Student Handbook

RIGMAN TRAINING FOR DRILLING AND WORKOVER OPERATIONS

SAUDI ARABIAN DRILLING ACADEMY (SADA)
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Preface

The Rigman Training for Drilling & Workover Operations textbook has been published in 2019 to serve as a reference book for Saudi Arabian Drilling Academy (SADA) students.

This textbook has been designed for entry level Rig operators working on Oil & Gas Rigs. The textbook covers a wide range of topics and tasks related to Rig Operations both onshore and offshore. Furthermore, the textbook includes various practical tasks and assignments for the Rigman to complete in order to capture the full experience of the Rig daily operations and activities specifically those related to the Rigman and Roustabout position. The textbook is edited and intended to raise the knowledge of its readers on the subjects covered to the level of 'intermediate.' Therefore, this book can be considered as a great reference for higher level of technical education on the Rigman Training For Drilling & Workover Operations. The manual is well structured to represent varoius operations normally being practiced on a real life rig drilling operation.

It is worth mentioning that it would not have been possible to come up with this reference book without the generous support received from Neft Energies, Saudi Aramco and (SADA) stake holders.

SADA appreciates all stakeholders for their contribution to the program development.

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1. BASIC SAFETY

1.1 OBJECTIVES

- To instill a safety culture in delegates.
- To make a clear understanding of key safety components pertinent to drilling.

1.2 OUTCOMES

Upon completing this section, they should be able to:

- Safely perform job-related routine or specific tasks.
- Safely use rig tools and equipment.
- Demonstrate a clear understanding of required permits to perform special operations.

1.3 INTRODUCTION

Safety is part of everyday living. It is an important consideration for everyone in everything he/she does at home, at work or play, on streets and highways – wherever he/she goes. Safe operating practices and procedures are vital in the drilling business because the work is hazardous, involving massive machinery, heavy tools and great physical strength. When accidents do occur, the work can be a serious peril to life and limb. Drilling personnel must know how to work safely on a rig in order to protect themselves, costly rig equipment, and the expensive hole being drilled. Everyone loses from an accident. Injuries result in pain and suffering and may leave a person disabled or handicapped for life. Even minor injuries may cause loss of time from work and lost pay. Insurance benefits are helpful, but compensation payments cannot restore a life, hand, eye or leg. Damaged machinery and equipment can usually be repaired but almost always at considerable cost, particularly if down time is taken into account. An expensive well may be lost because of the oversight of the incompetence of one person. Blowouts and fires cause losses of life and equipment and waste precious oil and gas from underground reservoirs. More than 90 % of all accidents are avoidable, being caused by human error rather than by mechanical failure. It is extremely important that every person on a drilling rig develop a sense of safety in drilling operations. That person must use this sense in combination with the kind of good judgment it takes to drive a car safely, or to do anything else in a safe manner.

1.3.1 Safety Induction

A safety induction is conducted to welcome new employees to the Rig and prepare them for their new role. It ensures workers are fully informed about the organization and are aware of their work and responsibilities. It serves as a starting point for an organization to introduce a culture of safety in the workplace.

Purpose of a Safety Induction

Employees without proper safety inductions have a higher habit to ignore health and safety regulations. Moreover, these workers are also disposed to injuries and fatalities because of misinformation or inadequate knowledge to properly deal with hazard in the workplace.

Common Safety Induction Topics

The following is a list of common topics to cover in any workplace health and safety inductions:

- Hazards and risks in your workplace.
- Special equipment, such as personal protective equipment (PPE), which may require additional training.
- Safe work practices.
- Work health and safety legislation.
- Emergency procedures.
- First aid and other emergency contacts.

A mobile checklist can help remind you of the steps required to follow and ensure consistency across your organization.

Example

Safety Induction for Students

Name		**Site**	
Date of Induction			
Person Conducting Induction			

	Please tick	**Yes**	**No**	**Comments**
1.	Introduction			
2.	Organisational overview and site tour			
3.	Outline of site rules (provide copy)			
4.	Mobile phone Use			
5.	ERP Alarms			
6.	Dress Code – PPE			
7.	Driving – Parking – Stickers			
8.	Work Ethics			
9.	Security including I.T.			
10.	Smoking			
11.	Restricted Areas			
12				
13				

Signature of HSE Advisor **Dated**

1.3.2 Job Safety Analysis (JSA)

Definition

A job safety analysis (JSA) is a procedure which helps integrate accepted safety and health principles and practices into a task or job operation. In a JSA, each basic step of the job is to identify potential hazards and to recommend the safest way to do the job.

The Basic Steps for JSA

Four basic stages in conducting a JSA are:

- Selecting the job to be analyzed.
- Breaking the job down into a sequence of steps.
- Identifying potential hazard.
- Determining preventive measures to overcome these hazards.

Important Factors When Selecting the Job

Ideally, all jobs should be subjected to a JSA. In some cases, there are practical constraints posed by the amount of time and effort required to do a JSA. Another consideration is that each JSA will require revision whenever equipment, raw materials, processes, or the environment change. For these reasons, it is usually necessary to identify which jobs are to be analyzed. Even if analysis of all jobs is planned, this step ensures that the most critical jobs are examined first.

Factors to be considered in setting a priority for analysis of jobs include:

- Accident frequency and severity: jobs where accidents occur frequently or where they occur infrequently but result in serious injuries.
- Potential for severe injuries or illnesses: the consequences of an accident, hazardous condition, or exposure to harmful products are potentially severe.
- Newly established jobs: due to lack of experience in these jobs, hazards may not be evident or anticipated.
- Modified jobs: new hazards may be associated with changes in job procedures.
- Infrequently performed jobs: workers may be at greater risk when undertaking non-routine jobs, and a JSA provides a means of reviewing hazards.

Breaking the Job into "Basic Steps"

After a job has been chosen for analysis, the next stage is to break the job into steps. A job step is defined as a segment of the operation necessary to advance the work.

Care must be taken not to make the steps too general. Missing specific steps and their associated hazards will not help. On the other hand, if they are too detailed, there will be too many steps. A rule of thumb is that most jobs can be described in less than ten steps. If more steps are required, you might want to divide the job into two segments, each with its separate JSA, or combine steps where appropriate.

An important point to remember is to keep the steps in their correct sequence. Any step which is out of order may miss serious potential hazards or introduce hazards which do not actually exist.

Each step is recorded in sequence. Make notes about what is done rather than how it is done. Each item is started with an action verb. Appendix A (below) illustrates a format which can be

used as a worksheet in preparing a JSA. Job steps are recorded in the top of each column, as shown here:

- Sequence of Events
- Potential Accidents or Hazards
- Preventive Measures

This part of the analysis is usually prepared by knowing or watching a worker do the job. The observer is normally the immediate supervisor. However, a more thorough analysis often happens by having another person, preferably a member of the health and safety committee, participate in the observation. Key points are less likely to be missed in this way.

The job observer should have experienced and be capable in all parts of the job. To strengthen full co-operation and participation, the reason for the exercise must be clearly explained. The JSA is neither a time and motion study in disguise, nor an attempt to uncover individual unsafe acts. The job, not the individual, is being studied to make it safer by identifying hazards and making modifications to eliminate or reduce them. The worker's experience contributes in making job and safety improvements.

The job should be observed during normal times and situations. For example, if a job is routinely done only at night, the JSA review should also be done at night. Similarly, only regular tools and equipment should be used. The only difference from normal operations is the fact that the worker is being observed.

When completed, the breakdown of steps should be discussed by all the participants (always including the worker) to make that all basic steps have been noted and are in the correct order.

Job Safety Analysis
Metal Shop

Division: Midwest
Location: Omaha, NE

#	Task	Hazard	Control
1	Step to right of machine and reach into metal box and grasp 15-pound casting	Strain/Overexertion - M **Notes:** Reaching, twisting, and lifting 15-pound castings	Place castings as close to machine as possible Place castings at waist height (use adjustable platform or pallet)
		Fall (Same Level) - L	Practice good housekeeping (keep floor clear of debris and obstructions)
2	Carry metal casting to grinding machine	Fall (Same Level) - L	Practice good housekeeping (keep floor clear of debris and obstructions)
3	Grind 20 to 30 castings per hour.	Airborne Particles (Debris/Dust/Smoke) - M **Notes:** Metal shavings, sparks.	Hazard Isolation (guard, shield, lockout, weld curtains, etc.) **Notes:** Use shield to reduce flying particles hazards
			Hazard Minimization (reduce or lessen intensity of hazard) **Notes:** Use local exhaust ventilation
			PPE: Eye/Face Protection (Safety glasses, face shield, goggles, etc.) **Notes:** Wear ANSI approved safety glasses and face shield
		Repetitive/Musculoskeletal - L	Buddy System **Notes:** Switch off with co-workers every hour as needed
			Take frequent rest breaks

Identifying Potential Hazard

Once the basic steps have been recorded, potential hazard must be identified at each step. Based on observations of the job, knowledge of accident and injury causes, and personal experience, list the things that could go wrong at each step.

A second observation of the job being performed may be needed. Since the basic steps have already been recorded, more attention can now be focused on each potential hazard. At this stage, no attempt is made to solve any problems which may have been detected.

To help identify potential hazards, the job analyst may use questions such as these (this is not a complete list):

- Can any body part get caught in or between objects?
- Do tools, machines, or equipment present any hazards?
- Can the worker make harmful contact with moving objects?
- Can the worker slip, trip, or fall?
- Can the worker suffer strain from lifting, pushing, or pulling?
- Is the worker exposed to extreme heat or cold?
- Is excessive noise or vibration a problem?
- Is there a danger from falling objects?
- Is lighting a problem?
- Can weather conditions affect safety?
- Is harmful radiation a possibility?
- Can contact be made with hot, toxic, or caustic products?
- Are there dusts, fumes, mists, or vapors in the air?

1.3.3 Work Permit

A permit-to-work system is a formal written system used to Control certain types of work that are potentially hazardous. It is implemented to help prevent accident or injury to personnel, prevent damage to plant/machinery and to prevent damage to a product or to a client site.

Uses of Work Permit

A permit is needed when maintenance work can only be carried out if normal safeguards are dropped or when new hazards are introduced by the work. Examples are, entry into vessels, hot work and pipeline breaking.

a) *Typical Permit Jobs*

Typical areas/work activities that should be covered by a permit include:

- Hot work (offshore, or within 150 ft of well bore on a land rig.)
- Working at heights (scaffold towers, mobile elevated working platforms (MEWP's), etc.)
- Hoisting personnel with the Man Riding winch.
- Lift works.
- Scaffold erection.

- Working in a confined space.
- Work in isolated locations, or areas with difficult access.
- Working near, or involving, pressure systems (mud pump maintenance, pressure testing of equipment, etc.)
- Handling of radioactive material.
- Working near to, or involving, explosives or highly flammable/toxic/corrosive substances (diesel/asbestos/acid.)
- High voltage electrical work.
- Working on equipment which requires energy isolation
- Live circuit access.
- Working on steam lines.
- Sand blasting during any operation.
- Excavation work (on land.)
- Demolition works.

Figure 1 Work Permit Example

b) *Typical Non-Permit Jobs*

- Tripping pipe.
- Making connections.
- Crane & forklift use operated by competently trained personnel.
- Lowering mast.
- Loading boats or trucks.
- Inspecting equipment.
- Mixing mud chemicals.
- Cleaning non energized equipment.
- Housekeeping.

