Course 901

Oil and Gas

Hazard Awareness

OSHAcademy
Occupational Safety & Health Training

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OSHAcademy Course 901 Study Guide

Oil and Gas Industry: Hazard Awareness

Contact OSHAcademy to arrange for use as a training document.

This study guide is designed to be reviewed off-line as a tool for preparation to successfully complete OSHAcademy Course 901.

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

Companies in the oil and gas extraction industry operate and/or develop oil and gas fields as a part of upstream oil and gas activities. These activities are sometimes referred to as exploration and production. Such activities may include:

- exploring for crude petroleum and natural gas
- drilling, completing, servicing and equipping wells
- operating separators, emulsion breakers, de-silting equipment, and field gathering lines for crude petroleum and natural gas
- performing other activities in preparing oil and gas up to the point of shipment from the producing property

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.

The information and resources provided in this course can help workers and employers identify and eliminate hazards in their workplace. The course introduces applicable OSHA regulatory requirements, as well as industry standards and guidance aimed at identifying, preventing, and controlling exposure to hazards.

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

Scenario

A derrickman was working on the derrick board of a rig. After taking a break, the derrickman climbed back up to the derrick board and did not attach his fall protection device after unhooking from the climb assist. The worker grabbed the first stand of pipe with the tail rope which helped keep his balance as the elevators were being sent up to attach to the pipe. When he released the tail rope, he lost his balance and fell 90 ft. to the rig floor, where he was fatally injured.

Here are some ways to prevent this type of accident:

1. Ensure that all employees who work at elevations above the ground or adjacent surfaces such as a rig floor are protected at all times from falling by guardrail systems, safety net systems, or personal fall arrest systems (PFAS).
2. Evaluate the worksite to identify jobs and locations where workers might be exposed to fall hazards.
3. Instruct all workers in the hazards of working at elevations and how to properly use personal fall arrest systems (PFAS).
4. Implement work rules which instruct workers that they must use fall protection equipment (e.g., ladder climbing assist devices; PFAS, etc.) when they are working at elevations.
5. Inspect all fall-related equipment (guardrails, ladders, PFAS) to make sure that they are not damaged or deteriorated.

Module 1: General Oil and Gas Safety

Too many workers are dying in the oil and gas drilling industry. According to the Bureau of Labor Statistics (BLS), the oil and gas fatality rate in 2012 was 7.6 times higher in the USA than the all-industry rate of 3.2 deaths per 100,000 workers.

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

To protect employees, employers need to ensure that:

- jobs are planned out
- everyone has adequate training in all aspects of safety
- workers need to be part of the planning

By identifying and eliminating hazards and training oil and gas workers to control these hazards, you can save lives.

Typical Types of Jobs on a Drilling Site

Regardless of company size, the task force employed at a well site is fairly small.

A typical drilling rig employs a **tool pusher** to supervise the drilling operation. Depending on well site location, he may be in charge of more than one rig.

The **driller** (shift foreman) is responsible for the immediate direction of work on the drilling rig. He operates the rig controls, supervises the changing of drill pipe and tripping operations, and directs any maintenance or repair work. His crew usually consists of one **derrickman** (relief driller) performing tasks from the upper portion of the derrick during tripping operations (the derrickman is normally the second man in charge of drilling operations), three **rotary helpers** (floormen) performing those tasks associated with the addition of pipe joints during drilling and tripping.

For large operations, such as deeper wells, the crew usually includes a **motorman** (usually the most experienced rotary helper) who is in charge of the mechanics of the equipment and also acts as a floorhand during tripping procedures, and an additional rotary helper.

An **electrician** normally is employed on electrically powered drilling rigs. Smaller drilling rigs normally require an average of five persons per shift (not including the pusher), whereas seven or eight persons per shift are needed on a larger rotary rig.

Drilling operations are continuous (24 hours/day, 7 days/week) until the well has been completed. When a well is being drilled, the rig usually is staffed for three 8-hour shifts, although in some remote areas the operation uses two 12-hour shifts.

Approximately seven employees per shift is a reasonable estimate of the number of persons at risk on a typical drilling operation.

Hazards that Cause Disabling Injuries

Rig Activity or Equipment Causing Injury

- tongs
- pipe
- cables, chains, ropes
- hose

- cathead
- elevator
- hand tools
- air tugger
- vehicles
- motors or generators
- fans
- clutches or brakes
- slips
- falling objects
- cranes
- belts or pulleys
- personnel falls
- overexertion
- rotary tables
- temperature extremes
- harmful substances

OSHA has identified the following hazards related to the oil and gas industry:

1. adverse weather
2. uneven, unstable ground
3. rough terrain

4. overhead power lines

5. buried utilities

6. wildlife / livestock

7. unhappy land owners

8. noise

9. day/night operations

10. fast pace

11. poor illumination

12. simultaneous operations and site congestion

13. heavy equipment

14. transportation

15. pressure

16. chemicals

17. nuisance dusts

18. toxic gases

19. radiation

20. confined space entry

21. excavations, trenches

22. communication

23. roll over

24. blind spots

25. medical emergencies

26. slips, trips, falls

27. sprains and strains
28. repetitive movement
29. caught-between
30. pinched-by
31. struck or crushed by
32. fall from height
33. equipment failure
34. electrical
35. wire line
36. blowout
37. hot work
38. fire
39. explosives /explosion
40. language
41. literacy
42. cultural differences
43. worker fatigue, boredom
44. workplace violence
45. substance abuse, impaired worker
46. lone worker
47. short service employee
48. worker fitness/health
49. human error

50. terrorism

51. other environmental hazards

The Importance of Training

Oil and gas industry accidents will be reduced when people who work on well sites are selected properly, oriented well, completely trained, retrained when necessary, always motivated and retained to become the best career oil field staff.

Selection - Selecting properly from a more qualified pool of applicants will begin to occur when escalation of activity in the industry decreases, or levels out, or when better retention of workers reduces the need for constant replacements. At the present time manpower needs are so urgent in the oil and gas industry that normal selection procedures are often by-passed.

Orientation - Orientation would be improved by industry cooperation with educational institutions in providing information and courses to prospective employees about opportunities in the oil fields. Recruitment should include exposure to packaged audio visual orientation material that would take the surprise out of first days on the job.

Training – Worker training must compensate for lack of experience when new employees, because of necessity, are promoted rapidly. The industry should be challenged to research the best methods and to implement excellent programs to train employees.

Retraining – Remaining aware of danger, as familiarity kills caution, requires constant retraining in a variety of ways in order to retain interest. This constitutes another developmental thrust for training institutions and personnel.

Motivation – Worker motivation to work safely and to stay within the industry must come from the companies. The opportunity to be employed year-around, develop pride in working for a good company, experience satisfaction with job conditions, know the work is meaningful and be rewarded generously should lessen the movement of workers throughout the industry. It will assist in raising public opinions about oil field work to the status of a respected career.

When initially employed, a worker should receive instruction and training pertinent to the hazards, safety precautions, safe work practices, and use of personal protective equipment applicable to the type of work performed.

The safety training oil and gas employees receive should adequately orient and alert the new employee to:

- the basic principles of a well drilling operation, including the safe work practices and hazards associated with rig equipment
- the purpose and operation of blowout prevention
- hydrogen sulfide and respiratory protection
- fire prevention and control
- confined spaces and entry procedures
- personal protective equipment
- emergency procedures

Each new employee should receive training in the safe use of all equipment or tools that are necessary for use and the safe performance of assigned tasks. The employer should require the worker demonstrate his ability to safely operate the tool or equipment prior to using it in a drilling situation.

As an employee advances to new positions and tasks, he should demonstrate his knowledge and ability to safely operate the equipment and perform the tasks before he is required to perform them in a drilling situation.

Retraining should be conducted as needed to ensure that employees are able to perform their tasks in a safe manner.

Module 1 Quiz

Use this quiz to self-check your understanding of the module content. You can also go online and take this quiz within the module. The online quiz provides the correct answer once submitted.

