the main borehole is to be drilled. A reserve pit and settling pits may be excavated and are used for water or drilling fluid (mud) discharges.

Potential Hazards:

- Dust and other airborne contaminants can cause respiratory problems or allergic reactions.
- Buried pipelines and cables can be damaged.

Possible Solutions:

- Wear appropriate respiratory protection. [29 CFR 1910.134]
- Perform a site line location survey.

Conductor Hole, Rathole, and Mousehole

Prior to commencing the rig-up process, the conductor, rathole and mousehole are completed.

Special companies may be hired to begin drilling these three holes:

- conductor hole and conductor pipe
- rathole
- mousehole

Conductor Hole and Conductor Pipe

This is a large diameter hole, lined with pipe, also called a starter hole, varies in depth down of tens of feet to a few hundred feet depending on the local geology.

Some sites do not require a conductor hole.

Potential Hazard:

- being struck by hoisting line or suspended drill or casing

Possible Solutions:

- Wear Personal Protective Equipment: hard hats, safety glasses, safety toe boots, and work gloves. [29 CFR 1910.135], [29 CFR 1910.133], [29 CFR 1910.136]
- Keep employees away if they are not working at this job.

Rathole

A rathole is a hole in the rig floor, 30 to 35 feet deep, lined with casing that projects above the floor, into which the kelly is placed when hoisting operations are in progress.

This is either done by the portable rig that drills the conductor hole or can be done by the primary rig after rigging-up.

Potential Hazard:

- falling or stepping into an uncovered rathole

Possible Solution:

- Cover the hole until it is lined with casing or other material during rigging-up.

Mousehole

A mousehole is a shallow bore hole under the rig floor, usually lined with pipe, in which joints of drill pipe are temporarily placed.

This is either done by the portable rig that drills the conductor hole or can be done by the drilling rig after rigging-up.

Potential Hazard:

- falling or stepping into an uncovered mousehole

Possible Solution:

- Cover the hole until it is lined with casing or other material during rigging-up.

Transporting Equipment to the Site

Depending on the location of the well, access to the site may require preparation of a road bed. A site, and its access road, must accommodate a large number of temporary and semi-permanent structures and tanks, all brought in by truck. The tasks are:

- transporting equipment by truck
- unloading at drill site

Transporting Equipment by Truck

Equipment is loaded on trucks at the previous drill site or storage yard, secured and transported to the new drill location.

Potential Hazards:

- At a newly prepared drill site, the soils may not be compacted sufficiently to support the incoming load. This could cause the load to become unstable.
- The load may not be secured properly, causing it to shift or the tie-downs to fail.

- In slick conditions, the truck may slide off the road.

Possible Solutions:

- Make sure that the access road and drill pad at the drill site has been properly prepared before attempting to drive on it.
- Drive slowly; always being cautious of shifting weight.
- Loads should be tied down with proper devices and inspected before and during transport. U.S. Department of Transportation, [49 CFR 393.100] General rules for protection against shifting or falling cargo.
- Always drive with caution, whatever the conditions.

Unloading at Drill Site

In this process, drill rig equipment is unloaded and placed approximately where it will be rigged up.

Potential Hazard:

- Improperly secured loads could cause equipment to slide or collapse during unloading.

Possible Solution:

- Inspect loads before loading or unloading.

Module 1 Quiz

1. **During the site leveling process, all the following are potential hazards, <u>except</u> _____.**

    a. irritant and toxic plants
    b. unpredictable weather changes
    c. damaging buried pipelines and cables
    d. animal migration patterns

2. **Potential hazards in drilling site excavation and trenching include which of the following?**

    a. Disruption of animal habitat
    b. Soil contamination
    c. Damaging buried pipelines and cables
    d. Temperature extremes

3. **Which of the following is a large diameter hole, lined with pipe, and also called a starter hole?**

    a. Rathole
    b. Conductor hole
    c. Mousehole
    d. Test hole

4. **Which of the following hazards is associated with completing a rathole on a drilling site?**

    a. Falling or stepping into the hole
    b. Being struck by the rat
    c. Being shocked by electrical equipment
    d. Interference by other workers

5. **Which of the following is a solution to the potential hazard when unloading and placing drill rig equipment?**

    a. Ensure drill pad is poured to specifications
    b. Ensure load is properly placed
    c. Monitor wind speed and direction
    d. Inspect loads before loading and unloading

Module 2: Rigging Up Safety

Introduction

Worker safety awareness is necessary for injury prevention during all phases of drilling operations. Procedures and processes will include safety meetings, Job Safety Analysis, and general and task-specific training. At the end of each card, resources are identified which provide more details for establishing safe work practices and procedures.

Rigging Up

Rigging up is placing and assembling the various parts of equipment that make up the rig, and preparing the rig for drilling.

There are many rig designs, and this course does not cover each type individually. This course focuses on the common hazards and solutions that many rig designs share.

During assembly of the rig, some equipment may be handled and set with cranes, rig up trucks, or forklifts, depending on the size of the rig. It should be noted that overhead hazards such as high voltage power lines may be present.

There may be two or more crews (teams) working together in the rigging up process. The rigging up process includes the following steps, some of which are done simultaneously.

Setting up the Substructure

Equipment is unloaded and positioned at or near the exact location that it will occupy during operations.

The substructure is assembled, pinned together, leveled, and made ready for other rig components on the floor.

Equipping the cellar begins but can be done throughout the rigging up process. This includes welding on a drilling nipple to the conductor pipe and attaching a flow line.

Potential Hazards:

- being struck by the crane, load, truck, or forklift tipping
- pinched fingers when assembling equipment

- burns from cutting and welding on the drilling nipple
- temporary eye irritation from welding light flash
- falling from heights

Possible Solutions:

- Instruct all workers in safety procedures and ensure that they are knowledgeable about job hazards. This can be done during pre-job safety meetings or JSA briefings.
- Instruct workers to stand clear and keep hands and other body parts away from pinch points
- Wear proper long sleeve clothing to protect from burns.
- Wear proper welding eye/face protection.
- Avoid looking directly at the flame or arc when welding.
- Wear fall protection when working from heights. [29 CFR 1926 Subpart M]

Setting Up the Rig Floor and Mast or Derrick

Once the substructure is set in place, the process of setting up the rig floor begins. Begin by installing stairways and guardrails to allow access to the rig floor. Then, the drawworks is set in place and secured to the substructure. On mechanical rigs, the engines are set in place; the compound and associated equipment are connected to the drawworks. On electric rigs, the electric cables (lines) are strung to the drawworks.