Key Points

- Any person in control of a premises could be required to enforce the use of a Permit to Work.
- Permits should only be issued by a competent person who understands the risks and the necessary control measures to put in place (Authorizing Person).
- A permit should be tasking specific and the necessary risk assessments and method statements still need to be done. A permit is not a replacement.
- Permits should only be in place for a limited duration and be clearly dated and with specific conditions attached.
- Permits should not be transferred to other people or companies.
- Any safety precautions required should be done prior to work commencing. The permit should state these requirements, for example, electrical isolation or discharge of pressuring systems.

- The authorizing person should only sign and date the permit when they are satisfied that all precautionary measures have been taken.
- If risks are too high, for example because of bad weather conditions or dangerous structure, then a permit should not be issued.
- When operating several permits at once, a Permit Register should be used to prevent conflicts in work activities. Each permit should have a unique reference number.
- All permits should be retained by the authorizing person.

Permitted Conditions

Listed below are some examples of control measures that should be considered when issuing a permit (not exhaustive):

- Workplace level from ground.
- Edge protection.
- Prevention of falls of materials or objects.
- Personal Protective Equipment.
- Atmospheric monitoring.
- Isolation.
- Emergency procedures.
- Adequate means of access.

Example (Hot Works)

- Good housekeeping.
- Use of protective curtains.
- All 'hot works' equipment should be regularly maintained and inspected.
- Ensure a competent person visits the area after the hot works has finished to ensure that no smoldering embers or hot surfaces remain.
- Provision of suitable fire extinguishers
- Ensure that sprinklers (if installed) are isolated and reactivated after the works.

Figure 2 Hot Work

Isolation

Once the permit comes into operation, where necessary, warning signs and often a lookout need to be posted around the area where work is being undertaken. When working on machinery and / or electrical systems, they should be physically isolated i.e. locked off (possibly with the contractor's own padlock) etc. When plant is isolated, it should be stated as being such on the permit.

Figure 3 Lockout Tagout Attachment

Cancellation of a Permit

When the operations laid out in the permit have been completed, it should be cancelled immediately and returned to the originator. They should ensure that the work detailed on the permit has been done satisfactorily. They should then sign off the permit to ensure that it is fully cancelled.

NOTE:

This may only be done when all personnel and equipment involved in the work detailed on the permit has been removed from the permit working area.

Returning to Service

The plant or work area, etc. may now be returned to service. The person responsible for the plant or work area must be satisfied that it is safe to do this - this person might require a final inspection before countersigning the final close of the permit.

Training

All staff should be made aware of the importance of the use and procedure of permit to work systems when they are in place or introduced into the workplace.

Overview

Permit to work forms should incorporate the following features:

- The permit must specify who is to do the work, the time for which it is valid, the work to be done and the necessary precautions.
- During the permit, no person shall work on any plant not covered by the permit.
- No person shall carry out work which is not authorized by the permit. If there is to be a change in the work, the permit must be amended/ cancelled. This can only be done by the authorized originator of the permit
- There must be liaison with other work areas whose activities could be affected by the permit system.

- Where the permit to work is to be carried out on part of a site or on specific plant, the limits of the work must be clearly marked.
- Permits must consider all contractors on site, who should be briefed prior to the commencement of work.

HSE-Form-002

Authorization Permit

Serial No.: safe work

Section 1 ☐Hot Work ☐Cold Work ☐Lockout-Tagout ☐Confined Space Entry ☐Over-ride Safety System ☐Release of Hazardious Liquids/GasesPermit

Division:_____ Rig No:_____Date:_____Start Time:_____Time Permit Expirees:_____

Work Location:

Specific Work to be done:

Crew Members Involved: (Print Names and Badge No.)

section 2 **Site Check: Issuer Signature**_____**Time:**_____**Receiver Signature**_____**Time:**_____

Safety Advisor Signature_____**Time:**_____

Section 3

Any special requirment and equipment place an "x" if require or leave blank if not required.

☐	Pre-Job safety Meeting Help (JSA Reviewed)	☐	Non-Essential Personnel Cleared From Area
☐	Lock-Out/Tag-Out requied:Breaker Switch No.	☐	Man Rider Rescue Plan in Place
☐	Power Off Verfied By:	☐	All tools Secured To Worker
☐	Ladders/Scaffolding Required	☐	Signals Disscussed (Verbal & Hand)
☐	Equipment Cleaned	☐	Fire Extinguisher, and all related fire protection equipment
☐	Combustible Material Removed	☐	Area Barriers / Signs Placed
☐	Face Shield /Goggles Required (circle one)	☐	Hearing Protection Required
☐	Grounding /Bonding Cables Required	☐	Non-Stand PPE Clothing (Type)
☐	Explosive Or Toxic Gas Monitoring	☐	Rubber Safety Boots Required
☐	Oxygen Deficiency Test Required	☐	Partical Dust Mask Reqired
☐	Standby Man Required	☐	Chemical Cartidge Respirator Required
☐	Safe Escape Routes From Work Area Identified	☐	Self Containd Breathing Apparatus Required " SCBA "
☐	Restricted Work Below Required	☐	Suplied Air Breathing Apparatus Required " SABA "
☐	Pa Announcement Prior to starting job	☐	Install, Inspect &Operate 3rd Party Contractor Equipment
☐	Fall Protection Equipment Required & Inspected	☐	SDS Reviewed With Appropriate Personnel

Comments and Additional Requirements: **Take Appropriate Actions Based On the Precautions Noted Above**

Section 4

Hot work and confined space entry permits are not valid untill a gas test has been completed by a certified gas tests.
Use the section below to record gas tests.

Start Time	Oxygen Level	LEL	H2S	CO2	Repeat Times	Oxgen Level	LEL	H2S	CO2
	%	%	PPM	PPM		%	%	PPM	PPM
	%	%	PPM	PPM		%	%	PPM	PPM
	%	%	PPM	PPM		%	%	PPM	PPM

Gas Test Performed By: (Print Name) _____

Section 5

SWAP Receiver and cert No: _____**Signature:** _____**Time:** _____**Date:** _____

SWAP Issuer and cert No: _____**Signature:** _____**Time:** _____**Date:** _____

Section 6

Permit Closeout: ☐ Job Completed ☐ Permit Canceled ☐ Permit Closed and Completed with New Permit

Copy Distribution:Pink-Work Site **White-SWAP Control Board** **Yellow-Issuer** **Green-safety Advisor Copy**

1.3.4 HSE – Alcohol / Drugs / Firearms

It is the policy of this company to prohibit the use, sale, transfer or possession of illegal drugs, drug related paraphernalia, regulated drugs not prescribed to the individual, alcoholic beverages, firearms, pyrotechnics, dangerous weapons and/or other contraband on company premises or work sites.

Testing - Pre-employment, random, post-accident, reasonable cause and operator requested. Employer will perform these tests to assist in maintaining a drug free workplace.

- All prescription medication must be reported upon arrival at the rig.
- Prescription must be in the original container and have only that prescribed medication inside.
- Must be within prescription's date.
- Must be accompanied by a note from the physician stating that these drugs can be taken while working around industrial equipment.

Figure 4 Helideck

Company reserves the right to search any and all belongings of the person departing from leaving from, present on company property or work locations.

1.3.5 HSE – First Aid

- First-aid kits and supplies are located around rigs.
- Trained personnel in basic first aid.
- All rigs maintain adequate first aid supplies.
- Supervisory personnel are adequately trained to respond to first aid situations.
- Safety reps on the rig.
- In the event of injury, get help & report incident to the Tool pusher.
- Report all injuries regardless of how insignificant you may think they are Respond only to the extent you are trained. Call for qualified assistance.

1.3.6 HSE – Blood borne Pathogens

Definition

Bloodborne Pathogens are pathogenic micro-organisms that are present in human blood and can cause disease in humans.

These pathogens include, but are not limited to, hepatitis B Virus (HBV) & Human Immunodeficiency Virus (HIV)

1.3.7 HSE – Fire Prevention

- Smoking and non-smoking areas should be designated to the drilling unit. Signs printed in English and the predominant local language should be present in these areas.
- Welding or burning is not permitted on the drilling location without prior hot work permits. Welding operations should be ceased in the event of hazardous conditions developing.
- During refueling operations or the transfer of fuel on the rig unit, all piping and connections should be checked to ensure against leakage that could lead to ignition.
- Fuel trucks are to be grounded while transferring fuel.
- Care should be taken not to overfill tanks during refueling as fuel can overflow through the vents, pouring all over the location.
- Do not overload electrical circuits.

Figure 5 Alarms and Lights for Gas and Fire

FIRE WATCH

Whenever any cutting or welding is to take place outside of the designated welding area, a "Hot Work Permit" is to be issued by the OIM/ Rig Manager. A crew member may be assigned to fire watch and will be available to assist the Welder when needed with the proper firefighting equipment.

The crew member must make sure the proper PPE is worn when working around the Welder. The Welder's equipment can cause severe damage to eyes if the proper glasses are not worn. As shown, the crew member is standing in a safe position while the Welder works.

Figure 6 Fire watchman with the proper firefighting equipment

As the Welder uses his cutter to cut some pipe, a Fire Watchman standby on fire watch, alert and ready to help.

Proper fire watch entails being trained to use a fire extinguisher, have the proper protection equipment in place, and knowing where the nearest fire call point is located.

The Fire Watchman helps the Welder set up and rig down equipment for the job. This may involve setting up safety barriers around the job so no one gets injured by the intense heat and bright flashes that the Welder's torch can generate. The Fire Watchman also must help make sure the area is ventilated properly as fumes and gases can accumulate in confined areas.

1.3.8 HSE – PPE

Everyone will in general be advised of the personal protective equipment required for a given task; however, if there is any question, the employee shall take the initiative to check with the Supervisor. Anyone not wearing the proper PPE is to be reported immediately. All equipment is to be inspected prior to use and any worn or defective part is to be reported to the Supervisor.