1. **To reduce fatalities and injuries, employers need to ensure that all the following are accomplished, except _____.**

   a. workers are part of the planning
   b. everyone has adequate training
   c. someone is assigned to the OSHA watch
   d. planning out jobs

2. **Oil and gas industry accidents will be reduced when the employer does all the following, except _____.**

   a. makes sure all employees receive safety training
   b. ensures employees receive effective safety orientation
   c. properly selects employees
   d. disciplines all instances of unsafe behavior

3. **Initial oil and gas safety training should adequately orient and alert the new employee to all the following, except _____.**

   a. fire prevention and control
   b. the OSHA inspection schedule
   c. derrick collapse
   d. hydrogen sulfide safety

4. **Which of the following positions is responsible for the immediate direction of work on the drilling rig?**

   a. The driller
   b. Derrickman
   c. Rotary helper
   d. Motorman

5. Which of the following positions performs those tasks associated with the addition of pipe joints during drilling and tripping?

a. The driller
b. Derrickman
c. Rotary helper
d. Motorman

Module 2: How Injuries Occur in Drilling Operations

The potential that an accident may occur on a drilling rig is inherent in all tasks. However, the probability or likelihood that an accident can occur may be greater for some tasks than for others. If you depend on "luck" more than anything else, the severity or degree of the injury will vary with each injury accident. The old saying, "It's not the fall that kills, it's the sudden deceleration," is very true.

Injury severity is reflected by the nature of the injury (amputation, fracture, laceration) and by the amount of time the injured employee is unable to work.

Injuries that result from hazards unique to oil and gas well drilling operations can be broadly classified into two major categories:

1. those injuries incurred from task-specific accidents

2. those injuries incurred during more catastrophic events such as blowouts, derrick collapse, and hydrogen sulfide exposures

Task-Specific Accidents

The first major category of accidents is representative of incidents that occur during task-specific operations. This major category has been further subdivided into accidents:

a. that occur during drilling operations

b. derrick tasks

c. materials handling activities

Drilling Operations

Drilling operations have been further categorized by the tools or equipment used in performing the task, such as slips, tongs, elevators, catlines, and working surfaces. Now, let's take a closer look at each of these hazards.

Hazards associated with Slips: Slips are the toothed wedges that are positioned between the drill pipe and the master bushing/rotary table to suspend the drill string in the well bore when it is not supported by the hoist.

Most of the accidents attributable to slip operations occur in relationship to materials handling. Strained backs and shoulders are common. Furthermore, the working surface may be wet and slippery, contributing to muscle strains, as well as to accidents such as falls and dropping the slips onto the feet.

Lack of communication between the driller and the employees engaged in the slip operations and lack of coordination between employees engaged in the task also contribute to accident potentials in slip handling.

Hazards associated with Tongs: Tongs are the large, counterweight-suspended wrenches used to "break out" the torqued couplings on the drill pipe.

Both sets of tongs have safety lines; when breakout force is put on the tongs, employees should step back from the outside radius of the tongs in the event a tong slips or a safety line slips or breaks. In these instances, employees positioned in the path of travel can suffer serious injury.

Another likely accident can occur when the driller actuates the wrong tong lever and an unsecured tong swings across the rig floor at an uncontrolled velocity. Sometimes the wrong lever is pulled because the levers are not placed in such a manner as to make them readily distinguishable, and sometimes because the driller is distracted or fatigued.

A common accident attributable to tongs can occur when an employee has his hand or finger in the wrong place as he attempts to swing and latch the tong onto the drill pipe resulting in crushing injuries and amputations of the fingers.

Hazards associated with Elevators: Elevators are a set of clamps affixed to the bails on the swivel below the traveling block. They are used to clamp each side of a drill pipe (the pipe is belled in this area) and hold the pipe as it is pulled from the well bore.

A number of accidents and associated injuries can occur during the latching and unlatching tasks-fingers and hands can get caught and crushed in the elevator latch mechanisms. The more severe injuries involve improper attachment of the pipe to the elevator. If the pipe is overhead when the latching mechanism fails, then the pipe may fall on employees working on the drill floor.

Hazards associated with Catlines: Catlines are used on drilling rigs to hoist material. Catlines and high lines should be designed to safely lift or otherwise handle the loads. The revolving cathead on the drawworks powers the friction pulley system. An employee wraps a rope, usually 1-1/4 inches in diameter, around the cathead and tensions the line. The tighter the rope and the more wraps around the cathead, the faster the material is hoisted.

Accidents that occur during catline operations may injure the employee doing the rigging as well as injure the operator. Minimal hoisting control causes sudden and erratic load movements, which may result in hand and foot injuries.

Safety measures:

1. The maximum allowable working loads should be based on manufacturers' tables.

2. A post or guard should be provided to deflect cathead lines away from the driller's position. Where posts are of the rotating type, the top and bottom ends should be guarded to contain the post in case the shaft fractures.

3. A catline grip should be provided and used to keep the catline tight when the line is not in use.

Hazards associated with working surfaces: The OSHA standards for walking/working surfaces apply to all permanent places of employment, except where only domestic, mining, or agricultural work is performed.

The rig floor is the working surface for most tasks performed in well drilling operations. This surface is frequently wet from circulating fluid and/or water used to wash it down. Prevailing weather may further increase the slipperiness of the surface.

Employees must lift, push, and pull heavy items as a routine part of their assignments. Slippery working surfaces can increase the likelihood of back injuries and other overexertion injuries. Slips and falls may result in sprains, strains, contusions, and lacerations. Exposed moving parts (rotary table and kelly bushing) may compound the injury potential and severity.

Additionally, the rathole (although usually an elevated tube) and mousehole, used to temporarily store the kelly bar and drill pipe, may be uncovered when not in use. Stepping into a floor hole can result in fractures and sprains.

The cellar is a pit in the ground below the derrick structure. Hydrogen sulfide, if released, and water may accumulate in this low area. Ladder access into the cellar is a potential accident source, as is lack of proper guarding.

Module 2 Quiz

Use this quiz to self-check your understanding of the module content. You can also go online and take this quiz within the module. The online quiz provides the correct answer once submitted.

1. **Which of the following are the large, counterweight-suspended wrenches that can cause serious injury if an employee is positioned in the equipment's path of travel?**

    a. Tongs
    b. Catlines
    c. Slips
    d. Working surfaces

2. **Which of the following pieces of equipment is used to hoist material and usually causes injury to operators and those doing the rigging?**

    a. Tongs
    b. Catlines
    c. Slips
    d. Working surfaces

3. **The cellar is a pit in the ground below the derrick structure. Which of the following may accumulate in this low area?**

    a. Hydrogen sulfide
    b. Methane
    c. Nitrogen
    d. Oxygen

4. **Which of the following pieces of equipment will cause the drill pipe to drop if it fails, causing serious injury?**

    a. Tongs
    b. Catlines
    c. Slips
    d. Elevators

5. **A catline _____ should be provided and used to keep the catline tight when the line is not in use.**

   a. grip
   b. hoist
   c. clutch
   d. preventer

Module 3: Task-Specific Accidents

Crane, Derrick, and Hoist Hazards

Moving large, heavy loads is crucial to today's manufacturing and construction industries. Much technology has been developed for these operations, including careful training and extensive workplace precautions. There are significant safety issues to be considered, both for the operators of the diverse "lifting" devices, and for workers in proximity to them.

This module is a starting point for finding information about these devices, including elevators and conveyors, and their operation.

The derrickman on a well drilling operation performs his tasks from various elevated work platforms in the mast. He is exposed to falls when not using fall protection equipment while climbing the derrick ladder, while working with the pipe stands, and while moving from the ladder to his platform station. The derrickman is also exposed to crushing injuries from shifting stands of pipe and elevator latching tasks.

Adequate and continuous fall protection is a prerequisite for the safety of employees working on a derrick. Conditions beyond the control of the derrickman (wind, vibration, pipe movement) make even momentary unprotected exposures hazardous.

The primary functions of the hoisting apparatus are to raise and lower the drill string components during tripping and drill stem lengthening operations and to support the drill string at the desired bit weight during drilling. The drawworks is essentially a rotating spool, usually located on the drill deck, controlled by a clutch and brake system operated by the driller. The wire rope drill line runs from the drawworks to the crown block at the top of the derrick, and then to the traveling block and hook, which is attached to the drill string during drilling operations. The drilling line diameter and reeving sequence of the blocks are determined by maximum drill string weight. The deadline anchor, usually located on the derrick substructure, serves as an adjustable terminal anchor point for the wire rope. Typically, the dead line anchor will be adjustable to allow for the continual addition of new wire rope to the hoisting system.