The bottom of the mast is then raised to the rig floor and pinned in place. The crown section is then raised into place on the derrick stand. The "A-legs" are raised and pinned into place. The monkeyboard is pinned in place on the mast and all lines and cables are laid out to prevent tangling when the mast is raised. A thorough inspection of the mast should be made before raising the mast/derrick.

The mast is now ready to be raised. The engines are started, and the drilling line is spooled onto the drawworks drum. Once the mast has been raised and pinned, the remaining floor equipment can be set into place. If the rig has safety guylines, they must be attached to the

anchors and properly tensioned prior to continuing the rigging up process. A derrick emergency escape device is installed on the mast.

Potential Hazards:

- falling or tripping during rigging up
- falling from rig floor
- being struck by swinging equipment
- being struck by falling tools
- being crushed or struck by equipment due to failure or overloading of hoisting equipment
- getting entangled in lines during raising of the derrick or mast
- failure to properly install derrick emergency escape device

Possible Solutions:

- Install, inspect, and secure stairs and handrails.
- Do not use guardrails for anchor points or for lifting or supporting loads.
- Use fall protection when installing or removing guardrails.
- Use a tag line to guide equipment, rather than positioning yourself under suspended loads.
- Check the derrick for unsecured tools before raising it.
- Allow only the operator raising the mast to be on the rig floor.
- Uncoil all lines so that they are clear of all workers when the mast or derrick is raised.
- Attach safety lines to all tools hanging from the rig.

- Keep a safe distance from moving equipment.
- Install derrick emergency escape device properly in accordance with manufacturer’s recommendations.

Module 2 Quiz

1. **Which of the following is the term used to describe placing and assembling the various parts of the rig, and preparing the rig for drilling?**

   a. Rigging up
   b. Building up
   c. Constructing
   d. Raising the rig

2. **All the following are potential hazards when setting up the substructure on a new drill site, except _____.**

   a. falling from heights
   b. temporary eye irritation from welding
   c. exposure to temperature extremes
   d. burns from cutting and welding

3. **All the following are solutions to the potential hazards when setting up the substructure on a new drill site, except _____.**

   a. wear fall protection when working at heights
   b. instruct workers to keep body parts away from pinch points
   c. avoid looking directly as flame or arc when welding
   d. wear proper full-face mask

4. **Hazards associated with raising the mast or derrick include all the following, except _____.**

   a. falling from the kelly support
   b. being struck by swinging equipment
   c. falling from rig floor
   d. being struck by falling tools

5. Once the rig floor is set in place, the process of raising the _____ begins.

a. kelly
b. platform
c. mast or derrick
d. flare pit

Module 3: Rigging Up Safety (Continued)

Installing Handrails, Guardrails, Stairs, Walkways, and Ladders

Handrails, guardrails, stairways, walkways, and ladders are installed where they are needed for safety and access. Take a look at the related hazards and solutions for this work.

Potential Hazards:

- falls from ladders
- falls or slips from ladders and stairs due to damaged or missing rungs or steps
- slips or falls on walkways due to debris or uneven surfaces
- falls from heights
- falling into the mud pit or mixing tank

Possible Solutions:

- Follow established procedures and best work practices.
- Instruct workers on proper procedures for using and installing ladders.
- Use only ladders in good repair that do not have missing rungs.
- Do not install stairs with missing or damaged steps. Repair them before installing them.
- Keep walkways clean and free of debris and tripping hazards.
- Use proper fall protection.
- Place guardrails in place prior to working in elevated areas.

Installing the Power System

Installing the power system is usually done simultaneously with setting up the rig floor, because power is needed to operate the equipment. Today there are generally two types of rigs being used on land. A mechanical rig is powered by engines and compounds. An electric rig is

powered by engines and generators. This type supplies power to electric motors, which drive the machinery.

All power cords, belts, and chains need to be connected to the machinery from their associated power source. Simultaneously, the fuel lines and tanks need to be hooked up. Then, start the engines.

Potential Hazards:

- tripping on power cords and hoses
- slips and falls on slick walking services
- getting caught in pinch points
- exposure to chemical hazards
- being shocked or electrocuted

Possible Solutions:

- Keep all cords and hoses orderly and clear of walking spaces.
- Clear and clean all walkways and walking surfaces of slipping hazards.
- Use caution around all chain and belt pinch point areas.
- Use proper PPE when working with chemicals.
- Use proper lockout/tagout/ procedures.

Rigging Up the Circulating System

While one crew finishes preparing the rig floor, another crew might be rigging up the circulating system.

The mud tanks and mud pumps are set into the predetermined location.

The mud lines are then connected and electric cords are strung.

Potential Hazards:

- being struck by or crushed by equipment being set into place
- getting caught in pinch points
- being struck by crane, load, truck or forklift tipping
- being struck by hammer when connecting mud line unions

Possible Solutions:

- Keep a safe distance from equipment that is coming together or moving.
- Maintain a safe distance from all pinch points.
- Stand clear of workers that may be swinging hammers.

Installing the Auxiliary Equipment

All remaining drilling and auxiliary equipment must be set into place and installed where needed.

The catwalk and pipe racks are positioned and the pipe and drill collars are set on the racks.

Potential Hazards:

- getting struck or pinched by, or caught in between, tubulars being loaded onto racks
- having feet pinched or crushed when setting up the pipe racks and catwalk

Possible Solutions:

- Keep a safe distance from equipment that is coming together.
- Use a tag line to guide the pipe racks and catwalks into position.

Inspecting the Rig

Perform a complete inspection of the rig before operating. The driller and/or rig superintendent/toolpusher/manager should walk around the entire rig and inspect for:

- missing or loose pins and bolts

- equipment guards
- adequate guard railings
- proper line and cable placement
- unclear walkways

Potential Hazards:

- falling from the rig
- tripping on power cords and hoses
- slipping and falling on slick walking services

Possible Solutions:

- Use proper fall protection.
- Keep all cords and hoses orderly and clear of walking spaces.
- Clear and clean all walkways and walking surfaces of slipping hazards.

Rigging Down

After production casing is run and cemented, the rig is taken down and moved to another site. The rigging down process is basically the reverse of rigging up.

The hazards and solutions are similar to those for rigging up.