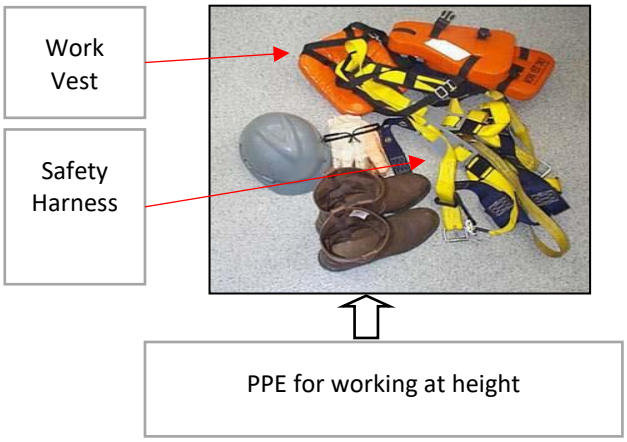


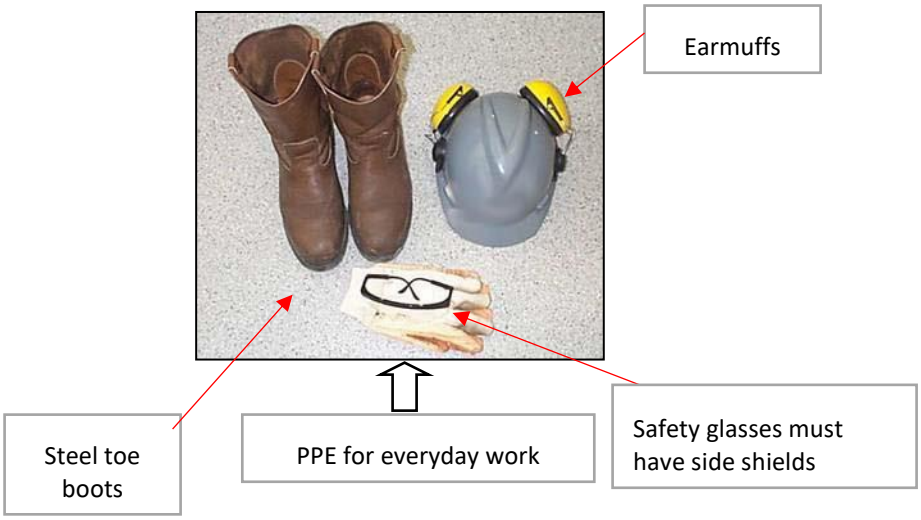
Figure 7 disposable ear plug dispenser

Ear protection must be worn when entering high noise areas such as the engine room.

Rubber gloves and face shields

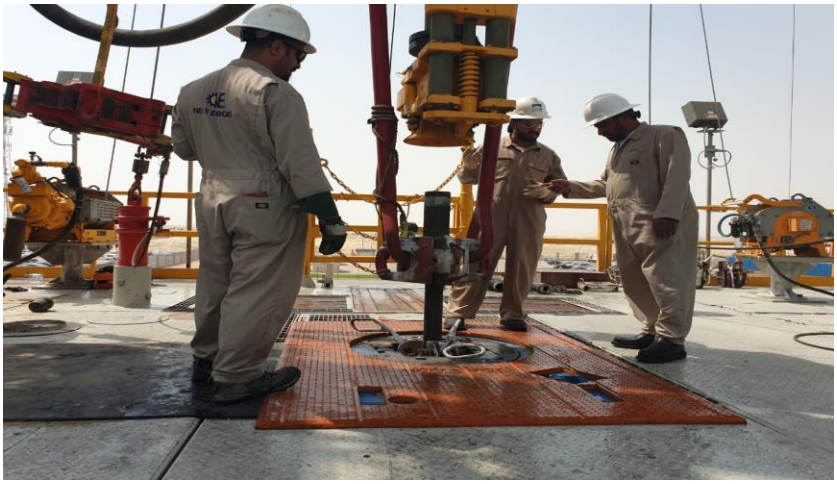
PPE for working with chemicals

Hard hats are to be worn by everyone working outside on the rig. Hard hats are to be worn correctly and not backward.



Head Protection

- Always Required to be worn by all personnel on duty.
- When working at heights ensure hat is secure.
- Metal hard hats are not allowed.
- Must be replaced every 2 years.



PROTECTS AGAINST:

- Falling objects such as tools
- Bumping head against objects, such as pipes or beams
- Contact with exposed electrical wiring or components

Safety glasses

- Made with metal/plastic safety frames.
- Most operations require side shields.
- Used for moderate impact from particles produced by jobs such as rig
- floor, chipping, grinding, handling chemicals.

WHEN TO USE:

- Dust and other flying particles, such as metal shavings or powder chemicals.
- Corrosive gases, vapors, and liquids.
- Molten metal that may splash.
- Potentially infectious materials such as blood or hazardous liquid chemicals that may splash.
- Intense light from welding and lasers.

PRESCRIPTION GLASSES

Ordinary glasses do not provide the required protection, proper choices include:

- Prescription glasses with side shields and protective lenses.
- Goggles that fit comfortably over corrective glasses without disturbing the glasses.
- Goggles that incorporate corrective lenses mounted behind protective lenses.

WELDING EYE PROTECTION

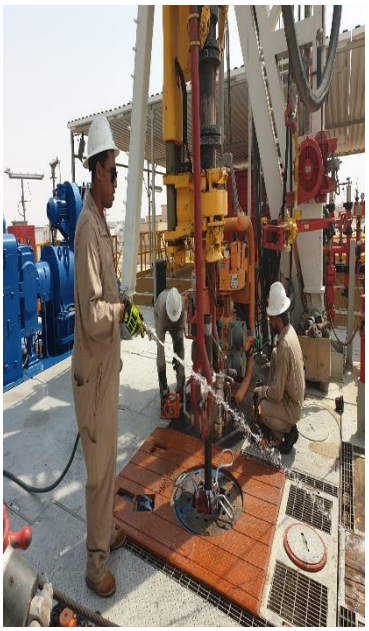
- Protects eyes against burns from radiant light.
- Protects face and eyes from flying sparks, metal spatter, & slag chips produced during welding, brazing, soldering, and cutting.

FACE SHIELDS

- Full face protection.
- Protects face from dusts and splashes or sprays of hazardous liquids.
- Does not protect from impact hazards.
- Wear safety glasses or goggles underneath.

Safety shoes

- Non slip soles & heels.
- Impact-resistant toes and heat-resistant soles protect against hot surfaces.
- Some have metal insoles to protect against puncture wounds.
- May be electrically conductive for use in explosive atmospheres, or nonconductive to protect from workplace electrical hazards.
- Must be worn by all personnel.
- Neoprene safety boots or over-boots shall be worn for chemical protection when handling caustics.

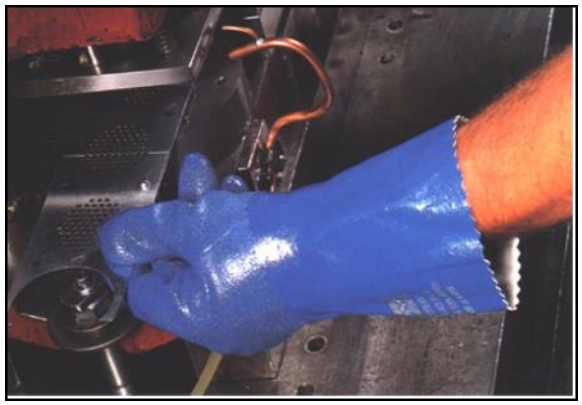


Gloves

Types of Gloves:

- Durable gloves made of metal mesh, leather, or canvas: Protects from cuts, burns, heat.
- Fabric and coated fabric gloves: Protects from dirt and abrasion.
- Chemical and liquid resistant gloves: Protects from burns, irritation, and dermatitis.
- Rubber gloves: Protects from cuts, lacerations, and abrasions.

Kevlar protects against cuts, slashes, and abrasion



Nitrile protects against solvents, harsh chemicals, fats and petroleum products and also provides excellent resistance to cuts and abrasions.

Stainless steel mesh protects against cuts and

lacerations, for use in Kitchens on our locations

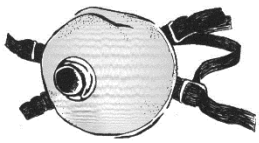
Hearing Protection

- When an employee's noise exposure exceeds an 8-hour time-weighted average (TWA) sound level of 90 Dba.
- High noise areas.
- When indicated by warning signs.

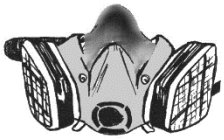
Figure 8 Wear (earmuffs, ear plugs, canal caps)

Self-Contained Breathing Apparatus (SCBA)

- Made readily available at the rig site.
- Must be properly maintained.
- Employees will not enter without proper breathing apparatus.
- A deficiency of oxygen.
- Contaminated atmosphere of toxic/flammable gases or vapors.
- Used when spray painting, cementing, mixing chemicals, etc.
- MSDS sheets will recommend type to use.
- Inspect and clean on a regular basis.
- Facial hair is removed to ensure proper fit.



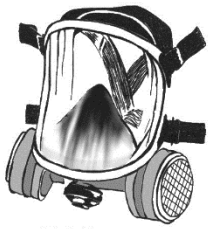
Half Mask,
Particulate



Half Mask,
Dual Cartridge
Disposable

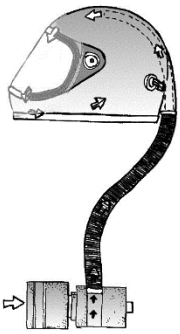
Half Mask,
Dual Cartridge
Reusable

Self Contained Breathing Apparatus (SCBA)

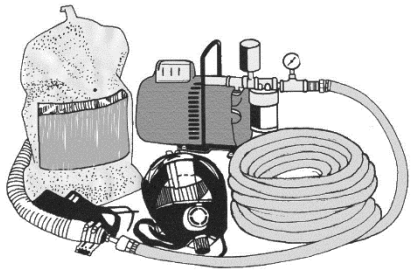


Full-Face
Dual Cartridge
Reusable

Canister Type
Gas Mask



Powered air Purifying
Respirator (PAPR)



Continuous Flow Supplied Air Respirator

1.3.9 HSE – Housekeeping

Good housekeeping habits result in good job and safety performance. All work areas are to be kept clean. All walkways, steps, are to be kept clear of tools or other equipment. Rig floors and decks are to be kept clear of trash, oil, and grease. All handrails are to be kept free of oil and grease. Tools not being used are to be stored. Combustibles such as oily rags are to be kept in containers for combustible materials. Flammables such as paint and paint thinners are to be stored in the Paint Locker.

All emergency items such as BOP controls, alarm switches, firefighting, lifesaving, and escape and rescue equipment are always to be freely accessible.

All temporary openings or hatches opened are to be barricaded when in use and closed when not in use.

Spills while handling sack or bulk materials shall be cleaned up as soon as practical.

Unsafe or damaged areas are to be repaired as soon as practical and are to be reported at once to your immediate Supervisor.

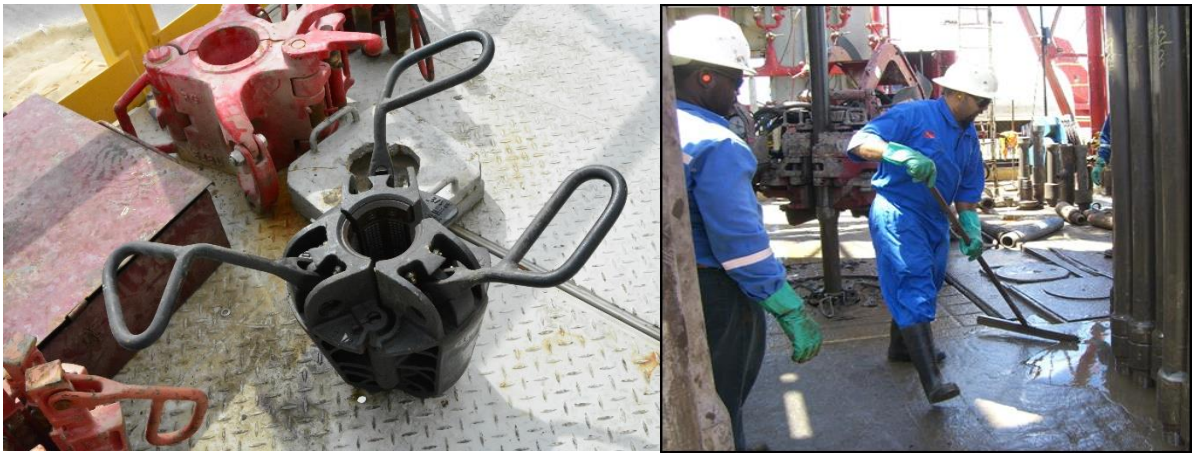
Figure 9 Housekeeping

Enforcing policies and procedures will result in greater job efficiency, productivity, and safety. Your responsibility as the Driller is to ensure the drill crew housekeeping duties are defined, assigned and completed as instructed. Anyone knowingly or willfully dumping anything without having permission and anyone knowingly or willfully violating written policy will be dealt with accordingly.