Employee exposure to hazards associated with hoisting should be slight unless structural defects exist or system overloading occurs. Routine inspection of elevated hoist mechanisms involves the risk of falls. Pinched fingers and injuries from wire rope splinters are other hazards.

Materials Handling Hazards

On a drill rig, most of the materials handling equipment are unique to the oil field. This equipment is used in the working routines of raising and lowering the drill string, adding new sections of drill pipe, and tripping. The most common type of accident that occurs in materials handling operations is the "caught between" situation (e.g.; when a load is being handled and a finger or toe gets caught between two objects.)

The requirement for material handling creates many hazards, including:

- **Overexertion Injuries -** Workers directly involved in these operations are close to moving equipment components, while performing tasks that require substantial exertion and good coordination between individuals.
- **Crush Injuries -** Transferring drill pipe from the rack to the drilling platform may result in the stockpile rolling or in the mishandling of suspended loads, with the risk of crushing injury.
- **Fall to Same Surface Injuries -** Rolling stock (drill pipe and collars) can shift and/or fall from a pipe rack or truck bed. Employees must be alert to the hazards attendant to pipe handling and racking.
- **Struck-by Objects -** Vertical and near-vertical storage of drill pipe on the inclined ramp requires adequate slippage protection and employee procedural training for safe handling.
- **Fall to Below Injuries -** Improper rigging of loads can result in load shifts and objects falling on those below. Materials handling is a support activity, so safe materials handling procedures frequently are not given the necessary emphasis.
- **Poor Posture Injuries -** Handling of the tongs requires well-coordinated efforts and proper body limb placement.
- **Caught-in Injuries-** Mistakes in the hands-on spinning chain operations can lead to entanglement that may result in crushing, amputation, and death.
- **Contact-with Injuries -** Machinery is activated by an operator who depends on visual and/or audible cues; a mistake can lead to premature activation while workers are still in contact with moving parts.

- **Unexpected startup/shutdown -** Mechanical failure from overloading systems can occur.

- **Slips, Trips, Falls -** Lifting and moving heavy items on wet surfaces may lead to slips, falls, and overexertion.

- **Eye Injuries -** Eyes are at risk from material falling off the drill pipe.

Potential hazards in these operations can be increased if the drilling crew has not worked together very long; teamwork is necessary to carry out the operations quickly and safely.

Catastrophic Events

Catastrophic accidents involve the destruction of the drilling rig and/or injuries to multiple employees. Blowouts, derrick collapse, and hydrogen sulfide accidents are included in this category. Even though these accidents frequently may involve loss of life as well as the major destruction of equipment, the actual number of casualties represents only a small percentage of the total occupational injury incidence and severity rates in well drilling.

Blowouts

A blowout is an uncontrolled flow of gas, oil, or other well fluids occurring when formation pressure exceeds the pressure applied to it by the column of drilling fluid.

Blowouts may occur when the formation fluid pressure exceeds the hydrostatic pressure of the circulating fluid in the well annulus such as the totally unexpected encountering of unpredictable pressures and/or when mechanical controlling methods (e.g., blowout preventers (BOP's) or other pressure-control techniques) fail through misuse, misapplication, or malfunction. During a drilling operation, the mud serves as the first control method.

Most wells are drilled in oil fields with predictable formation pressures. BOP's selected to be compatible with these pressures are installed as soon as the surface casing is in place. BOP's function by sealing off the well bore. A series of hydraulic (and some manual) rams activated from ground level (not on the derrick) seal and contain the formation pressures.

A kick is the entry of water, gas, oil, or other formation fluid into the well bore. 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 will occur.

If the kick is not noticed in time or the techniques used to control the formation pressures are not adequate, then a blowout occurs. Since blowouts and subsequent fires involve the loss of equipment and time (as well as employee exposure to extremely hazardous conditions), the industry usually takes great care to prevent their occurrences.

Derrick Collapse

Although not a common occurrence, derrick or mast collapse most frequently happens during rigging-up and rigging-down procedures.

- The greatest strains are exerted on the mast components during these operations.
- Derrick frames subjected to abuse during movement may be damaged and wrecked.
- Inspection of the derrick structure is important for the detection of weld weakness, oxidation, and bent members.
- Weight indicators and recorders allow the driller to stay within mast load tolerances; consequently, they must be maintained and inspected.
- Manufacturers' rig capacities and guying requirements should always be followed.

Hydrogen Sulfide Accidents

Hydrogen Sulfide gas is very corrosive and causes metals to become brittle. Therefore, employers need to take special precautions when choosing equipment when they may reasonably expect to encounter H2S. This may include appropriate H2S trimming of equipment in accordance with National Association of Corrosion Engineers (NACE) Standards. We will cover more on Hydrogen Sulfide safety later in the course.

Module 3 Quiz

Use this quiz to self-check your understanding of the module content. You can also go online and take this quiz within the module. The online quiz provides the correct answer once submitted.

1. **All the following conditions are beyond the control of the derrickman and make even momentary unprotected exposures hazardous, <u>except</u> _____.**

   a. hurry
   b. wind
   c. vibration
   d. pipe movement

2. **Materials handling equipment on a drill rig is used for all the following, <u>except</u> _____.**

   a. maintaining rig sections
   b. raising and lowering the drill string
   c. adding new sections of drill pipe
   d. tripping

3. **Catastrophic accidents related to drilling rigs include all the following categories, <u>except</u> _____.**

   a. thunderstorms
   b. blowouts
   c. derrick collapse
   d. hydrogen sulfide release

4. **Which of the following, although not a common occurrence, most frequently happens during rigging-up and rigging-down procedures?**

   a. Blast explosion
   b. Blowout
   c. Hydrogen sulfide release
   d. Derrick collapse

5. **Which of the following gases found in the oil and gas industry is very corrosive and causes metals to become brittle?**

   a. Hydrogen sulfide
   b. Methane
   c. Sulfur monoxide
   d. Hydrogen dioxide

Module 4: Other Hazards on the Drilling Site

Flammable and Combustible Liquids

Only approved containers and portable tanks should be used for storage and handling of flammable and combustible liquids. Approved safety cans should be used for the handling and use of flammable liquids in quantities greater than one gallon.

No persons (except those having necessary duties or those authorized by the employer) should be permitted within the vicinity of a job or operation where the atmosphere is known to be contaminated with hazardous concentrations of flammable vapors or gases.

Flammables, such as gasoline and naphtha should not be used as cleaning material due to their high flashpoints. Smoking or open flames should not be allowed within 75 feet of the handling of flammable liquids. Oxygen should not be stored or used in the vicinity of flammable liquids.

Any engine being refueled should be shut off during such refueling. An electrical bond should be maintained between containers when a flammable liquid is being transferred from one to the other. Dispensing nozzles and valves should be of the self-closing type.

Except for the fuel in the tanks of the operating equipment, no flammable fuel should be stored within 75 feet of a well bore. Drainage from any fuel storage should be in a direction away from the well and equipment. Spills should be immediately cleaned up. The area around all storage facilities should be maintained reasonably free of oil, grease, and other combustible materials.

Fuel storage tanks should be protected by crash rails or guards to prevent physical damage unless by virtue of their location they have this protection. Adequate berms should be placed around storage tanks.

Electrical Safety

Working with electricity can be dangerous. Engineers, electricians, and other professionals work with electricity directly, including working on overhead lines, cable harnesses, and circuit assemblies. Others, such as office workers and sales people, work with electricity indirectly and may also be exposed to electrical hazards.

Electricity has long been recognized as a serious workplace hazard. OSHA's electrical standards are designed to protect employees exposed to dangers such as electric shock, electrocution, fires, and explosions. Electrical hazards are addressed in specific standards for the general industry, shipyard employment, and marine terminals.

The primary power source is normally one or more internal combustion engines. On larger, modern rigs, the engines providing power are frequently located at ground level, 100 or more feet from the derrick. This is to minimize the potential of fires caused by engines igniting gases that could escape from the well bore. On smaller rigs, the engines frequently are mounted immediately next to the derrick. The most common fuel used is diesel; but gasoline, natural gas, liquefied petroleum gas, and purchased electricity are also used. Typically, several hundred horsepower (HP) will be generated and used on a drilling rig, although a larger rig may produce more than 3,000 HP.