Module 3 Quiz

1. **Hazards associated with the installing the power system includes all the following, except _____.**

    a. tripping on power cords and hoses
    b. slips and falls on slick walking services
    c. getting caught in pinch points
    d. interference with other contractors

2. **Solutions to hazards associated with the installing the power system includes all the following, except _____.**

    a. keep cords and hoses clear of walking spaces
    b. clear and clean all walking surfaces
    c. wear proper fall protection
    d. use caution around all chain and belt pinch point areas

3. **Hazards associated with installing the circulating system includes all the following, except _____.**

    a. falls from the derrick
    b. getting caught in pinch points
    c. being struck by crane, load, truck tipping
    d. being struck by a hammer

4. **Before initial operation of the rig, _____.**

    a. ensure OSHA and local officials are notified
    b. perform a complete inspection
    c. complete the well depth check
    d. coordinate the rigging down process

5. During the rigging down process, the hazards are _____.

a. unique to the process
b. more numerous due to the nature of the work
c. more serious because everyone is in a hurry to leave
d. similar to those for rigging up

Module 4: Drilling Ahead Safety

Introduction

Drilling ahead means the actual drilling of the well. The drilling rig will drill holes up to 14,000 feet. The rig can drill 1 to 22 or more wells on one pad. Eight to 20 people may work on a typical drilling rig.

Specific drilling processes vary, but many of the work hazards are similar. The following generic tasks assume the use of a kelly and rotary table. Other rig designs may include the use of a top drive.

Handling Tubulars

The following steps are completed while handling tubulars:

- The pipe is unloaded from trucks onto the pipe rack.
- The floor crew brings pipe from the pipe rack and catwalk, using the catline, air hoist or hydraulic winch, up to the drilling floor and places it in the mousehole.
- This is done for every connection.

Note: The rig supervisor should hold a pre-job meeting with the crew to review responsibilities and to coordinate the operations to be performed.

Potential Hazards:

- being struck by rolling or falling tubulars
- being struck by or caught between tubulars and other objects during movement (for example, being struck by tubulars being tailed into the rig floor)
- slips, trips, and falls

Possible Solutions:

- Use powered industrial truck (forklift) properly.
- Work the tubulars from the ends from ground level.
- Chock or pin tubulars on the racks properly.
- Level your pipe racks properly.
- Stand clear of suspended, hoisted, or moving loads.
- Be aware of tubulars or equipment being lifted through the V-door.
- Instruct workers about the need for proper use, inspection, and maintenance practices.
- Before each tour inspect the:
    - ire rope and slings
    - catline ropes and knots (do not allow a rope to lie in standing water)
    - chains and hooks
- Stand clear of suspended, hoisted or moving loads and be aware of your surroundings.

Preparing Drilling Fluid

Drilling fluid is an important component in the drilling process. There are several types of drilling fluids used depending on the drilling conditions encountered:

- **Water-based muds** are used most frequently. The base may be either salt or fresh water.
- **Oil-based muds**
- **Synthetic materials-** The oil and gas extraction industry has developed many new oleaginous (oil-like) base materials from which to formulate high-performance drilling fluids.

- **Air and form fluids** may be used in drilling wells. These fluids are less dense than drilling muds.

Drilling fluid is required in the wellbore to:

- cool and lubricate the drill bit,
- remove the rock fragments, or drill cuttings, from the drilling area and transport them to the surface,
- counterbalance formation pressure to prevent formation fluids (i.e. oil, gas, and water) from entering the well prematurely (which can lead to a blowout), and
- prevent the open (uncased) wellbore from caving in.

The mud is monitored throughout the drilling process. A mud engineer and/or the Derrickman may periodically check the mud by measuring its viscosity, density, and other properties.

Potential Hazards:

- burns, or physical injury caused by contact with skin or eyes
- being exposed to explosions or violent reactions from chemicals mixed improperly
- being exposed to inhalation hazards
- receiving strains and sprains
- slips, trips and falls

Possible Solutions:

- Ensure workers follow the safe handling procedures found in Safety Data Sheets (SDS). [29 CFR 1910.1200]
- Wear appropriate personal protective equipment, including, eye and face protection. [29 CFR 1910.132], [29 CFR 1910.133]

- Wear appropriate respiratory protection when handling chemicals and/or mud additives. [29 CFR 1910.134]
- Provide an eyewash station and other appropriate flushing apparatus as recommended by the MSDS. [29 CFR 1910.151(c)]
- Provide adequate ventilation.
- Use proper mixing procedures.
- Use designated containers for mixing certain chemicals (for example, baffled container with lid).
- Substitute less hazardous materials or use pre-mixed mud.

Note: Tank cleaning is a high-hazard operation requiring confined space entry procedures, training for personnel, PPE, and specialized equipment. [29 CFR 1910.146]

Starting the Drilling Process

To start drilling, a surface drill bit is attached to a bottomhole drill collar, which is in turn attached to the kelly. Once made up, the driller lowers the bit through the rotary table and engages the mud pump(s) and checks for leaks and other abnormalities.

The driller lowers the drill string and the kelly bushing is set in the rotary drive bushing and the rotary is engaged.

The driller then slowly lowers the bit to bottom and begins the drilling operation.

Potential Hazards:

- being struck by the tongs, the make-up chain, or pipe
- being caught between collars and tongs, spinning chain, and pipe
- receiving strains and sprains during lifting or controlling movement of drill collars, bit breakers, pipes, and tongs
- slips, trips, and falls

- encountering shallow gas

Possible Solutions:

- Implement an effective pipe handling, make-up, break-out procedure:
    - Stand outside the tong swing radius when breaking pipe.
    - Use proper tong latching techniques and use proper hand and finger placement on tong handles.
    - Stand clear of the rotary table when it is rotating.
- Use a tail rope on the spinning chain to keep hands away.
- Use proper lifting technique.
- Hoist slowly to limit pipe momentum.
- Use mechanical lifting aids such as a rig floor winch.
- Use tail rope to guide as necessary.
- Comply with the Blowout Prevention Program

Module 4 Quiz

1. **Potential hazards associated with handling tubulars include all the following, except _____.**

   a. being struck by rolling or falling tubulars
   b. being struck by or caught between tubulars
   c. exposure to hazardous chemicals
   d. slips, trips, and falls

2. **Solutions to the potential hazards associated with handling tubulars include all the following, except _____.**

   a. inspect fall protection equipment
   b. inspect wire rope and slings
   c. inspect catline ropes and knots
   d. inspect chains and hooks

3. **Drilling fluid is used in the wellbore to do each of the following, except _____.**

   a. cool and lubricate the drill bit
   b. remove rock fragments
   c. prevent the open wellbore from caving in
   d. providing casement support

4. **Hazards associated with drilling fluid processes include all the following, except _____.**

   a. exposure to violent chemical reactions
   b. exposure to pinch points
   c. slips, trips, and falls
   d. strains and sprains

5. **Solutions to the hazards associated with starting the drilling process include all the following, <u>except</u> _____.**

   a. using proper lifting techniques
   b. implementing effective pipe handling procedures
   c. being struck by vehicles
   d. using a tail rope on the spinning chain

Module 5: Drilling Ahead Safety (Continued)

Preparing to Break Out Pipe

In this process, the driller stops the drill string from rotating, and hoists the drill string with the drawworks until the kelly is out of the rotary table.