The Driller and his crew are responsible for the housekeeping on the drill floor. Keeping the rig clean is a major priority for rig operations. Trash such as rags, paper, damaged wires, old boxes, etc., around emergency areas such as walkways, emergency exits, or firefighting equipment areas need to be picked up and placed in the trash cans. Anytime trash is seen on the rig, take time to pick it up and put it in the right place.

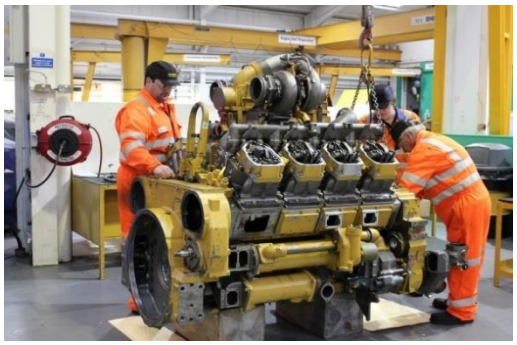
The rig floor should be kept clear of unnecessary tools and equipment. Brushes, mops, and rags along with water, soap, and commitment to the job are necessary for a safe and clean operation!

Clean decks and clean drilling equipment are considered a must on the rig floor. All Drilling Contractors standard is a safe and clean work environment.



Keeping oil base mud and other fluids off the rig floor makes it safer for the personnel carrying. out the drilling operations on rig

Keeping a neat work area eliminates safety hazards



Trash & rags to be picked up and disposed of properly *Maintenance team*

Rig crew need to understand the provisions for collection, segregation and disposal of items such as general waste, oily rags, used filters, empty aerosols, glass, paints and scrap metal. Efforts should be made to minimize waste.

Housekeeping is done to keep the rig safe, to keep the rig equipment working for a long time, and to save the company money on upkeep and repair.

Keeping the rig clean is a major priority for rig operations. Trash such as rags, paper, damaged wires, old boxes, etc., (especially around the helideck area or around emergency areas such as walkways, emergency exits, or firefighting equipment areas) need to be picked up and placed in the trash cans. All trash cans will then be dumped into a container and moved to a supply boat that will take it to a location on land to be handled. Any time trash is seen on the rig, take time to pick it up and put it in the right place.

Keeping rig floor clean

Keep helicopter deck clear

Store equipment and tools used during drilling after cleaning and inspecting

Proper Storage of Equipment and Supplies

- Helps maintain equipment better and offers less exposure to potential accidents.
- Saves extra steps for the employee, thus diminishing the exposure level for potential accidents. Prolongs equipment life**.**

- Store all lifting gear neatly and properly, this makes it easier to find and keep clean.
- Inspect and properly dispose of any damaged lifting device.

A critical part of your job is to make sure that you know the location of any safety hazards in their areas of responsibility in and around the drill floor. Such hazards may be high pressure vessels, check valves, pop-off valves, or areas where electrocution could result if water or water spray should hit a high voltage line.

Making sure the proper warning signs are in place and everyone is aware of the dangers should be a primary concern for the safety of crew and other personnel.

Make sure your crew know that high pressure vessels, lines, and valves are unsafe to stand by or work near!

Always check the work area before using a hose or water to clean the area. Always check to make sure the warning signs are still in place and are easily seen and legible.

Properly stored chemicals

Keep tools stored properly

Keep tools organized

Keep walkways clear

Wherever the Roustabout goes on the rig, housekeeping will always be a priority. Keeping the rig tidy helps keep the rig safe and efficient. By keeping the rig tools stored in the proper place the Roustabouts will be able to find the tools when needed. A clean rig is a safe rig.

Proper storage of tools is vital to keeping the drilling operation performing safely and efficiently. The Rig crew use the tools for the job to be done and must remember to put the tools back in the proper storage place so they can be easily obtained for the next job.

Rig crew will carry out wash-down and clean-up operations in the correct manner. Keeping decks free from oil and grease and cleaning up spillages and disposing of waste correctly will be a high priority for safe rig operations to prevent slips, trips and falls. If the Rig crew sees water, oil or any substance that has spilled or is left standing, it is to be cleaned up as soon as possible.

To avoid electrical incidents, water is not to be used to clean around generators, electrical switchboards or any other electrical device.

If the spilled substance is unknown, take the time to identify the substance and use proper cleanup and disposal techniques, which will be taught to all personnel. Any waste will be

disposed of in an approved container, with description of material, appropriate packaging, marking, emergency response information.

Special information should be available for handling procedures for waste known to be volatile or that has improper packaging and leaks.

1.4 TASKS

1. Actively participate in a toolbox (pre-job) meeting.
2. Maintain a clean work area and explain why this is important.
3. Demonstrate how to unplug drain systems, clean the deck (or rig-site location) using environmentally safe techniques.
4. Demonstrate the precautions to be taken when cleaning around active electrical equipment and machinery in operation.
5. Explain the Permit to Work System as it affects the job of the Rig crew.
6. Show how to use common hand tools and how to tie off tools when working at Hight.
7. Demonstrate the proper use of air powered tools such as needle scaler, buffer, and grinder.
8. Proper assembly and disassembly of scaffolding (under qualified supervision).
9. Demonstrate lifting and carrying techniques for mud sacks, drums, bits and similar heavy or bulky items.
   Show how to inspect and use personal fall-protection systems (safety harness with fall arrestor, harness with restraint lines, and ladder climbing system).
   Show how to use of the high-pressure wash gun unit.
10. Take part in the emergency response rescue team during a drill.
11. Take part in the firefighting team during a drill.
12. Show how to refuel vehicles on a land rig location.
13. Show how to apply lockout and tagout procedures when working on any machine that could release stored energy or start-up unexpectedly such as high-pressure washer, pumps, air grinder.
14. Explain how to fill STOP cards and submit it to your Supervisor.
15. Describe the hazards of entering a confined space and how to obtain a Permit to Work.
16. Enter a confined space as part of a team, following all required safe work procedures including job preparation, isolating, ventilating, atmospheric testing, use of entry equipment, and emergency rescue planning.
17. Demonstrate the crane signals used on your rig.
18. Demonstrate understanding of the following crane safety devices - over-boom stop, under-boom stop, fast line block savers, load and radius charts, weigh and radius indicators, lights, alarms.
19. Demonstrate how to use the portable fire-extinguishers on your rig.
20. Identify the major parts of the crane(s) on your rig.
21. Show how to perform forklift pre-operational checks (before starting) and operational checks (after starting).
22. Perform routine maintenance tasks on the forklift.
23. Demonstrate basic forklift operations such as starting and stopping, maneuvering in a restricted space, picking up, transporting and setting down a simple load, and parking correctly.
24. Show the importance of driver position, pedestrian traffic rules, safe travel speed, looking in direction of travel, and awareness of tail swing.

25. Show how to identify hazardous materials, read product warning labels and Material Safety Data Sheets (MSDS), and understand the written hazard communication plan.
26. Show how to dispose of chemical drums, sacks, and other containers.
27. Demonstrate how to identify, handle, and properly store bottled gases.
28. Identify H2S and hydrocarbon gas detectors (fixed and portable), their locations, and their visual and audible alarms.
29. Explain the Permit to Work System as it applies to the Rig crew.
30. Show familiarity with Company accident analyses and alerts, particularly those related to the Rig crew job.
31. Actively participate in a toolbox safety meeting before beginning a non-standard operation.
32. Show how to respond to emergency drills while working on the drill floor (including H2S, fire, man overboard, abandon rig).
33. Show how to keep the drill floor tidy and explain why this is important.
34. Describe the environmental risks from spillage of mud, mud chemicals, cleaning agents, lubricants or similar chemicals used on your rig, and how to minimize them.
35. Show what precautions to take when cleaning around sensitive items such as gas detector sensors, motors, electrical instrumentation and junction boxes.
36. Show how to clean and store drill floor hand tools.
37. Show how to organize the drill floor pipe handling tools such as subs, protectors, bushing puller, safety valves, and bit breaker.
38. Show how to maintain the drilling equipment store for optimum safety and efficiency.
39. Show how to tie the following soft line knots: Bowline, clove hitch, reef knot, sheet bend, half hitch, and eye-splice.
40. Show how the lifting equipment color code system works on your rig.
41. Show how to identify the SWL of lifting equipment on your rig.
42. Show how slings and other lifting gears should be inspected and stored.
43. Show how to use basket, bridle, and choker slings, and explain how the center of gravity of a load affects sling placement.

2. RIG MOVE

2.1 POLICY

Rig move operations are a critical task in the oil and gas industry and moving a rig is a very complex process involving numerous concurrent/simultaneous operations and activities with a variety of another contractor's present. Because of this level of activity, and the fact that different types of hazards, from those encountered during drilling operations, are present, preplanning, coordination and adequate supervision of the efforts of all personnel involved is essential to carry out a safe and efficient rig moving operation. It is Client policy that a Safety meeting shall be conducted prior to the start of each day's activities to review with all personnel involved, the operational goals for the day, the potential hazards that may be encountered and the necessary precautions required to control or eliminate the potential hazards.

2.2 DEFINITIONS

Several technical terms and drilling field terms have been used throughout this document, which would be difficult for a lay man to understand but is easily understood by those who deal in this field. Therefore, specific explanations are avoided at this stage. The specific stages start with the rig down procedure and finish with the rig up procedure at the new destination.

Critical loads

Rig loads that are essential to power up the rig and to spud the well, they must be moved during its specified schedule as other pieces of equipment rely on that piece to be in place for their assembly.

1. Mud Pump Skid
2. Engine Skid
3. Mud System
4. Sub-base and Rig

Non-essential loads

Rig loads, which can be moved at any convenient time during the rig move. Usually, those non- essential pieces of equipment that can be re-arranged in a rig move plan in order to expedite the Rig Move process.

Pre-move loads

Rig loads that are not required for finishing/completing the well and which therefore can be moved to the new location prior to rig release, but after Location Inspection and Approval (e.g. mud chemicals, some pipe baskets, some mud- or pre-mix tanks).

Lift

A single piece of equipment or pieces of equipment that are bound together, which alone or combined can be lifted as a single unit by a winch truck, forklift and/or crane. Examples: mud tank, choke manifold,

a master skid with 3 shakers (although the shakers are 3 individual pieces, they are bound together by the master skid which can be lifted as a single lift)

Load

Loads comprise any combination of lifts which when combined by a physical means for the purpose of moving, do so simultaneously. Ex: any lifts combined into a single truck, train, ship, and/or airplane are considered a load.

2.3 RESPONSIBILITIES

Supervisor Responsibilities

The Supervisor is responsible for planning and supervising all operations related to the rig move operation and ensuring that all work being performed during the rig move is done safely and efficiently.