The transmission is mechanical or electric. A mechanical transmission, which is more common in older rigs, utilizes a "compound" of clutches, chains and sprockets, belts and pulleys, and a number of driving and driven shafts. An electric transmission is more common in newer equipment.

Most exposures to hazards associated with the power generation and transmission system occur during maintenance, fueling, and lubrication. Inadequate or nonexistent equipment guards and ineffectual (or the lack of) lockout procedures for maintenance operations during continuous drilling increase the risk of physical injury. Other hazards include high voltages, and chemical injury to the eyes during fueling, fire, and explosion. The noise levels in power generation areas may be high, with the risk of hearing loss.

Electrical Hazard Zones: Areas of the drilling rig are classified into "electrical hazard zones" based on the operative potential of release and accumulation of flammable gases. Electrical equipment used in these zones must conform to OSHA regulations.

Grounding and Bonding: All temporary, 120-volt, single-phase, 15- to 20-ampere flexible electrical cords and receptacles must conform to OSHA grounding and bonding requirements by having a ground-fault circuit interrupter system or an assured equipment grounding program.

Lightning and Static Electricity

Each stationary and portable steel derrick and mast in use where flammable vapors or gases are present (or may escape to the atmosphere in sufficient quantity that the ignition would endanger the safety of employees) should be effectively grounded to a ground pipeline, well casing, or other equivalent source of grounding. Where not effectively grounded or bonded by contact or connection, provisions should be made to prevent the accumulation of a static electrical charge, which could create a source of ignition in the presence of flammable vapors or gases.

Conductors, used for bonding and grounding stationary equipment or conductors should be of copper wire no smaller than No. 8 American Wire Gauge. Bonding and grounding clamps or clips should be attached with secure and positive metal-to-metal contact.

Fire Safety

According to the Bureau of Labor Statistics' Census of Fatal Occupational Injuries Charts, 1992-2007, fires and explosions accounted for 3% of workplace fatalities in 2007. This page provides valuable reference materials for prevention of fire-related injuries in all workplaces.

The employer should develop a fire protection program to be followed throughout all phases of the operation. Appropriate firefighting equipment should be provided and access to the equipment maintained at all times.

At least four fire extinguishers having a minimum rating of 40 B:C should be conveniently located at the rig. Additional extinguishers should be provided for the doghouse, the cellar, the generator area, and any flammable storage areas.

Firefighting equipment should be periodically inspected and maintained in operating condition at all times. A record should be kept showing the date when fire extinguishers were last inspected, tested, or refilled. After any use, fire protection and firefighting equipment should be made serviceable and returned to its proper location.

Smoking, open flames, or spark-producing equipment should be prohibited in areas subject to contamination or accumulation of flammable liquids or gases. Areas for the prohibition of smoking and open flame should include all areas within 75 feet of the:

- well head or shale shaker, whenever potentially hydrocarbon-bearing formations are exposed in the well
- degasser while it is operating
- fuel storage areas

The following specific actions should be taken in areas where smoking and open flames are prohibited:

- Striking matches anywhere should be prohibited.
- Cigar/cigarette lighters and smoking materials should not be permitted.

- "No Smoking" or "No Open Flame" signs should be conspicuously posted.

Exhaust pipes from internal combustion engines, located within feet of any well bore or in other nonsmoking areas, should be constructed and used so that any emission of flame or spark is suppressed.

Engine-driven light plants should be located at least 75 feet from the well bore unless properly protected to prevent them from becoming a source of ignition and should have an adequate overload safety device.

Welders' torch lighters of the spark type should be prohibited in areas where the atmosphere is contaminated by flammable vapors or gases or where sources of ignition are forbidden, unless sheathed or otherwise protected against accidental operation.

Employee heating devices involving the use of an open flame or exposed electrical element should not be allowed in any crew doghouse located on the derrick, mast floor, or within 75 feet of the well bore. Heaters should be safely located more than 75 feet from the well bore or have an explosion-proof design.

Flare Pits and Flare Lines

A flare pit contains a flare and is used for temporary storage of liquid hydrocarbons. These hydrocarbons are not burned, but are sent to the flare during equipment malfunction.

Flammable waste vapors or gases should be burned or controlled to prevent hazardous concentrations from reaching sources of ignition or otherwise endangering employees.

When a flare is used to burn flammable waste gases or vapors, the following precautions should be taken:

- Flare pits should be lit from the upwind side. When there is no wind or when the wind direction is undetermined, no attempt should be made to light the pit unless the operator can position himself in an explosive-free area.
- The use of hand-thrown rags or similar flaming objects should not be permitted.
- Reliable and safe means of remote ignition should be provided when hydrocarbon gases are released to the air through flares.
- Flares should be located in such a manner that unburned gases or vapors will be dispersed without creating a hazard to employees.

- Means should be provided to prevent the prolonged escape of hazardous quantities of unburned gases or vapors from flare installations. Automatic warning devices are acceptable, provided they are tested at such regular intervals that their operation will be assured.

- Where a flare has been extinguished, and the means of igniting the flare has failed, employees should not enter or be required to enter the involved area for the purpose of relighting, until tests have established that the area is free from flammable gases or vapors.

- All combustible material should be cleared for a safe distance from the flare pit or end of the flare.

Exposure to Rotating Parts

Exposure to rotating parts on an oil rig is a daily occurrence. All rotating equipment parts have inherent dangers. Even slowly rotating equipment can grip material it contacts. Where there are protrusions, the potential for catching increases and the travelling motion of a rotating piece of equipment is a cause for yet greater vigilance.

In addition to rotating the drill string and bit, the rotary table provides for free vertical motion of the drill as the bit penetrates into the earth. Torque is transmitted from the rotary table to the drill by the kelly, which also conveys the drilling mud that is pumped into it through a swivel connector.

A typical drill string consists of 30-foot sections of drill pipe, male and female threaded, that weigh between 14 and 18 pounds/foot (500 pounds/joint). Several heavy, thick-walled joints of pipe, called drill collars, are made up in the drill stem, just above the bit, so the bit will penetrate into the formation being drilled. A single drill collar can weigh between 2,500 and 4,000 pounds (or more) depending on its diameter.

Employee exposure to rotating parts during drilling makes this operation one with a high potential for severe injuries, although the frequency of occurrence is low. The rotary table and kelly bushing are in nearly continuous motion and are not usually provided with any guarding mechanism. Contact with either is likely to cause slips, falls, and bruising accidents; also, there is a risk of being caught between stationary and rotating parts.

Circulating Fluid Systems

Drilling fluid, or "mud," is typically a mixture of water and bentonite (an absorbent, gel-forming clay) and sometimes oil or other components. It has four primary functions: cooling, lubricating, and cleaning the bit; removing the cuttings; providing hydrostatic pressure to prevent entry of formation fluids into the well bore; and reducing the risk of hazardous blowouts.

Mud pumps force the mud up a standpipe and through the flexible kelly hose to the swivel, where it enters the drill string via the kelly and eventually emerges at the bit in the well bore. Cuttings carried by the drilling fluid are taken for analysis to determine the composition of the stratum being drilled.

Typical hazards associated with working on or around components of circulating fluid systems are various:

- **Chemical:** Mixing of the mud exposes workers to airborne respirable dust and chemical splashes.
- **Falls:** Tanks in which mud is mechanically stirred are hazardous when unguarded.
- **Electrical:** Effective lockout procedures may not be followed during tank maintenance operations.
- **Slips and trips:** Walking surfaces nearby may be slippery, especially in wet or icy weather.
- **High pressure**: Pressure surges causing line rupture are an occasional hazard.

Hand and Power Tools

Hand and power tools are a common part of our everyday lives and are present in nearly every industry. These tools help us to easily perform tasks that otherwise would be difficult or impossible. However, these simple tools can be hazardous and have the potential for causing severe injuries when used or maintained improperly.

Special attention toward hand and power tool safety is necessary in order to reduce or eliminate these hazards. Hand and power tool hazards are addressed in specific standards for the general industry, shipyard employment, marine terminals, longshoring, and the construction industry.

Scenario

On February 15, 2002, a 31-year old male rig hand/welder was fatally injured when he was pulled upward and entangled in the rotating drive shaft between the chain case and the rotary table in the substructure of the oilrig derrick. The victim had previously removed a non-working light from the rig substructure and taken it to the doghouse, a general-purpose room that is a combination tool shed, meeting room, office, and communications center.