The driller then shuts down the mud pump(s). The floor hands set the slips around the joint of pipe. The tongs are then latched onto the tool joints above and below the connection.

Potential Hazards:

- pinching fingers or other body parts between slips or slip handles and rotary table
- experiencing muscle strain from improper lifting technique
- pinching fingers when latching the tongs onto the pipe

Possible Solutions:

Implement effective, safe work procedures for using slips and tongs, which include:

- Proper finger and hand placement on slip handles and tong handles
- Proper stance and slip lifting techniques
- Proper tong latching techniques

Breaking Out Pipe

During this process, the tongs and cathead are used to break out the pipe. Either the rotary table or kelly spinner is used to spin the drill string or kelly to unscrew it from the drill pipe joint.

The diagram to the right demonstrates the “Tong Swing Radius.” It is an illustration placed on the drilling floor and is a circular area marking the tong swing radius or four feet from the hole center, adjacent to the mousehole. In red, from the hole center and above in the upper quarter of the circle, is an arc marked as the hazardous area. All other areas are marked in yellow for caution. Only tong operators stand in the tong swing area. All other personnel are outside. No one should stand in the red zone.

Potential Hazards:

- Being struck by:
    - swinging tongs if the tong dies fail, or the tong counterweight lines were to break
    - the slip handles if the rotary table is used to spin the drill string
    - reverse backlash of tongs (backbiting) during spinning out operations
    - the tongs if a snub line breaks or the tongs come unlatched
    - pipe
- Release of excess drilling mud resulting in skin contact, loss of footing, etc.

Possible Solutions:

- Inspect tong dies, counterweight cables, and snub lines hourly and prior to each trip.
- Implement an effective spinning out pipe procedure:
    - Personnel other than tong operators stand outside the tong swing radius when breaking pipe.
    - No one should stand in the red zone
    - Use proper tong latching techniques and use proper hand and finger placement on tong handles.
    - Stand clear of the rotary table when it is rotating.
    - Use special operational procedures when using a high torque connection.
- Maintain good communication between floor crew and driller.
- Use a mud bucket to direct mud down into the rotary table.
- Close the mud saver valve on the kelly (if present).

Making Up Pipe in the Mousehole

During this process, the crew swings the kelly out over the mousehole and stabs it into a new joint of pipe.

The driller then spins up the kelly using the kelly spinner or spinning chain and the crew uses tongs to torque the joint.

Potential Hazards:

- being struck or pinched by the kelly
- losing footing while swinging the kelly out over the mousehole and stabbing it into a new joint of pipe
- being struck by or caught in the spinning chain

Possible Solutions:

- Use proper hand placement.
- Keep the work area around the rotating table clean and clear of mud, ice, snow, debris and other materials that may cause slipping or tripping.
- Inspect chain for broken or distorted links. Chains with the metal reduced by wear at any point less than 90 percent of its original cross section area should be discarded.
- Lubricate and maintain guide rollers to prevent undue wear on the chain or cable.

Raising the Kelly and New Joint

In this procedure, the driller uses the drawworks to raise the kelly and attached joint out of the mousehole.

Potential Hazards:

- being struck by debris or overhead objects if the traveling block runs into the crown block or if the traveling block or swivel hits the derrick
- being struck by kelly or pipe

Possible Solutions:

- Install a crown safety device on the drawworks and ensure proper functioning.
- Keep personnel clear of the potential swing path of the kelly and pipe.

Adding Pipe to the String

In this process, the new joint is guided over to the drill hole, the tool joint is doped, and stabbed into the end of the pipe suspended in the rotary table with the slips.

The joints are threaded together using the pipe spinner, kelly spinner, or spinning chain. Final torque is provided by the tongs.

The drawworks lifts the kelly and attached string to facilitate removal of the slips.

Potential Hazards:

- being struck by:
    - swinging kelly and pipe
    - tongs if the stabber misses the stump
    - the jerk or spinning chain
- being caught between the swinging pipe and the tongs
- being caught between the joint of pipe being stabbed and the stump
- getting pinched between tongs or pipe spinner and pipe
- slips, trips, and falls

Possible Solutions:

- Never step over a jerk chain and stay clear of spinning chain when a connection is being made.
- Keep hands away from end of stump or inside of pipe.

- Keep feet and legs away from underneath tongs when the pipe is being stabbed.
- Use proper tong latching techniques and hand and finger placement on tong handles.
- Never stand or walk under suspended loads.
- Keep the work area around the rotary table clean and clear of drilling fluids, mud, ice, snow, debris, and other materials that may cause slipping or tripping.
- Inspect chains for worn or damaged links, and replace a chain having a broken or distorted link with the metal reduced by wear at any point less than 90 percent of its original cross section area.

Resuming Drilling

In this process, the driller starts the pump and picks up off the slips.

The drill crew then removes the slips.

The driller lowers the string until the kelly drive bushing engages the master bushing.

Once the bushings are in place, the driller begins rotating the drill string, lowers the bit back to bottom, and continues making hole.

Potential Hazards:

- being thrown off the rotary table when engaged
- getting caught by loose clothing

Possible Solutions:

- Stand clear of the rotary table.

Coring

In some cases the operator orders a core sample of the formation for testing.

A special core barrel is lowered to the bottom on the drill string and is rotated to cut a core from the formation.

This core is brought to the surface and examined in a laboratory.

Potential Hazards:

- being pinched or struck by the core barrel and associated tools during floor operation being struck by the core as it is removed from the barrel
- encountering other hazards similar to those encountered during tripping out/in

Possible Solutions:

- Wear appropriate PPE.
- Instruct workers in handling and using the special tools required during drill core extraction.