The Supervisor must check the condition of all access roads prior to moving rig onto location. Conditions to be checked include:

a. Designated rig move route
b. Identify obstructions (low overhead structures, power lines, etc.)
c. Identify road hazards (gates, condition of roads, shoulders, etc.)

Truck Pusher Responsibilities

The Truck Pusher must be advised of all hazards and conditions, and he is fully responsible to pass that information onto the truck drivers.

Have all the proper local and other government permits provided by rig supervisor.

Establish the correct routing after consultation with the operator and/or drilling contractor. Ensure all drivers are aware no deviation from the designated safe route of travel identified in the rig move plan.

Employee Responsibilities

It is the responsibility of every employee to work in a safe and efficient manner which will neither expose himself or his fellow workers to any undue risks. Employees will wear and use safety equipment and utilize tag lines to ensure safe working conditions for themselves and others.

- Employees shall identify and eliminate hazards when they are observed and will utilize the Program to identify and correct “at risk behaviors” immediately.
- Employees shall report equipment deficiencies or unsuitable equipment immediately to their Supervisor to ensure that deficient or unsuitable equipment is not used during the rig move operation.
- Employees shall ensure that they operate equipment in a safe and efficient manner in accordance with the safe working loads and capacities of the equipment they are operating and to only use approved lifting points where applicable.
- Employees shall report any incident that occurs during the rig move operation no matter how small the injury or damage.

- Employees shall ensure that they take adequate breaks to rehydrate during the day to ensure to prevent dehydration which can cause heat exhaustion or heat stroke.
- Establish the location of all overhead obstructions along the route (power lines, telephone lines, overpasses and bridges).
- Make sure that all loads will clear obstructions.
- Ensure all loads are properly secured before moving.
- Examine all loads before moving: mount flags, signs and warning lights on all over width and over length loads as appropriate and according to local regulations.
- Lower all gin poles and booms to avoid contact with any obstructions.
- Ensure that major components are marked with a weight and measurement tag which includes length, width, height and weight range (within a 10% variance). Whenever possible, indicate load centers with an arrow on, or just above, skid.
- Whenever a highway crossing is involved during the move, ensure the presence of Local Police crews.
- Ensure that suitable communication is provided and maintained by the pilot vehicles leading and following the convoy so that in the event of a breakdown or other emergency arising while travelling in convoy all vehicles can be easily stopped to investigate and correct the situation that has arisen.

2.4 SITE PREPARATION

Site preparation activities at oil and gas well drilling sites are including:

1. Transporting equipment to and from the site.
2. Lease road construction.
3. Grubbing and clearing (removal of unwanted vegetation, trees, and general debris).
4. Leveling the site.
5. Pad construction.
6. Digging pits and trenches.

Figure 10 Clearing the drilling site

Figure 11 Excavating the drill site

Leveling, Excavation, Digging and Trenching

A road to the site is first constructed and the site leveled (if necessary), typically with bulldozers and/or graders. The scale and duration of leveling, digging, excavating, and trenching are site-specific depending on the available area and terrain. 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 also be excavated and are used for water, drilling fluid (mud) storage, or discharge.

Safety Precautions During Leveling & Digging Operations:

- Perform a Job Safety Analysis (JSA) before beginning work and whenever work activities change.
- Ensure the use of high-visibility clothing and spotters when appropriate.
- Instruct spotters and pedestrians to not walk backwards, or close to operating/moving equipment, and to watch for oncoming equipment/traffic.

Figure 12 Reserve pit after digging and excavating

- Prevent damage to underground pipelines and utilities by contacting One Call prior to excavation and digging operations.
- Limit pedestrian traffic during road leveling work.
- Train and require mobile equipment operators to follow equipment manufacturer requirements, including how to operate equipment on sloped and/or uneven ground.
- Eliminate ruts, slopes, and uneven walking surfaces where possible.
- Provide rollover guards on equipment used in site preparation operations.
- Provide overhead and rear canopy guards on rider-operated equipment. Plan for hazards that are the result of weather changes and weather emergencies. Obtain updates from the National Weather Service and plan site activities accordingly.
- Use water, rest, and shade during hot weather events and acclimatize employees to the heat.
- Wear layered clothing during winter months and take frequent breaks in a heated area.
- Train employees to understand and recognize the signs and symptoms of heat and cold stress, and periodically monitor employees for these signs and symptoms.
- After weather changes, conduct inspections for new hazards.
- Protect employees engaged in site clearing from animal and insect hazards and from toxic or irritating plants that may be present.
- Ensure adequate information is provided to employees about abatement requirements such as long sleeves and pants, high length boots, insect repellant, initial clearing before employees enter, etc.
- Teach the employees about available first aid treatments.
- Utilize water trucks to keep dusts, pollens, and other particulates from becoming airborne.
- Implement and utilize appropriate personal protective equipment (PPE) for the hazards, including respiratory protection to employees who are or may be exposed to airborne dusts, pollens, or other particulates.

2.5 PROCEDURE / IMPLEMENTATION

New route plan and new location

The Tool pusher must check the condition of access roads prior to moving rig onto location. Conditions to be checked include:

- **Obstructions (low overhead structures, power lines, etc.)**
- **Road hazards (gates, condition of roads, shoulders, etc.)**

The Client should establish the correct routing after consultation with the Operator and/or Drilling Contractor. Where applicable, the Client should establish the location of all overhead obstructions along the route (power lines, telephone lines, overpasses and bridges) and make sure all loads will clear those obstructions.

Once the rig move route has been surveyed and approved the Client Company Man, Tool pusher and Truck Pusher shall hold a pre-move meeting. The minutes of this meeting shall be documented on a Safety Meeting Form and signed off. This meeting will include, but not be limited to the following topics:

- Load out sequence
- Specific travel routes
- Additional equipment needed for the move (i.e. – lifting equipment and their corresponding lift plans).
- Lessons learned from the last rig move.
- Any special inspections (i.e. – derrick) or repairs to be completed before next rig up.
- Any first-time employees (Short Service Employees) with limited experience which may require “out of the way jobs” or additional supervision or other extra precautions.

- When determining the direction of setting up the rig, the prevailing wind direction should be considered so that substructure and engines can be set such that engine exhaust is carried away from the rig floor.
- Inspect all equipment that is to be used in the rig up operation. Especially inspect all rigging equipment (hoisting line, slings, chains, hooks and cables) before using. If the equipment appears worn or frayed, inform the driller/tool pusher (or truck pusher).
- While complete guarding is always not possible during rigging up/down, keep floor openings covered when not in use.
- Handrails around the rig floor should be put up first and taken down last when rigging up/down the rig floor.
- Stairs should be placed as soon as possible and taken down as late as possible. Once placed the stairs should be secured against movement.
- Be aware of the movement of trucks and other equipment around the rig location. All personnel should be instructed to be aware of the driver's visual area so that they do not walk into a blind spot when the truck is moving.
- When placing a load that is close to another structure, do not get between the load being placed and the set-in structure.
- Be sure walkways are free of skids and other items that may cause a slip/fall exposure.
- Fall protection should be used when workers are over 6 feet from the ground/deck such as while rigging up the derrick or substructure.
- Make sure that the lighting is adequate around the rig floor, derrick and work areas around the location (catwalk area, pipe racks, etc.)
- Tong hanger line sheaves and other sheaves that are in the derrick should be inspected and replaced if necessary while the derrick sections are on the ground.
- Take care when rigging up tongs, etc., on the rig floor.
- Once the derrick is raised and pinned, the drawworks cover should be installed on the front of the draw works.
- Organize and clean up the rig floor as soon as possible once it is rigged up.
- Winch truck/Crane operations:
- Never get between a load and the winch truck (crane).
- When placing the winch truck in position to tie onto a load, all personnel are to stay clear of the truck path and avoid placing themselves between the winch truck and load. Stay out of pinch points!
- At all times avoid working or walking beneath a suspended load.
- Lift the load a few inches to observe the balance and reset slings to balance the load.
- When signaling winch truck drivers, stay away from the truck but in the driver's view. Do not stand in line with the ends of the block shafts.
- When loads are being lifted, the driver assistant should stand clear of the load line path and be clear of the direct line from the block shafts.
- Keep your hands off a load that is being lifted, lowering or positioned. Use a tag line when necessary to control the load.
- Keep clear of overhead power lines; clearance should be at least 10 feet from the winch truck poles or any object protruding or suspended from it.
- Hand signals should be discernible and consistent. Only one person should be designated as the signal person to the operator.

- Movement of the load should not occur until all personnel have moved out of the path of the load and the signal person is within sight of the driver.
- Oilfield winch trucks should not be used for raising or lowering personnel.
- No one should ride on the outside of trucks, cranes, or on loads, buckets or hooks suspended from gin poles.

Trucking arrangements

Once the Rig Superintendent or the Tool pusher has received confirmation to start the initial move from the Operator and/or Company Man, arrangements must be made to make sure personnel and all other resources required for rig move are mobilized.

Assignment of work

The Tool pusher shall ensure that the employees have received adequate training and have knowledge of, and experience in, the application, use, and limitations of the equipment to make sure the use or operation of the equipment is done in a safe and efficient manner to rig down, rig move and rig up on the new worksite. The following topics are essential for a safe and efficient rig move:

- Daily planning – organizing and communicating to all personnel the rig move plan for each day.
- What to do first – sequential order of rigging out, loading and moving
- Delegation of tasks and what to do
- Work safe and effective – review the job specific JSA for each task with all those involved in the task

2.6 RIGGING UP

As the equipment arrives to the new location it must be spotted as per the rig move schedule. The moment to move the Rig site Camp and Warehouse buildings will be decided strictly on an agreement by the Tool pusher and Aramco Company Man, who depending of locations distance, road survey results and well completion, will choose the right moment for moving.

The Mechanic and Electrician on site will notify the Tool pusher the best moment for them to move the mechanic/electrician workshop from the current location to the new one, making sure they have the proper tools to rig down and rig up activities.

A safety meeting must be held every day, 15 minutes before each shift and all personnel including other service companies‟ personnel must attend. Also, a Job Safety Analysis meeting must be held just before conducting a potentially hazardous operation, Toolbox Talks must be utilized throughout the rig move operation to enhance communication during the operation.

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

Figure 13 Hoisting the mast

During assembly of the rig, some equipment may be handled and set with crane, rig up trucks, or forklift, 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:

1. Setting Up the Substructure
2. Setting Up the Rig Floor and Mast or Derrick
3. Installing Handrails, Guardrails, Stairs, Walkways, and Ladders
4. Installing the Power System
5. Rigging Up the Circulating System
6. Installing the Auxiliary Equipment
7. Inspecting the Rig

1. 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.

Figure 14 Setting up the substructure

Job task of Setting Up the Substructure:

- 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.
- Offload sub-structure and spot it on the right place. Spot, Start rig up Sub-structure beams.

2. 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 draw works is set in place and secured to the substructure. On mechanical rigs, the engines are set in place and the compound and associated equipment connected to the draw works. On electric rigs, the electric cables (lines) are strung to the draw works.

The bottom of the mast is 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 monkey board 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 using Mast raising/lowering lines.