The replacement light was a 2-foot, 2-bulb fluorescent light with a 6-8-foot-long cord. To attach the light to the rig substructure beam, he stood on either the hydraulic winches that lift the drill pipe, or the winch mounting brackets, or both. The winches/mounting brackets were located about 3½ feet above the rotary drive box for the chain case drive unit. By standing on the winches/mounting brackets, it placed him approximately 3 feet below and to the right of the rotating drive shaft. The 2-foot long drive shaft was approximately 8 inches in diameter, was located approximately 4-6 inches below the rig floor deck and was rotating at least 70 rpm.

The rig was not shut down or locked out during the removal of the defective light or when placing the replacement light. The event was unwitnessed, so it is unknown how the victim became entangled in the drive shaft. A co-worker heard a thumping sound and observed the victim spinning with the drive shaft. The co-worker shut down the rig and emergency services were called. The victim was pronounced dead at the scene.

Recommendations

- Employers should ensure that workers follow established lockout/tagout procedures for control of hazardous energy prior to service and maintenance of equipment.
- Employers should train workers to recognize potential workplace hazards and participate actively in workplace safety.
- Company management should consider developing a joint health and safety committee.
- The company should develop a written disciplinary procedure for safety and health policy violations.

- Oilrig manufacturers should consider engineering a guard to provide worker protection from rotating drive shafts when working in the derrick substructure.

Module 4 Quiz

Use this quiz to self-check your understanding of the module content. You can also go online and take this quiz within the module. The online quiz provides the correct answer once submitted.

1. **Only approved safety cans should be used for the handling and use of flammable liquids in quantities greater than _____.**

   a. one gallon
   b. one pint
   c. five gallons
   d. 10 gallons

2. **An electrical bond should be maintained between containers when a flammable liquid is being _____.**

   a. off loaded to the platform
   b. transferred from one to the other
   c. stored on site
   d. tested for contaminants

3. **Except for the fuel in the tanks of the operating equipment, no flammable fuel should be stored within _____ of a well bore.**

   a. 75 feet
   b. 50 feet
   c. 35 feet
   d. 150 feet

4. **All temporary, 120-volt, single-phase, 15- to 20-ampere flexible electrical cords and receptacles on the drilling rig must have a ground-fault circuit interrupter system or _____.**

   a. electrical monitoring program
   b. maintenance and testing process
   c. lockout/tagout program
   d. an assured equipment grounding program

5. **All the following specific actions should be followed in areas on a rig where smoking and open flames are prohibited, <u>except</u> _____.**

    a. prohibiting worker entry
    b. prohibiting striking matches
    c. prohibiting cigarette lighters
    d. prohibiting smoking materials

Module 5: Other Hazards on the Drilling Site (Continued)

Confined Spaces

Many workplaces contain spaces that are considered "confined" because their configurations hinder the activities of employees who must enter, work in, and exit them.

A confined space means a space that:

1. is large enough and so configured that an employee can bodily enter and perform assigned work; and
2. has limited or restricted means for entry or exit; and
3. is not designed for continuous employee occupancy.

Confined spaces include, but are not limited to underground vaults, tanks, storage bins, manholes, pits, silos, process vessels, and pipelines.

OSHA uses the term "permit-required confined space" (permit space) to describe a confined space that has one or more of the following characteristics:

1. contains or has the potential to contain a hazardous atmosphere
2. contains a material that has the potential to engulf an entrant
3. has walls that converge inward or floors that slope downward and taper into a smaller area which could trap or asphyxiate an entrant
4. contains any other recognized safety or health hazard, such as unguarded machinery, exposed live wires, or heat stress

Confined space hazards are addressed in specific standards for the general industry and shipyard employment. Also, see OSHAcademy course 713 Confined Space Program for more information.

Scenario

Confined Space Rescue and Recovery: Oil Field Worker Dies on the Job in California

According to KBAK-KBFX TV station in Bakersfield, California, a supervisor and a welder were in a 15-foot tall tank. They apparently were testing for leaks by adding air pressure inside the tank. This process required having a “false bottom” in the tank. It wasn’t clear if the air pressure had built up under the false bottom. Investigators at the scene said there weren’t any harmful fumes inside the tank at the time of the accident. Eyewitnesses told reporters they heard a “loud sound, like an explosion.”

Crews at the scene used a tripod with a rope, and sent a firefighter into the tank. However, the rescue team found the deceased worker inside the tank. He died from a severe head injury. The other worker at the site suffered a broken ankle.

Source: KBAK - KBFX TV - Eyewitness News - Oct 3, 2012

Pressure Vessels

Generally, a pressure vessel is a storage tank or vessel that has been designed to operate at pressures above 15 p.s.i.g. Recent inspections of pressure vessels have shown that there are a considerable number of cracked and damaged vessels in workplaces. Cracked and damaged vessels can result in leakage or rupture failures. Potential health and safety hazards of leaking vessels include poisonings, suffocations, fires, and explosion hazards. Rupture failures can be much more catastrophic and can cause considerable damage to life and property. The safe design, installation, operation, and maintenance of pressure vessels in accordance with the appropriate codes and standards are essential to worker safety and health.

Pressure vessel hazards are addressed in specific standards for the general industry, shipyard employment, and the construction industry.

Compressed Gas and Equipment

Hazards associated with compressed gases include oxygen displacement, fires, explosions, and toxic gas exposures, as well as the physical hazards associated with high pressure systems. Special storage, use, and handling precautions are necessary in order to control these hazards.

Special storage, use, and handling precautions are necessary in order to control these hazards. Gas cylinders should be stored in upright positions and immobilized by chains or other means to prevent them from being knocked over. If the cylinders fall over and are damaged the can be turned into rocket! Other important precautions to take include:

- Store cylinders away from highly flammable substances such as oil, gasoline, or waste.

- Store cylinders away from electrical connections, gas flames or other sources of ignition, and substances such as flammable solvents and combustible waste material.
- Keep all flammable gases separated from oxidizing gases in storage areas. Acetylene and propane cylinders should be separated from oxygen cylinders when not in use.
- Separate oxygen and fuel gas cylinders by a minimum of 20 feet when in storage. A fire-resistant partition between the cylinders can also be used.
- Keep storage rooms for cylinders dry, cool, and well- ventilated. The storage rooms should be fire resistant and the storage should not be in subsurface locations. Cylinders should be stored in secure areas at temperatures below 125 deg. F, away from radiators or other sources of heat.
- Store cylinders away from incompatibles, excessive heat, continuous dampness, salt or other corrosive chemicals, and any areas that may subject them to damage?
- Permanently post the names of the gases stored in the cylinders in storage areas.
- Make sure all compressed gas cylinders have safety pressure relief valves.
- Maintain cylinders at temperatures below 125 deg. F.
- Ensure flames never come in contact with any part of a compressed gas cylinder.
- Store and label charged or full cylinders away from empty cylinders.
- Protect the bottom of the cylinder from the ground to prevent rusting.
- Regularly inspect compressed gas cylinders for corrosion, pitting, cuts, gouges, digs, bulges, neck defects and general distortion.
- Ensure cylinder valves are closed at all times, except when the valve is in use.
- Move compressed gas cylinders, even short distances, using a suitable hand truck. They must never be dragged across the floor. Serious accidents have occurred when a cylinder with a regulator in place was improperly moved. The cylinder fell, causing the regulator to shear off, and the cylinder rocketed through several brick walls.

- Never use wrenches or other tools for opening and closing valves.
- Never hammer on valve wheels to open them should be strictly prohibited. For valves that are hard to open, contact the supplier for instruction.
- Always use suitable pressure regulating devices whenever the gas is emitted to systems with pressure-rated limitations lower than the cylinder pressure.

Hazards Associated with Other Drilling Techniques

Compressed Air - Compressed air may be used instead of drilling mud when there is no risk of encountering high-pressure, permeable formations or formations containing water. It has the advantages of faster drilling and of not having to recondition the circulating mud. The drilling dust is discharged from the "blooey line" and may be blown across the working area to cause a respiratory hazard; dust particles may cause eye injuries.