Module 5 Quiz

1. **Hazards associated with preparing the break out pipe include all the following, except _____.**

   a. pinching body parts between slips
   b. muscle strain from improper lifting
   c. falling to below
   d. pinching fingers when latching tongs

2. **To prevent injuries associated with preparing the break out pipe, you can do all the following, except _____.**

   a. using proper sun screen
   b. inspecting tongs, cables and snub lines
   c. using a mud bucket
   d. not standing in the red zone

3. **Hazards associated with making up pipe in the mousehole include all the following, except _____.**

   a. being struck or pinched by the kelly
   b. losing footing while swinging the kelly
   c. being struck by or caught in the spinning chain
   d. falling down the mousehole

4. **Hazards associated with adding pipe to the string include all the following, except _____.**

   a. being struck by the kelly and pipe
   b. being caught between the kelly and platform
   c. being struck by tongs if the stabber misses the stump
   d. getting pinched between tongs or pipe spinner and pipe

5. To prevent injuries while coring, you can do all the following, <u>except</u> _____.

a. wearing appropriate PPE
b. instructing workers in handling special tools
c. using proper hearing protection
d. instructing workers on using special tools

Module 6: Tripping Out/In

Introduction

Controlling exposures to worksite hazards is the fundamental method of protecting workers on a construction site. Traditionally, the widely-accepted hierarchy of controls has been used as a means of determining how to implement feasible and effective controls.

Tripping refers to the process of removing and/or replacing pipe from the well when it is necessary to change the bit or other piece of the drill string, or when preparing to run certain tests in the well bore.

The activities that comprise “tripping out” are listed below. “Tripping in” essentially comprises the same steps in reverse order.

Setting Slip

The floor crew sets slips around the drill stem.

Potential Hazards:

- getting fingers or other body parts pinched between slips or slip handles and rotary table
- receiving muscle strain from improper lifting technique

Possible Solutions:

- Use proper hand placement when setting slips.
- Use proper stance and slip lifting techniques.
- Slips have three handles and should be lifted jointly by more than one person.

Breaking Out and Setting Back the Kelly

In this process, the crew breaks out the kelly and set it into the rathole.

Potential Hazards:

- release of excess drilling mud resulting in skin contact, loss of footing, etc.

- being struck by the slip handles if the rotary table is used to spin the drill string
- being struck by the kelly if the pullback line unhooks when kelly is being pulled toward the rathole

Possible Solutions:

- Shut down the mud pumps before breaking out the kelly.
- Close the mud saver valve on the kelly (if present).
- Use a mud bucket to divert flow of excess mud.
- Stand clear of the rotary table when it is rotating.
- Consider other technologies (such as a pipe spinner, kelly spinner, or top drive unit) to eliminate this hazard.
- Implement an effective pullback line attachment procedure.
- Ensure workers stand in a safe location away from the pullback line and rathole during this pullback operation.

Attaching Elevators to the Elevator Links

The crew attaches elevators to the elevator links.

Potential Hazards:

- being pinched by the elevator links while attaching elevators (or attaching elevator links to the hook)
- being struck by the elevators
- receiving strains and sprains

Possible Solutions:

- Use proper hand placement when attaching elevator links.

- Ensure workers stand away from swing-path of the elevators and elevator links.
- Use lifting equipment and limit manual positioning of elevators.
- Use proper mounting procedures.

Latching Elevators to Pipe

In this process, the floor crew latches the elevators onto the pipe.

Potential Hazards:

- getting hands or fingers pinched in elevators
- being struck by elevators not securely latched
- getting hands or fingers caught between elevators and stump

Possible Solutions:

- Ensure workers are instructed in proper latching procedure, including the use of handles on elevators as they are descending into place over the stump or tool joint.
- Inspect and maintain elevators.

Working on the Monkeyboard

In this process, the derrickman climbs up the derrick to the monkeyboard.

From here he unlatches the elevators and guides the stands of pipe into the fingerboard.

The elevators are then lowered and attached to the next stand of pipe.

Potential Hazards:

- falling while climbing up or down the ladder
- falling from monkeyboard or fingerboard
- slips, trips, and falls

- falling during an emergency descent
- being caught between pipe and other objects
- receiving strains and sprains
- being struck by dropped objects

Possible Solutions:

- Use a climb assist device.
- Wear appropriate fall protection including a full body harness. For Fall Protection guidance, consult:
    - [29 CFR 1910.23(c)(1)], Fall Protection when working from platforms.
    - [29 CFR 1910.66 App (C)], Fall Protection guidelines.
    - [29 CFR 1910 Subpart D], Walking-Working Surfaces.
- Wear the proper Personal Protective Equipment (PPE) such as:
    - hard hat
    - work gloves
    - safety-toed footwear
- Practice 100% tie-off while working in the derrick.
- Use slip-resistant coatings or materials on working surfaces.
- Train personnel in use of emergency escape device.
- Practice proper hand placement and use of pullback (tail) ropes.
- Implement a dropped objects program, such as tie-off for all tools.
- Use extra caution while personnel are working overhead.

- Do not carry tools while climbing the derrick ladder. Raise tools with a line to any worker above the derrick floor.

Breaking Out Pipe

In this process, the crew uses the tongs and cathead to breakout the pipe.

The rotary table may be used to spin out the pipe after breaking the connection.

Potential Hazards:

- being struck by swinging tongs if they break free from the pipe
- being struck by the slip handles if the rotary table is used to spin the drill string
- being struck by reverse backlash of tongs (backbiting) during breakout operations
- being struck by the tongs if a snub line breaks or the tongs come unlatched

Possible Solutions:

- Implement an effective breakout pipe procedure:
    - Personnel other than tong operators stand outside the tong swing radius when breaking pipe.
    - No one should stand in the red zone.
    - Use proper tong latching techniques and use proper hand and finger placement on tong handles.
    - Stand clear of the rotary table when it is rotating.
    - Use special operational procedures when making high torque connections.
- Inspect tong dies and snub lines each tour.
- Maintain good communication between floor hands and driller.

Maneuvering Pipe to Racking Area

In this process, the stand is raised and maneuvered to the pipe racking area.

Potential Hazards:

- getting hands and fingers pinched between stands of pipe
- getting feet or toes crushed or amputated under a stand of pipe
- slips, trips, and falls
- receiving strains and sprains

Possible Solutions:

- Keep hands and fingers from between pipe stands.
- Position feet away from the bottom of the pipe stands.
- Keep the area free of debris.
- Use proper lifting, lowering, pushing, pulling techniques.

Tripping in – Latching Elevators to Top of Stand

In this process, the derrickman latches the elevators onto the pipe from the monkeyboard.

Potential Hazards:

- getting hands or fingers pinched in elevators
- being struck by elevators not securely latched
- getting hands or fingers caught between elevators and stump

Possible Solutions:

- Ensure workers are instructed in proper latching procedure.
- Do not place hands or fingers between elevator and stump.

- Inspect and maintain elevators.