- Mast raising/lowering lines; also called bull lines or bridle lines; are used to set mast in erected or lowered position. Raising mast is a process where lines are passed around raising sheaves and shafts positioned in the A-frame structure & mast, then connected to the traveling block, when drawwork pulls travelling block up, the block drag the lines which is attached to the mast causing it to raise up.

  Safety precautions should be applied during that process so no one can be hurt. Make certain that lines are in place in sheave grooves before and during each raising or lowering operation.

Change out raising line on time. Do not exceed the working life span or cycles set by the manufacturer. Three principal factors, which may limit the life of a raising line, are wear, corrosion, and damage. Wear is a function of the number of times a mast or substructure is raised. Corrosion is related to time and environmental conditions. Damage bears no relation to either wear or corrosion, it may occur at any time.

The following points may be useful in determining inspection and replacement procedures:

a) Mast and/or substructure raising lines should be inspected before any raising or lowering operation.
b) Rusty raising lines should be inspected and replaced as necessary.
c) Areas adjacent to end connection should be examined closely for any evidence of corrosion.
d) A line showing kinking, crushing, or any other damage resulting in distortion of the rope should be replaced.

The engines are started, and the drilling line is spooled onto the draw works drum. Once the mast has been raised and pinned, the remaining floor equipment can be set into place. If the rig has safety guy lines, 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.

Figure 15 Raising the doghouse and rig floor

Figure 16 Setting mast on rig floor

Figure 17 Setting crown on derrick stand

Figure 18 Rigging up the mast

Figure 19 Raising the mast

Job task of Setting up the Rig Floor and Mast or Derrick

- 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 manufacturers recommendations.
- Setback Rotary Table and Draw work.
- Rig up the mast sections, connect raising line, Spot store cabins in place, offloading equipment.
- Install SPM and other gauges.
- Inspect the tong hanger cables, mud box and other cables that are in the derrick before raising the derrick.

3. Installing Handrails, Guardrails, Stairs, Walkways, and Ladders

Handrails, guardrails, stairways, walkways, and ladders are installed where they are needed for safety and access.

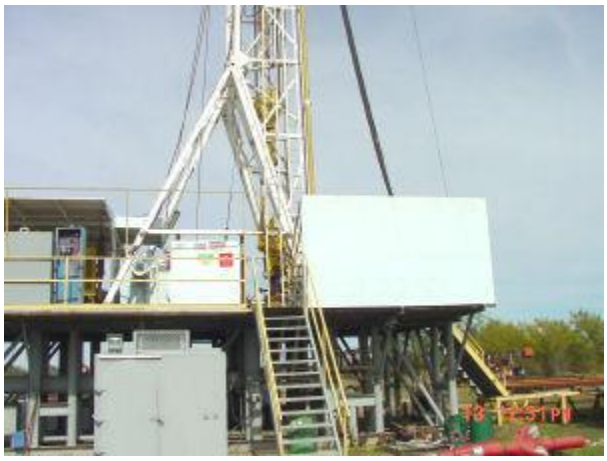


Figure 20 Stairways, guardrails, and ladders

Figure 21 Stairways

Job task of Installing Handrails, Guardrails, Stairs, Walkways, and Ladders

- 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.
- Install catwalk, V-Door. Rig-up TDS as per procedure

- Install flow line, stabbing board, continue rig-up of rig floor equipment.

4. 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 compound. 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.

Figure 22 Engines and generators

Figure 23 Power house

Job task of installing the Power System

- 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. Install all guards.
- Use proper personal protective equipment when working with chemicals.
- Use proper lockout/tagout/ procedures.
- Install all diesel tanks
- Connect all engines, make Preventive maintenance “pm” task on koomey unit (recharge the accumulator bottles and inspected the valves as per PM task.

5. 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.

Figure 24 Mud pump

Figure 25 Mud system

Job task of rigging Up the Circulating System

- 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.

6. 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.

Figure 26 Tubulars on pipe racks

Figure 27 V-door, pipe ramp, pipe rack and cat walk

Job task of installing the Auxiliary Equipment

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

7. Inspecting the Rig

Perform a complete inspection of the rig before operating. The driller and/or rig superintendent/tool pusher/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, and unclear walkways.

Figure 28 Inspecting the rig

Figure 29 Inspecting rig equipment

Job task of installing the Auxiliary Equipment

- 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.

2.7 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.

Figure 30 Loading doghouse onto trailer

2.8 RIG MOVE SAFETY REQUIREMENTS & GUIDELINES

Personnel safety

Safety of personnel is of the utmost importance. After all attempts have been made to minimize the hazards associated with rig moves, the supervisor should make sure the workers use the specific Personal Protective Equipment issued to and made available for the employees to use.

It is the responsibility of every employee to work in a safe and efficient manner which will neither expose himself or his fellow workers to any undue risks. Employees will wear and use safety equipment and utilize tag lines to ensure safe working conditions for themselves and others.

Pre-move safety meeting

Pre-move safety meetings will be held prior to initiating rig move activities. The meeting should be conducted by the Tool pusher

- Planned objectives for the rig move
- Emergency contingency plan – a written plan must be available for each rig move

Precautions at the well site

While operating bed trucks and gin pole trucks, the driver must ensure that the driver assistant is ALWAYS in view of the driver to signal hazards and that all personnel are clear of moving trucks.

Use a bed truck to tailboard loads on soft surfaces.

When operating tractor trailer units, the driver must ALWAYS know the position of the driver assistant and the rig crew before backing up. Drivers are not permitted to back any vehicle on site without the use of a driver assistant.

Use a relay signaler to give signals when the driver's view of the primary signaler is obstructed.

The driver should ensure that the ground is solid, before shifting loads to the rear axles, to avoid upsets.

Access roads

Once the rig move route has been received, the Tool pusher, Truck Pusher, and the Company Man should survey the route. The route should be checked for all the following;

- There should be enough clearance under all power lines and bridges for the tallest loads. If the route passes over a bridge, the bridge weight rating must be adequate to support the heaviest loads.
- All corners or junctions in the road should be wide enough to accept the longest and largest loads. Care should be taken to ensure that the outside of the corner or junction is not damaged and can support the heaviest loads.
- If any wide loads are to be moved down busy or public roads, permission should be obtained in advance. Wherever possible, wide loads should be moved when the road is not busy. Avoid rush hours.
- Any damaged roads should be noted, and arrangements made to have them repaired before the move starts. Avoid moves in foggy, rainy, and dusty weathers, where visibility is less than 100 meters.
- Any steep incline should be noted, and arrangements made for additional prime, movers or bulldozers, if required, to safely manage the heavy loads over this section of the route.
- Once the route has been surveyed, the problems should be reported, and arrangements made to correct the problem or arrange an alternate route. There must be no deviation from the finalized agreed route.

After the route has been surveyed and approved, a Pre-move meeting should be held on the Rig between the Tool pusher, Truck Pusher, and the Company Man, and where possible, an office-based Drilling Contractor Representative.

During the move, a meeting will be held at the start of every day between the Tool pusher and the Truck pusher. The day's agenda will be decided (what loads to move on trucks based on the specific rig move plan).

Travelling in Convoy

It is highly recommended that loads being moved to the new location be moved in a convoy of trucks, it is also recommended that whenever possible two truck pushers should be used when conducting a rig move.

No rig moves are allowed during inclement weather such as: foggy, rainy or dusty conditions where visibility is less than 100 meters. It is the responsibility of the Tool pusher to ensure that weather conditions are favorable, and that adequate visibility exists for the rig move otherwise he must delay the rig move until conditions improve.

Night-time rig moves must be avoided as much as possible. The Tool pusher has the responsibility and the authority to shut down any night move when in his opinion conditions make it unsafe to continue. Furthermore, loading and moving oversized loads is not permitted during night-time hours or after dark.

Rig routes should be planned to avoid crossing any highways. If it is necessary to cross a highway, then only authorized crossing points are to be used.

All wide loads shall be moved in convoy with a lead escort vehicle and a following escort vehicle, these escort vehicles must equip with flashing orange rooftop lights to make other vehicles aware of an impending hazard approaching.

When travelling in convoy each vehicle shall maintain a safe following distance away from the vehicle in front of him and be alert watching for tools or equipment falling from the vehicle ahead. If something falls from the vehicle ahead the driver shall stop his vehicle and alert the following escort vehicle to communicate to the lead escort vehicle to stop the remainder of the convoy to pick up the fallen tool or equipment.

When conducting long distance rig moves in convoy, the Tool pusher/Truck Pusher shall designate an assigned schedule for the convoy to stop so that each driver in the convoy can conduct a walk around inspection of his truck and load to ensure that no new hazards have arisen and to let the tires cool off on the equipment to prevent the tires from bursting due to excessive heat. Currently

each driver will ensure that all components of their loads are secured and have not come loose during the rig move.

When travelling in convoy or out of convoy, only the approved designated rig route shall be followed, no deviations from the approved rig move route are permitted.

All overhead cables are to be approached with caution. Each truck must stop then proceed slowly under the cables to avoid any excessive movement of the Truck suspension.

Highway and railway crossing flagging crews

For railway crossings, the Rig Superintendent, Tool pusher or the Truck Pusher will contact the Drilling Contractor to schedule a crew to open the gates at authorized railway crossing points, making sure they

are aware of the train's scheduled crossing at that point and also provide one (1) signal-man with the proper communication device (walkie-talkie and flags) on each side of the crossing to alert if a train is coming before allowing the convoy to cross the railway crossing.

For highway crossings, the Truck pusher will contact the Operations Department at rig to schedule a fully equipped crew to be at the approved highway crossing to stop traffic and allow the convoy to cross the highway. Whenever deemed necessary Client will request the intervention of the Local Traffic Police.

Rigging up and rigging down – general

Rig directional signs shall be placed on the rig access road before the start of rig-up operations in the event it is necessary for an emergency vehicle to locate the rig site.

Until all equipment has been spotted in place, operations should not be restricted to daylight hours. Before a mast is raised or lowered, a complete visual inspection of all its parts shall be made by the Tool pusher or some other qualified person designated by the Company using the Mast Inspection Report.

The mast (derrick) stand shall be free of bends, cracks, or other physical defects, and shall be equipped with a ladder for workers to use in gaining access to the mast during rig-up operations.

The Tool pusher or some other qualified person designated by the Company shall oversee and be present during the raising or lowering the mast.

Except for the operator of the controls, no Company personnel shall be required or permitted to be on or beneath a mast during raising or lowering operations.

No loose tools, equipment, or materials shall be kept in a mast while it is being raised, lowered, or operated.

Provisions shall be made to prevent the mast from overturning or collapsing as a result of wind velocity. This shall be accomplished using guidelines, constructing the mast foundations in such a manner as to resist overturning (within the specifications of the manufacturer), or by a combination of both guying and foundation.

Forklifts

When a forklift is required, the following safety procedures will be followed:

- Only trained and competent personnel will be allowed to operate the forklift. The assigned driver must be fully aware of all safety procedures during loading and unloading.
- Prior to using the forklift at the start of each shift the Forklift Operator must perform an inspection of the forklift.
- Absolutely no personnel can ride on the forklift other than the driver and no worker shall be allowed to use the bucket or forks as an at height working platform.
- The forklift will have a back-up alarm and rotating beacon light on top.
- When the forklift operator is unable to see his forks, then he will receive instructions from the signaler before proceeding.
- The forklift shall not be driven forward when carrying a load so high or wide as to obstruct the view of the driver.
- The forklift shall not be driven forward while the lift prongs are raised higher than 12 inches (300 mm) off the ground.