Directional Drilling - Directional drilling occurs when a contractor intentionally drills a well that is out of plumb. Surface conditions may dictate that a drilling rig cannot be erected over the formation to be explored or, as in offshore operations, the rig may be costly enough that multiple formations should be explored from a central drilling position. Directional drilling is achieved by a number of different methods. Directional tools include downhole hydraulic turbine motors, jet deflector bits, bent subs, flexible joints, or, most common in past years, whipstocks.

Redrilling - The redrilling of a well takes place when well depth must be extended. (The existing formation may not be productive and the well may be extended to tap a lower formation.) In some instances, the prior drilling operation may have stopped for reasons associated with annulus collapse, damaged casing, lost drilling string, or blowout.

Control of Hazardous Energy (Lockout/Tagout)

Workers servicing or maintaining machines or equipment may be seriously injured or killed if hazardous energy is not properly controlled. Injuries resulting from the failure to control hazardous energy during maintenance activities can be serious or fatal!

Failure to control hazardous energy may result in electrocution, burns, crushing, cutting, lacerating, amputating, or fracturing body parts, and others. For example, an effective Lockout/Tagout Program would have prevented the following accidents:

- A steam valve is automatically turned on, burning workers who are repairing a downstream connection in the piping.
- A jammed conveyor system suddenly releases, crushing a worker who is trying to clear the jam.
- Internal wiring on a piece of factory equipment electrically shorts, shocking an employee who is repairing the equipment.

Module 5 Quiz

Use this quiz to self-check your understanding of the module content. You can also go online and take this quiz within the module. The online quiz provides the correct answer once submitted.

1. **OSHA defines a confined space as a space that includes all the following criteria, <u>except</u> _____.**

   a. contains any material matter
   b. has limited or restricted means of entry or exit
   c. is not designed for continuous employee occupancy
   d. large enough for bodily entry and work

2. **Generally, a _____ is a storage tank or vessel that has been designed to operate at pressures above 15 p.s.i.g.**

   a. stationary container
   b. pressurized vessel
   c. confined space
   d. IDLH space

3. **An effective Lockout/Tagout Program on a rig could have prevented all the following accidents, <u>except</u> _____.**

   a. a worker strains his back lifting a piece of equipment
   b. a steam valve turns on burning a worker
   c. a jammed conveyor belt releases crushes a worker
   d. a wire shorts out shocking a maintenance worker

4. **Usually, failure to control hazardous energy may result in all the following injuries, <u>except</u> _____.**

   a. lacerations
   b. amputation
   c. electrocution
   d. strains and sprains

5. **OSHA defines a permit-required confined space as a space that includes any of the following characteristics, except _____.**

    a. limited lighting for employees engaged in work
    b. contains actual/potential hazardous atmosphere
    c. contains material that can engulf the entrant
    d. inwardly converging wall or floors that slope downward

Module 6: Other Hazards on the Drilling Site (Continued)

Hot Work/Welding

Hot work is any work that involves burning, welding, using fire- or spark-producing tools, or that produces a source of ignition. Welding and cutting operations are common to drilling and servicing operations. Test for flammable gases in the work area before starting any hot work. Potentially hazardous areas include, but are not limited to, well heads, fuel tanks, mud tanks, tank batteries, gas separators, oil treaters, or confined spaces where gases can accumulate.

Slips, Trips and Falls

Slips, trips, and falls constitute the majority of general industry accidents. They cause 15% of all accidental deaths, and are second only to motor vehicles as a cause of fatalities.

The areas where most exposure exists for slips, trips and falls is the rig floor because that's where most of the work is accomplish and where most of the equipment is housed.

There are many ways to protect from slips, trips, and falls. Even so, they still happen and the following are means to either prevent slips, trips, and falls or to minimize the consequences if they should happen.

- 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 drilling floor, servicing rig floors or other platforms.
- Keep all work areas clean and clear of oil, tools, and debris.
- Use non-skid surfaces where appropriate.
- Provide guardrails and guards around work areas that are prone to slips, trips, and falls.
- Install, inspect, and secure stairs and handrails. [29 CFR 1926.1052]
- 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. [29 CFR 1910.22]
- Keep all cords and hoses orderly and clear of walking spaces.
- Cover open cellars.
- Conduct a pre-job inspection to identify, then eliminate or correct hazardous work surfaces.
- Use waterproof footgear to decrease slip/fall hazards.

Fall Protection

Falls are among the most common causes of serious work-related injuries and deaths. Employers must set up the work place to prevent employees from falling off overhead platforms, elevated work stations or into holes in the floor and walls.

Falls from elevated areas account for a relatively low percentage of the accidents that occur in drilling operations; however, those accidents that do occur usually are severe or fatal.

Most of the falls occur while erecting the derrick, climbing the derrick ladders, or working from one of the platforms. Adequate worker protection can be provided during most, if not all, of these situations by the use of safety belts, lifelines and lanyards, safety nets, and climbing devices.

Strains and Sprains

Any work on a drilling rig that is performed with high force, with many repetitions, or in a position that feels awkward is risky. Even a motion that is harmless in and of itself, like stretching out the arm to grasp an object or squeezing a tool, may put the worker at risk of injury if it is repeated over and over.

Sprains and strains are two types of musculoskeletal disorders (MSDs).

- A sprain is a stretch or tear of a ligament (a band of fibrous tissue that connects two or more bones at a joint).

- A strain is an injury to a muscle or tendon (a fibrous cord of tissue that connects a muscle to a bone).

Ergonomic controls can help eliminate or limit exposure to MSDs on a drilling rig. Types of controls usually fall into these ergonomic categories:

- **Prolonged standing:** Static postures may occur as workers continuously stand in one position causing muscle fatigue and pooling of blood in the lower extremities. Rig workers generally do not suffer from static posture injuries due to the nature of their work.

- **Forceful exertions:** Movement such as lifting, lowering, pushing or pulling heavy equipment or supplies, can cause back, neck and shoulder injury resulting in muscle strain, tendinitis or rotator cuff injuries, etc.

- **Awkward postures:** The probability of injury increases when any forceful exertion or repetitive motion is accomplished while the worker assumes an awkward posture such as twisting.

- **Repetitive motions:** Performing hand-intensive tasks with a bent wrist creates considerable stress on the tendons of the wrist and can lead to irritation and swelling. MSDs such as Carpal Tunnel Syndrome, Tendinitis, and Tenosynovitis may result.

General solutions for strains and sprains include:

- Use proper lifting technique.

- Hoist slowly to limit pipe momentum.

- Seek assistance when moving awkward and heavy guards and covers.

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

- Use lifting equipment and limit manual positioning of elevators.

- Practice proper hand placement and use of pullback (tail) ropes.

- Use mechanical lifting aids, proper lifting techniques, and team lifting where appropriate.
- Use proper hand and body positioning.
- Ergonomics: OSHA Safety and Health Topics Page
    - Hand Injury
    - Lifting
    - Repetitive motions

Motor Vehicle Safety

Truck drivers and workers in pickup trucks often travel between oil and gas wells located on rural highways which often lack firm road shoulders, rumble strips, and, occasionally, pavement.

Oil and gas workers often are on 8- or 12-hour shifts, working 7--14 days in a row. Fatigue has been identified as an important risk factor in motor-vehicle crashes. A targeted program that addresses fatigue among workers in this 24-hour industry might reduce motor-vehicle crashes and fatalities.

To reduce the number of vehicle accidents to oil and gas industry drivers, do the following:

- Require employees to wear seat belts when they are traveling in company vehicles.
- Develop and implement a company vehicle safety program for all employees, including supervisors, crew members, sales personnel, etc.
- Instruct employees to comply with all highway safety regulations and to reduce driving speed during inclement weather and when road conditions have deteriorated.
- Stress to employees that operating vehicles while fatigued is dangerous to themselves, their passengers, and others that may encounter their vehicle. Make sure that employees understand that management does not want them driving if they are too fatigued to drive safely.
- Ensure vehicles are properly maintained, such as making sure the brakes are in good working order and the tire pressure is at an appropriate level.

Powered Industrial Trucks

Powered industrial trucks, commonly called forklifts or lift trucks, are used in many industries, primarily to move materials. They can also be used to raise, lower, or remove large objects or a number of smaller objects on pallets or in boxes, crates, or other containers. Powered industrial trucks can either be ridden by the operator or controlled by a walking operator. Over-the-road haulage trucks and earth-moving equipment that has been modified to accept forks are not considered powered industrial trucks.