Module 6 Quiz

1. **The process of removing and/or replacing pipe from the well when it is necessary to change the bit or other piece of the drill string is called _____.**

   a. tripping
   b. boring
   c. drilling
   d. slipping

2. **To prevent injuries while breaking out and setting back the kelly, you can do all the following, <u>except</u> _____.**

   a. shut down the mud pumps before breaking out the kelly
   b. being struck by the slip handles
   c. stand clear of the rotary table when it is rotating
   d. personal protective equipment

3. **Hazards encountered while attaching elevators to the elevator links include all the following, <u>except</u> _____.**

   a. being pinched by the elevator
   b. being struck by the elevators
   c. being caught between kelly and platform floor
   d. receiving strains and sprains

4. **To prevent injuries while working on the monkeyboard, you can do all the following, <u>except</u> _____.**

   a. training on use of emergency escape device
   b. wearing appropriate hearing protection
   c. implement a dropped objects program
   d. not carrying tools while climbing derrick ladder

5. **Hazards encountered while the derrickman latches elevators to the top of stands include all the following, <u>except</u> _____.**

   a. getting hands or fingers cause between elevators and stump
   b. being struck by elevators not securely latched
   c. getting hands or fingers pinched in elevators
   d. being struck by moving slips

Module 7 –Casing Operations Safety

Introduction

Casing is a steel pipe that is usually larger in diameter and longer than drill pipe and is used to line the hole to:

- prevent the wall of the hole from caving in
- prevent movement of fluids from one formation to another
- aid in well control

Casing operations occur periodically throughout the drilling process starting with the surface casing, intermediate casing, and ending with production string which takes place during well completion.

The activities involved in casing operations can vary according to the type of casing being installed, but generally fall into these steps:

- installing casing tools
- running casing into the hole
- installing casing accessories
- circulating and cementing

Installing Casing Running Tools

In this process, specialized casing handling tools, such as the casing elevator and spiders, are installed to run casing.

Note: The special service supervisor should always hold a pre-job meeting with the special service crew and other involved personnel to review responsibilities and to coordinate the operations to be performed.

Potential Hazards:

- being struck by or caught between tubulars and other objects during movement (such as being struck by tubulars being tailed into the rig floor)

- experiencing strains and sprains from maneuvering tools
- falling from work platform and/or stabbing board

Possible Solutions:

- Stand clear of suspended, hoisted or moving loads.
- Be aware of tubulars or equipment being lifted through the V-door.
- Use proper hand and foot placement to avoid pinch points, including use of tag lines.
- Use rig floor winch or other powered equipment to handle heavy casing tools.
- Use fall protection while installing equipment in the derrick.
- Keep the area free from slip, trip, and falls.

Running Casing into the Hole

In these procedures, casing pipe is run into the hole to a pre-determined depth.

Potential Hazards:

- hazards are similar to those for drilling ahead or tripping
- getting caught between, struck by, or pinched by the power tongs, casing or other equipment
- being struck by or caught between tubulars and other objects during movement (for example, struck by tubulars being tailed into the rig floor)
- falling from the stabbing board or work platform
- getting struck by dropped objects

Possible Solutions:

- Include the casing crew and the drilling crew when conducting a JSA and pre-job safety meeting to coordinate the activities of casing operations.

- Stand clear of suspended, hoisted, or moving loads. Be aware of tubulars or equipment being lifted through the V-door.
- Emphasize all normal worker safety procedures, such as fall protection, PPE, placement of hands and feet, and teamwork and communication between workers.
- Implement full fall protection program for the casing stabber.
- Identify clearance between the stabbing board and casing elevators.
- Secure all items used by the casing stabber overhead with a safety line.

Installing Casing Accessories

As casing is being run, accessories such as centralizers, scratchers, guide shoe, and a float collar are installed and used as needed.

Note: The special service supervisor should hold a pre-job meeting with the special service crew and other involved personnel to review responsibilities and to coordinate the operations to be performed.

Potential Hazards:

- dropping guide shoe or float collar onto legs or foot
- getting fingers pinched between tools and casing tongs when manually moving guide shoe or float collar
- back strain
- exposure to hazardous materials, especially thread lock compounds

Possible Solutions:

- Use winch, air hoist, or other powered equipment to handle guide shoe, float collar, or other heavy casing equipment.
- Use appropriate PPE as required by the MSDS.
- Keep fingers away from pinch points when moving accessories.

Circulating and Cementing

After the casing is landed, drilling fluid is circulated through the casing and annulus to remove any residual gases and to condition the mud.

After circulating and conditioning the mud, the casing is cemented. **Cement** is a powder consisting of alumina, silica, lime, and other substances that hardens when mixed with water. It is extensively used in the oil industry to bond casing to the walls of the wellbore.

During this process the casing is reciprocated or rotated to allow the scratchers to work to remove excess wall cake to give the cement a better bond.

Usually another special servicing company is hired to conduct cementing operations.

Potential Hazards:

- being struck by high-pressure lines failing if not secured properly
- having a high-pressure connection failure caused by mismatched or excessively worn hammer unions

Possible Solutions:

- Hobble high-pressure lines properly.
- Use proper equipment inspection techniques to include hammer unions.
- Ensure compatible high-pressure line connections.
- Stay updated on safety alerts. International Association of Drilling Contractors (IADC).
    - High Pressure Lines and Hammer Unions. Alert 98-01, (1998, April).
    - More on Mismatched Hammer Unions. Alert 99-33, (1999, November).
    - Additional Serious Incidents with Mismatched Hammer Unions. Alert 00-15, (2000, May).
    - Mismatched Hammer Unions Still Being Found. Alert 03-16, (2003, April).
    - Mismatched Hammer Union Results in a Fatality. Alert 06-01, (2006, January).

Module 7 Quiz

1. **A pipe that is usually larger in diameter and longer than drill pipe and is used to line the hole is called _____.**

   a. outer pipe
   b. mud pipe
   c. casing pipe
   d. tubular pipe

2. **Hazards encountered while running the casing pipe include all the following, <u>except</u> _____.**

   a. being struck by tubulars
   b. exposure to release of mud
   c. strains and sprains from maneuvering tools
   d. falling from the work platform

3. **Hazards encountered while running the casing pipe into the hole include all the following, <u>except</u> _____.**

   a. getting caught between, struck by, or pinched by power tongs
   b. being struck by or caught between tubulars and other objects
   c. exposure to excessive noise
   d. falling from the stabbing board or work platform

4. **To prevent injuries while running the casing pipe into the hole, you can do all the following, <u>except</u> _____.**

   a. keeping away from excessive impact noise sources
   b. using a winch, air hoist or other powered equipment
   c. using appropriate PPE
   d. keeping fingers away from pinch points

5. **To prevent injuries while circulating and cementing, you can do all the following, <u>except</u> _____.**

    a. ensure compatible high-pressure line connections
    b. hobbling high-pressure lines properly
    c. using proper equipment inspection techniques
    d. keeping away from temperature extremes

Module 8: Maintenance Activities

Introduction

Proper maintenance prevents premature equipment failure, which may cause injuries or fatalities. Drilling equipment is subjected to stress and vibration during operations. Maintenance is a necessary and ongoing activity on the drilling site.