- The forklift shall be parked and secured when weather conditions deteriorate, and the vehicle cannot operate safely.
- All personnel working around the forklift must remain alert to the vehicle's presence and remain out of its path of travel.
- Surfaces where the vehicle is to travel must be kept as dry as possible. The vehicle will be parked when the surface becomes too slick for safe operation.
- The forklift must have an overhead guard to protect the operator from being hit by falling objects; the guard must not block visibility

Figure 31 Forklift

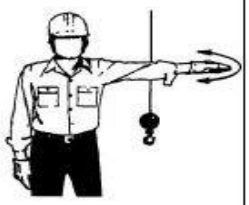
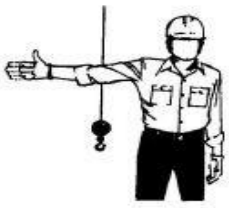
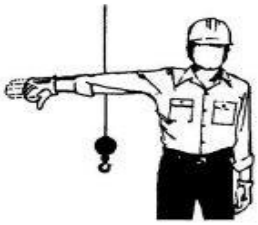
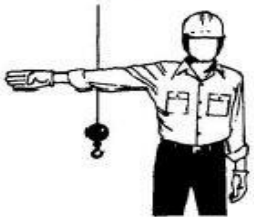
Cranes

Only trained and competent personnel will be allowed to operate a crane during rig move operations. The assigned Crane Operator must be fully aware of all safety procedures contained in procedure Crane Operation Safety found in the MJEPS Management System available at Head Office.

Prior to using any crane, at the start of each shift the Crane Operator must perform an inspection of the crane.

Lift plans for every critical load must be developed before the loading starts. A safety meeting will be held, and critical load data sheets will be elaborated to ensure the safe handling of the loads.

The crane operator shall respond to the signals only from the appointed signal person but should obey an emergency stop signal at any time no matter who gives the signal. Hand signals will be in accordance with those shown on the crane hand signals chart posted on the crane and around the rig.

Hoist	Lower	Move Slowly	 Stop
Raise Boom	Lower Boom	Use Main Hoist	Retract Boom
 Swing and Pick Up Load	 Swing and Lower Load	Use Auxiliary Hoist (Whip Line)	Extend Boom
 Swing Boom	Travel Both Tracks	Lock Track Turn Travel Track	Dog Everything

When two or more cranes are used to lift one load, one qualified person shall be responsible for the operation. The responsible person must analyze the operations and instruct all personnel involved in the proper positioning, rigging of the load and the movements to be made.

Tag lines will be attached to each load for the safe positioning of the load. See tag lines paragraph further in this section.

Cranes can be dangerous machines in the wrong hands and, as such, require skilled persons to operate them. As well as the actual Crane Operator, at least one more important and essential member is required to make up the team. It is the Rigger/ Crane Helper/ Slinger and his duties include:

- Ensure that both he and the Crane Operator are familiar with the method of signaling to be used.
- Be aware of the wind speed and direction.
- Know the weight of the load.

- Be familiar with the line capacities of the crane in use.
- Check that the lifting gear being used is in good condition, certified for use, correctly color coded and of sufficient capacity to carry out the lift.
- Ensure that taglines are attached to any long or awkward loads to facilitate easier handling.
- Be aware of any obstructions within the crane's radius and working area.
- Check that the area around the load to be lifted is clear and that the load is not attached to the deck, transportation cradle, or adjacent equipment.
- Ensure his hands are free from lifting gear and stand clear before the crane takes the strain.
- If using hand signals, stand in a position where the Crane Operator can clearly see you and you can maintain visual contact with the load.
- Always use clear and distinct signals (either by hand or by radio) to control lifting operations. In poor light conditions, exaggerate all hand signals.
- When lifting, stop the load just clear of the deck to check the balance and security of the load. This will also give the Crane Operator the opportunity to check the function of his hoist brake.
- Make it clear to the Crane Operator where the load has to be moved to and placed. If possible, precede each load to its destination.
- Warn other personnel in the area of the movement of the load.
- Keep a check on other activities within the crane's operating area to avoid the development of unforeseen hazards.

Figure 32 Crane

Care and handling of line Slings

Check for the following: broken or kinked strands, wickers, flat spots, loose eyes, condition of wedge knot, proper color coding, and inspection tags.

- Replace worn slings or damaged slings.
- Always hook slings to the proper pick-up points or centering points. Use proper method of attaching slings to prevent any accident.
- DO NOT use chains for loading or lifting.
- DO NOT drag slings on the ground.
- Coil or hang slings properly when not in use (cool, dry storage).
- Use separate slings for towing and loading.

- Never handle wire rope slings without gloves and always handle with a hand over hand motion to prevent being injured by unforeseen wickers.
- Only use properly rated sling for the lifting weight required.

Tail Chains

- Check that the knot in the winch line has not slipped or begun to fray.
- Hook tail chains to shackle or winch line.
- Hook tail chains with hook openings AWAY (out) from the truck.
- Replace tail chain when links start to become stretched.

Winch Lines

- Check for the following: broken or kinked strands, wickers, flat spots, condition of wedge or knots.
- Ensure all equipment is in good working order and of the proper size.
- Use hand-over-hand grip procedures when handling winch lines. DO NOT let the line slip through your grip.
- Ensure even lays in spool line on winch drum.
- Ensure that the winch line is securely anchored to winch drum.

Snatch Blocks

- Check for excessive wear at the pins.
- Ensure all equipment is in good working order and of the proper size. A heavy-duty snatch block (10-20-ton capacity) is required for most operations.
- Keep hands and clothing away from moving snatch blocks.
- Lubricate snatch block with grease when required.
- Ensure that the loading sling is long enough so that the snatch block is picked up on the trailer before the load starts to come up.
- Use double line procedure on heavy loads.
- For further Rigging and Slinging information refer to Lifting Equipment Inspection Program found in the MJEPS HSE Management System available at Head office.

Suspended loads

- Never stand under a suspended load.
- Use tag lines to control and position suspended loads.
- When working around suspended loads, maintain enough distance between yourself and the load in case a sling, winch line, etc. fails causing the suspended load to fall or shift. To reduce the risk of being crushed, NEVER stand between a suspended load and a stationary object (e.g., another building).

Tag lines

Procedures for using tag lines:

Tag lines will be used to control all suspended loads. If tag lines are impractical during final positioning of the load, caution should be taken to ensure that no part of the person's body guiding the load be between the load and any stationary object.

Hand-held tag lines will be constructed of a non-conductive material such as ½ inch rope or a 1- inch nylon strap. Chains or steel cables are not acceptable.

Never attempt to guide a load with the tag-line wrapped around your hand or waist. Never use a tag line with a knot in the end.

A tag line should be of enough length to ensure that no part of the person guiding the load be under the load at any time.

The person holding the tag line should never position themselves between a suspended load and a stationary object.

Personal Protective Equipment (PPE)

The minimum required Personal Protective Equipment during a rig move consists of the following and will always be worn and when applicable:

- Steel toed safety boots
- Hard hats
- Safety glasses
- Gloves
- Coverall with light reflective striping
- If no light reflective striping, fluorescent vests (day and night)
- Full body safety harness with lanyards, if working 2 meters (6 ft) above work surface
- Flashlights for personnel working after dark

2.9 RIG MOVE PAPERWORK

Job safety analysis (JSA)

A job safety analysis must be used to help identify unsafe acts and unsafe conditions prior to a job being performed in order to make it safer.

The Tool pusher must make sure a JSA is performed just before a planned activity is performed. Also, must sign off on the JSA when completed and ensure that the JSA is filed in the JSA Workbook for future reference.

The Tool pusher must lead the JSA and make sure the crew members involved in the operation are present. Also, must follow the JSA procedure and ensure a complete understanding of the JSA by the crew performing the job.

The crew members must participate in the JSA and provide the Tool pusher with information of specific tasks involved with the job. Also, the crew must comply with the JSA steps.

Work permits

It is an established assessment method to ensure all hazards associated with specific operations are evaluated, known and communicated by a formal system to minimize potential risks and control hazards associated with the performance of these specific tasks.

Work permits will be required prior to commencing the rig move operations. The work permits are available at the Rig HSE office on location. The work permit will identify site-specific concerns, address safety concerns and cover general rig move policies.

2.10 TASKS

1. Follow the instructions from your supervisor during Rig move.
2. Attend pre-job safety meeting with all crew.
3. Help Electrician and Mechanic to disconnect their equipment.
4. Disconnect all Mud tanks, hoses and cables.

3. RIG ACCEPTANCE STANDARDS (RE-SPUD PREPARATION)

This document provides the outline of the minimum requirements for a rig to be accepted for operations on a well location. A rig can be a drilling or work-over rig, snubbing unit, coil-tubing unit, wire-line rig or pulling rig.

GENERAL

1. A detailed rig acceptance procedure shall be included in any Call for Tender and in the rig contract.

2. Prior to the signing of a Well Operations contract or agreement, the Contractor and the Company must have agreed the acceptance criteria.

VITAL RIG EQUIPMENT

1. A rig must be subjected to a comprehensive inspection covering as a minimum its vital equipment which must be found to be in good working condition.

2. Rig Vital Equipment is considered as:

- Rig Power: engines, generators and all associated equipment
- Drawwork: Lifting function, main brake and secondary electric brake or equivalent
- Travelling and crown blocks
- BOP stack including Control System, BOP installation carrier
- Diverter and Diverter Control System when applicable
- Top Drive: all functions
- Mud Pumps – Including supercharging pumps, dampeners and associated safety devices
- Mud mixing system
- Bulk System - including air dryers
- Shale shakers and associated mud treatment equipment
- Conductor tensioning system when applicable
- Cranes
- Jacking system (including jetting system) – Cantilever skidding system or anchor winches depending on the type of unit, when applicable.

CERTIFICATES

1. In addition, the rig owner must provide proof of class (Rig Certificates) maintenance according to inspections by relevant inspecting authorities, proof of insurance and all current certifications and clearances required by local regulations to carry out rig operations.

2. Should the rig contractor's drill-pipe be utilized for operations, inspection certificates will be inspected for validity together with all BHA subs, cross-overs and pups. Likewise, for HWDP. Premium is the lowest acceptable condition.

RIG INSPECTION

1. The rig inspection survey must be carried out by a recognized competent third-party in conjunction with the Well Operations and HSE functions.

2. The findings of the inspection must be prioritized and ranked. Items identified as having significant impact on mechanical integrity or safety of the rig will be classified as 'critical'. Rig acceptance with outstanding 'critical' items will not be allowed unless written dispensation has been given.

3. The Rig Superintendent and Well Operations Manager shall be satisfied that the rig and site areas are as safe as reasonably possible prior to commencing well operations. This shall be recorded on the IADC/API Daily Drilling Report Form.

EQUIPMENT

1. The following minimum equipment shall be present and fully functional:

- Full-opening safety valve and associated required Xovers
- Surface installed inside BOP.
- Gas sensors with alarm on rig floor and BOP area

2. A rig shall be equipped with a trip tank with a level indicator that can easily be read from the driller's cabin which shall be accurate to a maximum of 0.5 barrels.