What are the hazards associated with operating powered industrial trucks?

There are many types of powered industrial trucks. Each type presents different operating hazards. For example, a sit-down, counterbalanced high-lift rider truck is more likely than a motorized hand truck to be involved in a falling load accident because the sit-down rider truck can lift a load much higher than a hand truck. Workplace type and conditions are also factors in hazards commonly associated with powered industrial trucks. For example, retail establishments often face greater challenges than other worksites in maintaining pedestrian safety. Many workers can also be injured when:

1. lift trucks are inadvertently driven off loading docks;
2. lifts fall between docks and an unsecured trailer;
3. they are struck by a lift truck; or
4. they fall while on elevated pallets and tines.

Adverse Weather Conditions

Weather conditions can create hazardous working conditions. Therefore, it is necessary to monitor weather conditions and forecasts to allow time to prepare for such conditions as may occur.

Lightning is especially hazardous and unpredictable. When lightning is present, crews must avoid situations where they could become part of potential current paths.

Module 6 Quiz

Use this quiz to self-check your understanding of the module content. You can also go online and take this quiz within the module. The online quiz provides the correct answer once submitted.

1. **Any work that involves burning, welding, using fire- or spark-producing tools, or that produces a source of ignition is called _____.**

    a. burnishing
    b. fire watch
    c. hot work
    d. flame work

2. **Which of the following cause 15% of all accidental deaths, and are second only to motor vehicles as a cause of fatalities?**

    a. Electrocutions
    b. Slips, trips and falls
    c. Crush accidents
    d. Burn injuries

3. **Each of the following would help prevent slips, trips and falls on a drilling rig, except _____.**

    a. put warning signs up at regular intervals
    b. proper use and installation of ladders
    c. keep cords and hoses out of walkways
    d. cover open floor holes

4. **Any work on a drilling rig that is performed with high force, with many repetitions, or in a position that feels awkward can lead to _____.**

    a. reprimand by management
    b. shorter workdays
    c. slips, trips and falls
    d. musculoskeletal disorders (MSDs)

5. **Powered industrial truck operators can be injured when any of the following occur, <u>except</u> _____.**

    a. lift truck fails to properly start
    b. lift truck driven off the loading dock
    c. lifts fall between dock and unsecured trailer
    d. workers are struck by the lift truck

Module 7: Health Hazards in Drilling Operations

Introduction

Oil and gas well drilling and servicing activities involve the use and production of potentially hazardous materials. OSHA, the National Institute for Occupational Safety and Health (NIOSH), and industry and safety groups continue to evaluate the type and extent of chemical and other health hazards across the industry.

Health hazards on a drilling site include all the following:

- silica
- hydrogen sulfide
- noise
- diesel particulate matter
- hazardous chemicals
- naturally occurring radioactive material (NORM)
- temperature extremes
- fatigue

Exposure to Silica

Silica is a mineral that is found in stone, soil and sand. The amount of silica in soil and rock may vary widely depending on the local geology. Breathing in silica dust can cause silicosis, a serious lung disease. Using rock-drilling rigs mounted on trucks, crawlers, or other vehicles to drill into rock, soil, or concrete may expose workers to hazardous levels of airborne silica. The small particles easily become suspended in the air and, when inhaled, penetrate deep into workers' lungs.

Control Methods for Silica Dust

There are three main methods used to control silica dust during earth and rock drilling. OSHA recommends that drill operators always use a combination of these dust-control techniques.

The three methods are:

Dust Collection Systems: Best practices when using dust-collecting equipment for rock drills include using a movable duct attached to a shroud, a flexible rubber skirt that encloses the drill hole opening and captures cuttings that come through the hole. Equipment without these controls can be retrofitted by the manufacturer or a mechanical shop.

Dusty air is pulled from inside the deck shroud through a flexible duct to primary and secondary filter media. The primary filter or dust separator often includes a self-cleaning back-pulse feature that dumps the collected particles to the ground. Secondary release of particles to the air is minimized by a dump shroud.

Wet Methods: The proper use of wet methods requires a trained and skilled operator. In wet drilling, too much water can create mud slurry at the bottom of the hole that can trap the bit, coupling and steel extensions. Too little water will not effectively control escaping dust.

Operator Isolation: Drill operators using rigs with enclosed cabs can reduce their silica exposure by staying inside the cab as much as possible during drilling. To be effective, the cab must be well-sealed and well-ventilated. Ensure that door jambs, window grooves, powerline entries and other joints are tightly sealed.

Where control methods do not reduce silica exposures to OSHA's permissible exposure limit, respirators are required, and employers must have a written respiratory protection program in accord with OSHA's Respiratory Protection standard.

Exposure to Asbestos and Refractory Ceramic fibers (RCFs)

Asbestos is the name given to a group of naturally occurring minerals that are resistant to heat and corrosion. Asbestos has been used in products, such as insulation for pipes (steam lines for example), floor tiles, building materials, and in vehicle brakes and clutches. Oil field workers are among those at elevated risk for asbestos-related diseases such as asbestosis and mesothelioma.

Asbestos is added to drilling mud, which was used in the oil industry, for decades. Since the 1960s, such asbestos drilling has occurred both onshore and offshore. Drilling mud composition contains asbestos, which has caused mud engineers to be exposed to asbestos in drilling mud.

Asbestos fibers associated with these health risks are too small to be seen with the naked eye. Breathing asbestos fibers can cause a buildup of scar-like tissue in the lungs called asbestosis and result in loss of lung function that often progresses to disability and death.

There is no "safe" level of asbestos exposure for any type of asbestos fiber. However, OSHA limits exposure to asbestos to an 8-hour time-weighted-average (TWA) of .1 fiber per cubic centimeter (.1 f/cc). Asbestos exposures as short in duration as a few days have caused mesothelioma in humans.

Where there is exposure, employers are required to further protect workers by:

- establishing regulated areas,
- instituting engineering controls to reduce the airborne levels,
- reducing exposure by using administrative controls and PPE, and
- conducting medical monitoring where legal limits and exposure times are exceeded.

Refractory Ceramic fibers (RCFs)

Refractory Ceramic fibers are similar to asbestos fibers in size, shape, and long-term (months to years) exposure effects on humans. RCFs are amorphous synthetic fibers produced by the melting and blowing or spinning of calcined kaolin clay or a combination of alumina, silica, and other oxides. Oil and gas workers may be exposed to RCFs while installation and removal of RCF-containing insulation such as inside high-temperature furnaces.

RCFs, like asbestos, get into the body primarily by inhalation. The International Agency for Research on Cancer (IARC) and the American Conference of Governmental Industrial Hygienists (ACGIH) have classified RCFs as possibly carcinogenic to humans. OSHA has set an exposure limits for RCFs is.

To limit exposure proper ventilation and personal protective equipment should be used to limit the 8-Hour TWA to .2 fibers per cubic centimeter (.2 f/cc). Workers who may be exposed to RCFs should also be provided with information on the health effects and safe work practices related to RCFs. For more information, see the NIOSH Publication 2006-123, Occupational Exposure to Refractory Ceramic Fibers.

Exposure to Hydrogen Sulfide Gas

Hydrogen Sulfide, or sour gas (H_2S), is a highly toxic, colorless gas. It is a very insidious industrial hazard for two reasons: unreliability of odor as a warning, and sudden onset of incapacitation. Hydrogen sulfide has been identified by NIOSH as a leading cause of sudden workplace death. At concentrations up to 30 parts per million (ppm), it has an odor of rotten eggs. However, at more deadly concentrations (100 ppm), hydrogen sulfide rapidly fatigues the olfactory nerves.

A person may momentarily smell the gas but think little of it when the odor is no longer detectable. If exposure is sufficiently, intense, unconsciousness and respiratory failure may occur without warning symptoms. The gas is 1.2 times denser than air, and at high concentrations will tend to accumulate in low spots. Mixed with air in concentrations of 4.3-45.5%, hydrogen sulfide is explosive. It may also burn with the production of toxic sulfur dioxide.

Exposure on the Drilling Site

During oil and gas well drilling operations, H_2S is first released to the atmosphere at the shale shaker area and later at the circulation fluid treatment areas. It may also be released during tripping procedures in the immediate area around the drilling operation. Typically, however, only nominal amounts of H_2S are released during normal drilling operations.