Maintenance activities include maintaining the:

- rig floor
- drilling line maintenance
- wire rope maintenance
- mud circulating system
- generator, electric motors and electrical systems
- engines
- derrick equipment maintenance

Rig Floor Maintenance

Maintenance activities include inspecting, adjusting, and servicing on equipment such as drawworks, rotary, catheads, tongs, air hoists, and wire rope.

Potential Hazards:

- slips, trips, and falls
- being caught in chains or other moving equipment
- getting fingers and hands pinched in machine guards or covers
- receiving sprains and strains

Possible Solutions:

- Wear personal protective equipment (such as hard hats, work gloves, safety shoes, and eye protection).
- Be aware of the slipping and falling hazards when performing maintenance on the drilling floor.
- Keep all work areas clean and clear of oil, tools, and debris.
- Use non-skid surfaces where appropriate.
- Use proper lockout/tagout procedures. [29 CFR 1910.147]
- Seek assistance when moving awkward and heavy guards and covers.
- Maintain all machinery free of leaks by regular preventive maintenance and repairing when necessary.

Drilling Line Maintenance

A **drilling line** is a wire rope hoisting line, reeved on sheaves of the crown block and traveling block (in effect a block and tackle). The primary purpose is to hoist or lower drill pipe or casing from or into a well. It must be inspected, slipped and cut regularly.

Potential Hazards:

- receiving injuries to face and eyes from flying chips of metal when slipping and cutting the line
- being caught in moving equipment
- slips, trips, and falls
- being struck by drilling line

Possible Solutions:

- Use proper lockout/tagout procedures. [29 CFR 1910.147]
- Wear proper personnel protective equipment when cutting line.

- Attach a red flag or other warning device to the drawworks clutch lever as a reminder to the driller whenever the crown safety device is moved or deactivated to allow the traveling block to be raised above the preset stopping point.

- Secure drilling line ends prior to cutting.

Wire Rope Maintenance

Wire rope is a cable composed of steel wires twisted around a central core of fiber or steel wire to create a rope of great strength and considerable flexibility. Maintenance activities involved with wire rope include visually inspecting wire ropes daily or per maintenance schedule.

Potential Hazards:

- getting cuts from the wickers or loose strands on the rope

- receiving injuries to face and eyes from flying chips when cutting wire rope

Possible Solutions:

- Wear proper personnel protective equipment when cutting wire rope.

- Seize wire rope before cutting.

Mud Circulating System

Maintenance activities involved with the mud circulating system include inspecting, adjusting, servicing on equipment such as mud pumps, hoses, hose connections, pop-off valve, shale shakers, belts, and guards.

A mud pump is a large, high-pressure reciprocating pump used to circulate the mud on a drilling rig. A typical mud pump is a two or three-cylinder piston pump whose replaceable pistons travel in replaceable liners and are driven by a crankshaft actuated by an engine or a motor.

Potential Hazards:

- being caught between, or struck by equipment

- slips, trips, and falls

- receiving a foreign body or fluid in the eye
- burned by fluid contact
- drowning in mud tank/pit
- receiving strains and sprains

Possible Solutions:

- Use proper lockout/tagout procedures.
- Wear personal protective equipment (such as hard hats, work gloves, safety shoes, and eye protection).
- Be aware of the slipping and falling hazards when working on the mud circulating system.
- Provide guardrails and guards around mud tanks.

Electric Generators, Motors and Systems

When conducting maintenance on electrical equipment and systems, make sure that:

- electrical connections and power cords are checked for wear for deterioration and replaced if needed.
- Electric motors are serviced at recommended intervals.
- All guards are present and correctly installed.
- Motors electrical connections need to be kept sealed.

Potential Hazards:

- receiving flash burns or shocks when servicing motors, generators, and breaker panels
- being caught on moving equipment

Possible Solutions:

- Do not wash down generators, electric motors and breaker panels with water hose.
- Avoid wearing jewelry.
- Do not stand directly in front of breakers when operating.
- Use dielectric mat in front of control panel or breaker panel.
- Use proper lockout/tagout procedures.
- Wear appropriate personal protective equipment.
- Cover with appropriate shields or guards all exposed revolving parts such as belts, flexible drives, generators, shafts and other moving parts to prevent contact and injury.

Engines

Engines require maintenance and servicing at recommended intervals.

Potential Hazards:

- getting burned by hot fluids or engine parts
- being caught in moving equipment or moving parts
- being cut while working on engines

Possible Solutions:

- Wear appropriate personal protective equipment.
- Let engine cool down before working on it.
- Use proper lockout/tagout procedures.
- Cover all exposed revolving parts with appropriate shields and guards.

Derrick Equipment Maintenance

Maintenance activities in the derrick consists of lubricating the swivel, traveling block, and crown block, and replacement of swivel packing.

Potential Hazard:

- getting caught between equipment and objects
- falling from heights
- being struck by falling tools or equipment

Possible Solutions:

- Use proper lockout/tagout procedures.
- Use appropriate fall protection.
- Wear appropriate personnel protective equipment.
- Minimize the number of personnel working on the rig floor.
- Tie off tools.

Module 8 Quiz

1. **Hazards encountered while conducting maintenance on the rig floor include all the following, except _____.**

   a. getting fingers and hands pinched in machine guards
   b. being caught in chains or other moving equipment
   c. exposure to excessive noise
   d. slips, trips, and falls

2. **To prevent injuries while conducting wire rope maintenance, it is important to do all the following, except _____.**

   a. using detergent to clean wire rope
   b. seizing wire rope before cutting
   c. wearing appropriate PPE for cutting rope
   d. using fall protection when working at elevation

3. **Hazards encountered while conducting maintenance on the mud circulating system include all the following, except _____.**

   a. strains and sprains
   b. drowning in a mud pit/tank
   c. slips, trips, and falls
   d. exposure to harmful bacteria

4. **Which of the following is a cable composed of steel wires twisted around a central core of fiber or steel wire to create a rope of great strength and considerable flexibility?**

   a. Fiber rope
   b. Wire rope
   c. Synthetic cable
   d. Synthetic rope

5. Which of the following is the primary purpose of the drilling line?

a. Moving tubulars to the derrick
b. Positioning drill pipe to the tubular stack
c. Hoist or lower drill pipe or casing from or into a well
d. Hoist and lower drill pipe from trucks

Module 9: Well Control Safety

Introduction

Properly trained personnel are essential for well control activities. Well control consists of two basic components:

1. an active component consisting of drilling fluid pressure monitoring activities, and
2. a passive component consisting of the Blowout Preventers (BOPs).

The activities involved in well control are:

- blowout prevention program
- monitoring and maintaining mud system
- testing BOPs, accumulators, and choke manifold
- maintaining surface control system

Blowout Prevention Program

The first line of defense in well control is to have sufficient drilling fluid pressure in the well hole. During drilling, underground fluids such as gas, water, or oil under pressure (the formation pressure) opposes the drilling fluid pressure (mud pressure). If the formation pressure is greater than the mud pressure, there is the possibility of a blowout.

Potential Hazard:

- receiving injuries caused by loss of well control

Possible Solutions:

- Must have appropriate training for the tasks performed. Example topics include the following:
    - causes of kicks, including detection
    - pressure concepts and calculations
    - well control procedures
    - gas characteristics and behavior
    - fluids
    - constant bottom hole pressure well control methods
    - well control equipment
    - regulatory information
- Use of appropriate well control equipment including:
    - specification
    - installation
    - maintenance

Monitoring and Maintaining Mud System

The mud circulatory system consists of the elements shown in the figure to the right.

Schematic of the circulating system: The drill bit, drill collar, annulus, drill pipe, kelly and swivel are depicted in the upper right. Drilling mud flows through the mud return line (center) upon its return to the surface from the hole to the shale shaker (upper left), then to the adjacent desander, desilter and degasser back to the mud tank (upper left). Mud passes through the suction line, and the mud pump (center) circulates the mud through the discharge line (above), the stand pipe (upper right) through the rotary hose (right) and the swivel (lower right), back to the kelly and into the drill pipe.

Each part of this system must function and be in good repair to maintain well control.

If the mud level increases, it may be a sign that a kick is in progress. A kick is an entry of water, gas, oil, or other formation fluid into the wellbore during drilling. It occurs because the pressure exerted by the column of drilling fluid is not great enough to overcome the pressure exerted by the fluids in the formation drilled. If prompt action is not taken to control the kick, or kill the well, a blowout may occur.

On some rigs there is a mud float level gage which sounds an automatic alarm if the mud exceeds a pre-specified level.

Potential Hazard:

- loss of well control (blowout)

Possible Solutions:

- Keep the mud circulating system in good working order.
- Check and maintain the properties of the drilling fluid, including proper pit level periodically.
- Properly train crew in monitoring and well control procedures.
- Maintain a properly functioning surface control system.

Installing and Testing BOPs, Accumulator, and Choke Manifold

In the well control system installation process, the **blowout preventer** (BOP), **accumulator** and **choke manifold** are installed by the rig crew after the surface casing is set and cemented.

The **BOP** is one or more valves installed at the wellhead to prevent the escape of pressure either in the annular space between the casing and the drill pipe or in open hole (for example, hole with no drill pipe) during drilling or completion operations.

The accumulator and choke manifold have been set into place during rigging up and now need to be hooked up and tested.

The **accumulator** is a storage device for nitrogen pressurized hydraulic fluid, which is used in operating the blowout preventers.

The **choke manifold** is the arrangement of piping and special valves, called chokes, through which drilling mud is circulated when the blowout preventers are closed to control the pressures encountered during a kick.

- The **choke line valve** is used to redirect the mud from the well bore to the choke manifold during a kick.
- The **kill line valve** is used to direct drilling fluid to the BOP during a kick.

The BOPs, accumulators, and choke manifold should be regularly tested and properly maintained.

Potential Hazards:

- being crushed by falling equipment if hoisting slings fail
- being struck by, pinched by or caught between equipment during installation
- being hit by hoses or sprayed by hydraulic fluid if there is a seal or hydraulic line failure during pressure testing

Possible Solutions:

- Ensure workers stand clear of equipment being hoisted and tag lines are used where appropriate.
- Coordinate hoisting tasks with rig crew.
- Inspect the hoisting slings for wear before any hoisting operation.
- Ensure all personnel wear proper PPE.
- Ensure workers stand clear of pressurized lines during testing procedures.

Maintaining Surface Control System

Properly maintain the surface control system.

Potential Hazards:

- protruding pipes and objects
- being struck by dropped objects
- slips, trips, and falls
- atmospheric hazards

Possible Solutions:

- Wear appropriate personal protective equipment (such as hard hats, work gloves, safety shoes, and eye protection).
- Implement injury awareness training (such as dropped objects, working from heights)
- Use appropriate fall protection.
- Ensure workers are aware of the slipping and falling hazards.
- Monitor for potential hazards (H_2S, methane, O_2 deficiency).

Module 9 Quiz

1. **A _____ is an entry of water, gas, oil, or other formation fluid into the wellbore during drilling.**

   a. injection
   b. release
   c. kick
   d. contamination

2. **To prevent injuries associated with well control, it is important to do all the following, <u>except</u> _____.**

   a. reprimanding workers for all well control infractions
   b. conducting training on well control tasks
   c. using appropriate well control equipment during installation
   d. using appropriate well control maintenance equipment

3. **Hazards encountered while installing BOPs, accumulators, and choke manifolds on a drilling rig include all the following, <u>except</u> _____.**

   a. being crushed by falling equipment
   b. being struck by equipment
   c. being caught between equipment
   d. being exposed to excessive noise

4. **During drilling, the pressure from underground fluids such as gas, water, or oil is also called _____ pressure.**

   a. mud
   b. formation
   c. drilling fluid pressure
   d. up-pipe

5. **The _____ is the arrangement of piping and special valves, called chokes, through which drilling mud is circulated when the blowout preventers are closed to control the pressures encountered during a kick.**

   a. kill line valve
   b. accumulator
   c. choke manifold
   d. kelly

Endnotes

1. Dept. of Labor, Occupational Safety and Health Administration (2014). Oil and Gas Well Drilling and Servicing eTool. Retrieved from: https://www.osha.gov/SLTC/oilgaswelldrilling/otherresources.html

2. American Petroleum Institute (2014). Guidance Document for the Development of a Safety and Environmental Management System for Onshore Oil and Natural Gas Production Operations and Associated Activities. Retrieved from: http

3. Bureau of Land Management (2014). Public Lands: Interior. Retrieved from: www.blm.gov/pgdata/etc/medialib/blm/mt/blm_programs/energy/oil_and_gas/policy/cfr3160.Par.28656.File.dat/cfr3160.pdf