With the exception of exploratory or "wildcat" wells, drilling operations take place in oil fields where the hydrogen sulfide locations and formation pressures likely to be encountered are known. With the demand for hydrocarbons increasing, formations historically deemed too dangerous to produce are now being developed. In some instances, there is frequent to nearly continuous employee exposure to hydrogen sulfide at concentrations from 10 ppm (OSHA 8-hour permissible exposure limit (PEL)) to life-threatening levels requiring the wearing of self-contained breathing apparatus. Innovative technologies, alarm systems, and respiratory protective equipment and programs are being employed without uniform Federal regulation.

Effects of H_2S

The effect of hydrogen sulfide on metals, known variously as metal fatigue, hydrogen embrittlement, and sulfide stress cracking, can cause failure of the drill string during a well control situation. Such failure can result in the release of hazardous concentrations of H_2S in the drilling area. Careful selection of resistant metals and chemical treatment of drilling fluids can effectively guard against such failure.

Iron sulfide is a byproduct of many production operations and may spontaneously combust with air. Flaring operations associated with H2S production will generate Sulfur Dioxide ($S0_2$), another toxic gas.

Active monitoring for hydrogen sulfide gas and good planning and training programs for workers are the best ways to prevent injury and death.

H_2S Special Precautions

All well drilling sites should be classified into areas of potential and/or actual exposure to hydrogen sulfide by the definitions outlined below. The safety recommendations made are a minimum. The American Petroleum Institute (API) has published "RP 49: *Recommended Practice for Safe Drilling of Wells Containing Hydrogen Sulfide*" which details recommendations in more depth and should be followed in all medium and high exposure areas. Below are OSHA and API definitions for each hazard area:

No Hazard Area – Any well that will not penetrate a known hydrogen sulfide formation. No special hydrogen sulfide equipment is needed (OSHA) (API).

API Condition I - Low Hazard Area – Work locations where atmospheric concentrations of H_2S are less than 10ppm (OSHA). This includes any well that will penetrate a formation containing hydrogen sulfide that could result in atmospheric concentration of 10 ppm or less and/or in which the hydrogen sulfide zone has been effectively sealed off by casing/cementing and/or cementing method (API). For low-hazard areas, a 30-minute, self-contained breathing apparatus for emergency escape from the contaminated area only is recommended.

API Condition II - Medium Hazard Area - Work locations where atmospheric concentrations of H_2S are greater than 10ppm and less than 30ppm (OSHA). Any well that will penetrate a formation containing hydrogen sulfide and is not defined as a low or no hazard area, including all exploratory (wildcat) well sites (API).

The following are recommended for medium hazard areas:

- NIOSH/MSHA approved manifold air masks with emergency escape cylinders for each employee
- two NIOSH/MSHA approved, 30-minute, self-contained breathing apparatus for emergency escape from the contaminated area only
- two wind socks and streamers
- oxygen resuscitator
- a properly calibrated, metered hydrogen sulfide detection instrument
- audible and visual alarm system

API Condition III - High Hazard Area - Work locations where atmospheric concentrations of H_2S are greater than 30ppm (OSHA). Any operation expected to bring free hydrogen sulfide gas to the surface. The following are recommended for work in high hazard areas:

- Two NIOSH/MSHA approved, 30-minute, self-contained breathing apparatus for emergency escape from the contaminated area only.
- The use of three wind socks and streamers.
- The use of an oxygen resuscitator.
- Two hydrogen sulfide detectors. One should be a properly calibrated, metered detection instrument, and the other should be a pump type with detector tubes.
- The use of a separate audible and visual warning system.
- Employees should not be permitted on location without hydrogen sulfide safety training. Employees may be permitted on location for specific hydrogen sulfide training purposes not to include general rig training.
- Two means of egress at each location in a high hazard area should be provided.
- A means of communication or instruction for emergency procedures should be established and maintained on location along with the names and telephone numbers of the person or persons to be informed in case of emergencies.
- Signs should be posted 500 feet from the location on each road leading to the location warning of the hydrogen sulfide hazard.
- All hydrogen sulfide safety equipment should be checked to ensure readiness before each tour change.

The recommendations and employee instruction will vary depending on the type of area.

Employee Hydrogen Sulfide Instruction

Employees present at all medium and high hazard wells should be instructed in the use of the safety equipment provided onsite. Hydrogen sulfide instruction should be given by a qualified person(s). The instruction of personnel should include, as a minimum, the following elements:

- the characteristics of hydrogen sulfide and its hazards
- proper first-aid procedures to be used in a hydrogen sulfide
- knockdown
- use of personal protective equipment
- use and operation of all hydrogen sulfide monitoring systems
- corrective action and shutdown procedures

Other Health Hazards on the Drilling Site

Other suspected health hazards, that have not yet been quantified, may include exposure to:

- **Noise:** Oil and gas workers can be exposed to harmful noise levels during equipment operation. Loud noise can also create physical and psychological stress, reduce productivity, interfere with communication and concentration, and contribute to workplace accidents and injuries by making it difficult to hear warning signals.
- **Diesel Particulate Matter:** Diesel engines power a variety of machinery, vehicles, and equipment on a drilling site. Workers might be exposed to harmful levels of diesel particulate matter during the operation of these engines.
- **Hazardous Chemicals:** Workers, who use hazardous chemicals during work processes, especially during hydraulic fracturing, might be exposed to hazardous byproducts of oil and gas drilling. The degree of potential hazard depends on individual chemical properties and toxicity, but possible hazards include chemical burns from caustic substances and inhalation of toxic vapors. All employers with hazardous chemicals in their workplaces must have labels and safety data sheets for their exposed workers, and train them to handle the chemicals appropriately. Establishing effective engineering controls and work practices can reduce potential worker overexposures.
- **Naturally Occurring Radioactive Material (NORM):** NORM might be released from oil and gas formations. Workers at risk of exposure include those who handle pipes and equipment that might have been contaminated with NORM. Sludge, drilling mud, and pipe scales, for example, often contain elevated levels of NORM, and the radioactive

materials might be moved from site to site as equipment and materials are reused. Disposal, reuse, and recycling of NORM might cause worker exposures.

- **Temperature Extremes:** Well-site workers are exposed to extreme temperatures and should take precautions to stay safe. Any worker exposed to hot and humid conditions is at risk of heat illness, especially those doing heavy work tasks or using bulky protective clothing and equipment. Anyone working in a cold environment may be at risk of cold stress. Oil and gas workers may be required to work outdoors in cold environments and for extended periods.

- **Fatigue:** Workers might experience fatigue due to long shifts and when working multiple days in a row. Fatigue is a message to the body to rest. It is not a problem if the person can and does rest. However, if rest is not possible, fatigue can increase until it becomes distressing and eventually debilitating. The symptoms of fatigue, both mental and physical, vary and depend on the person and his or her degree of overexertion.

Module 7 Quiz

Use this quiz to self-check your understanding of the module content. You can also go online and take this quiz within the module. The online quiz provides the correct answer once submitted.

1. **Health hazards on a drilling site include all the following, except _____.**

   a. temperature extremes
   b. silica
   c. defective tools
   d. fatigue

2. **Using rock-drilling rigs mounted on trucks, crawlers, or other vehicles to drill into rock, soil, or concrete may expose workers to hazardous levels of _____.**

   a. hydrogen sulfide
   b. airborne silica
   c. diesel particulate matter
   d. dust

3. **Why has hydrogen sulfide been called an insidious industrial hazard?**

   a. Sudden onset of incapacitation
   b. Employees like the odor
   c. Most monitoring equipment is insufficient
   d. If you can smell it, you're dead

4. **A well that will not penetrate a known hydrogen sulfide formation is designated by OSHA _____.**

   a. as a No Hazard Area
   b. as an API Condition I – Low Hazard Area
   c. as an API Condition II – Medium Hazard Area
   d. as an API Condition III – High Hazard Area

5. **Work locations where concentrations of hydrogen sulfide are greater than 10 ppm and less than 30 ppm are designated by OSHA _____.**

   a. as a No Hazard Area
   b. as an API Condition I – Low Hazard Area
   c. as an API Condition II – Medium Hazard Area
   d. as an API Condition III – High Hazard Area

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://www.api.org/

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