3. The minimum mud logging sensors required for drilling operations are:

a. Active pit volume – (all pits in critical wells)

b. Mud weight in/out

c. Total gas (%) at header box

d. Weight on bit

e. Hook-load

f. Rotary speed

g. Standpipe pressure

h. Rate of penetration

i. Pump strokes per minute (SPM)

j. Flow in and out on critical wells

k. Temperature in and out on critical wells.

4. On drilling rigs equipped with a top-drive, one of the Kelly valves shall be remotely operable from the driller's cabin.

5. A Crown-o-matic or equivalent safety brake shall be installed on the drawwork and be operational at all times whilst drilling and tripping drill-pipe and bottom hole assembly components shall be inspected and graded in accordance with API RP7G specifications. Equipment must be delivered with inspection certificates and checked by the Site Supervisor. Non-destructive testing (NDT) inspection shall also be carried out to an agreed schedule and prior to the commencement of a new contract.

6. All pressure vessels shall be directly fitted with an overpressure relief device.

7. A suitably rated, independently powered fire-fighting pump capable of supporting two fire hoses or one foam branch, shall be provided at the rig-site. An adequate water supply or water reservoir shall also be available.

8. Safety (drench) showers or eyewash stations shall be provided at the rig at: Mud mixing hoppers, Mud pump area, Rig floor, Cement unit and any hazardous chemical mixing or pumping area.
9. The rig shall be fitted with an emergency battery started generator capable of making the well safe and providing the necessary services for well control.

10. If a mud-logging unit is installed it shall have a kick detection system. Note: For drilling the use of a mud-logging unit is mandatory for all operations unless dispensation is obtained

11. Well control equipment shall be as detailed in WOR 16 – Well Control.

12. All rig pressure gauges shall be covered with valid calibration certificates.

13. Hazardous area signals to local regulations or a minimum of API RP 500B shall be available.

14. All electrical equipment shall be certified for any location (hazardous or not) in which it operates.

4. DRILL STRING AND ROUTINE OPERATION

4.1 OBJECTIVES

To make trainees knowledgeable about following drilling string items:

- Marking and identification.
- Inspection standards.
- Measurement.
- Color coding.
- Cleaning and greasing.
- Making and breaking.

4.2 OUTCOMES

Upon completing this section, they should be able to:

- Recognize drill string and tool joints.
- Visually inspect for any defect in the drill string.
- Properly measure, clean and apply grease where needed.
- Safely use drill string handling tools.
- Understand the sequence for making up the BHA.
- Recognize the drill pipe specification and properties.

4.3 DRILL STRING MARKING AND IDENTIFICATION

Sections of drill string manufactured in accordance with API **Specification 7** are identified with markings on the base of the pin connection. An additional pin base marking, representing the DP weight code, is recommended as shown in Figure 53

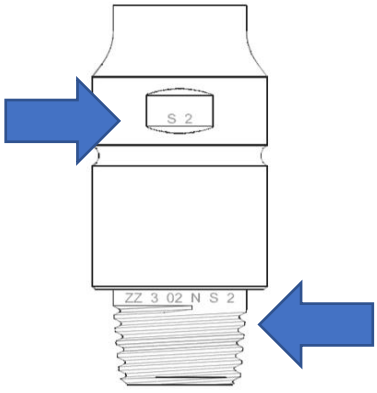


Figure 33 Pin base marking

It is also recommended that drill string members be marked using the mill slot and groove method as shown in Figure 1

1	2	3	4	5	6
ZZ	3	02	N	S	2

1. Tool Joint Manufacturer's Symbol (ZZ Company)
2. Month welded (3-March)
3. Year welded (02-2002)
4. Pipe manufacturer's symbol (N-United Steel Company)
5. DP grade (S-grade S135 DP)
6. DP weight code (see below)

Month	Year
1 through 12	Last two digits of year
Month and Year Welded	

DP Grade	
Grade	Symbol
E 75	E
X 95	X
G105	G
S135	S

The recommended weight codes are shown below

(1) Size OD inches	(2) Nominal Weight lb per ft	(3) Wall Thickness inches	(4) Weight Code Number
2 3/8	4.85	.190	1
	6.65*	.280	2
2 7/8	6.85	.217	1
	10.40*	.362	2
3 1/2	9.50	.254	1
	13.30*	.368	2
	15.50	.449	3
4	11.85	.262	1
	14.00*	.330	2
	15.70	.380	3
4 1/2	13.75	.271	1
	16.60*	.337	2
	20.00	.430	3
	22.82	.500	4
	24.66	.550	5
	25.50	.575	6
5	16.25	.296	1
	19.50*	.362	2
	25.60	.500	3
5 1/2	19.20	.304	1
	21.90*	.361	2
	24.70	.415	3
6 5/8	25.20*	.330	2
	27.70	.362	3

*Designates standard weight for drill pipe size.

Figure 34 Recommended Weight Codes

PROPERTIES OF DRILL PIPES & TOOL JOINTS

(1)	(2)	(3)	(4)	(5)	(6)
Size OD in. *D*	Nominal Weight Threads and Couplings, lb/ft	Plain End Weight[1] lb/ft	Wall Thickness in.	ID in. *d*	Section Area Body of Pipe[2] sq. in. *A*
$2^3/_8$	4.85	4.43	.190	1.995	1.3042
	6.65	6.26	.280	1.815	1.8429
$2^7/_8$	6.85	6.16	.217	2.441	1.8120
	10.40	9.72	.362	2.151	2.8579
$3^1/_2$	9.50	8.81	.254	2.992	2.5902
	13.30	12.31	.368	2.764	3.6209
	15.50	14.63	.449	2.602	4.3037
4	11.85	10.46	.262	3.476	3.0767
	14.00	12.93	.330	3.340	3.8048
	15.70	14.69	.380	3.240	4.3216
$4^1/_2$	13.75	12.24	.271	3.958	3.6004
	16.60	14.98	.337	3.826	4.4074
	20.00	18.69	.430	3.640	5.4981
	22.82	21.36	.500	3.500	6.2832
5	16.25	14.87	.296	4.408	4.3743
	19.50	17.93	.362	4.276	5.2746
	25.60	24.03	.500	4.000	7.0686
$5^1/_2$	19.20	16.87	.304	4.892	4.9624
	21.90	19.81	.361	4.778	5.8282
	24.70	22.54	.415	4.670	6.6296
$6^5/_8$	25.20	22.19	.330	5.965	6.5262
	27.70	24.22	.362	5.901	7.1227

Figure 35 Properties of Drill Pipes & Tool Joints

DC weight table

Drill Collar OD, inches	Drill Collar ID, inches												
	1	1 1/4	1 1/2	1 3/4	2	2 1/4	2 1/2	2 13/16	3	3 1/4	3 1/2	3 3/4	4
2 7/8	19	18	16										
3	21	20	18										
3 1/8	22	22	20										
3 1/4	26	24	22										
3 1/2	30	29	27										
3 3/4	35	33	32										
4	40	39	37	35	32	29							
4 1/8	43	41	39	37	35	32							
4 1/4	46	44	42	40	38	35							
4 1/2	51	50	48	46	43	41							
4 3/4			54	52	50	47	44						
5			61	59	56	53	50						
5 1/4			68	65	63	60	57						
5 1/2			75	73	70	67	64	60					
5 3/4			82	80	78	75	72	67	64	60			
6			90	88	85	83	79	75	72	68			
6 1/4			98	96	94	91	88	83	80	76	72		
6 1/2			107	105	102	99	96	91	89	85	80		
6 3/4			116	114	111	108	105	100	98	93	89		
7			125	123	120	117	114	110	107	103	98	93	84
7 1/4			134	132	130	127	124	119	116	112	108	103	93
7 1/2			144	142	139	137	133	129	126	122	117	113	102
7 3/4			154	152	150	147	144	139	136	132	128	123	112
8			165	163	160	157	154	150	147	143	138	133	122
8 1/4			176	174	171	168	165	160	158	154	149	144	133

4.3.1 Drill Pipe and Tubing Strings Inspection Standards

Special attention to the critical failure areas should be performed during inspection to facilitate crack detection in drill strings which have been subjected to abnormally high bending stresses. Drill pipe which has just been inspected and found free of cracks may develop cracks after very short additional service through the addition of damage to previously accumulated fatigue damage.

A crack is a single line rupture of the pipe surface.

a) The rupture shall be of enough length to be shown by magnetic iron particles used in magnetic particle inspection or
b) Identifiable by visual inspection of the outside of the tube and/or optical or ultrasonic shear-wave inspection of the inside of the tube.

Drill pipe tubes, tool joints, and drill collars found to contain cracks should be considered unfit for further drilling services. Shop repair of some tool joints and drill collars, containing cracks, may be possible if the unaffected area of the tool joint body or drill collar permits.

4.3.2 Full-Length Visual Inspection

A full-length visual inspection of the entire outside and inside surfaces excluding the threads shall be conducted to detect gouges, cuts, pits, dents, grinds, mechanical damage, lack of straightness, and other visually detectable imperfections. On electric weld pipe special attention is given to weld flash and trim. Rolling each length and viewing the entire surface is required. The entire inside surface is inspected using a high intensity light, mirror or borescope (depending on size).

4.3.3 Visual Thread Inspection

Visual thread inspection is a procedure for locating thread imperfections without the use of magnetic particles or thread gauges other than a profile gauge. This inspection applies to exposed round threads on casing and tubing, and exposed buttress threads on casing. Visually evident manufacturing defects or mechanical damage to the threads are detected by this inspection.

Floor hands will help repair the drill string components at the rig site when possible. Any damage seen needs to be reported to the Supervisor. Some repairs to the drill string can be done on the rig. Threads can be repaired, and shoulders of the pipe can be made smooth again. Small thread cuts can be repaired with a file. Keeping the threads clean and free from metal fillings after repair is very important. Doping and replacing thread protectors is vital to keeping the drill string strong and ready for service.

Damaged threads

Checking for damage

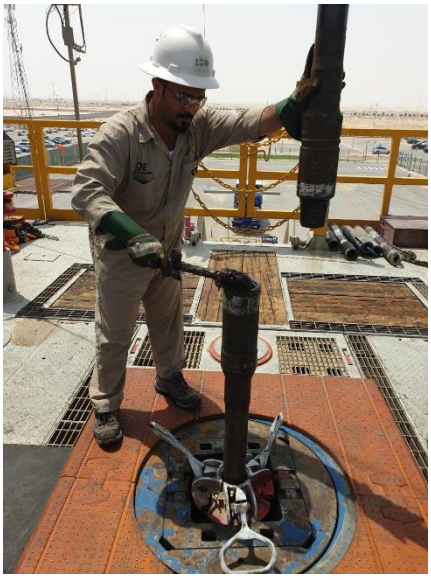
Damaged shoulder

4.3.4 Cleaning

Clean all exposed threads thoroughly. Ensure that no thread compound, dirt, or cleaning material remains on the threads.

CAUTIONS: Solvents and other cleaning agents may contain hazardous material. Solvents are normally volatiles and may build up pressure in containers. Material Safety Data Sheets should be read, and the precautions observe when handling products of this type. Storage, transport, use, and disposal of excess materials and containers should be considered. Observe appropriate regulations relative to disposal of used solvents and generated waste materials.

4.3.5 Greasing



When making up joints of drill string, the Rig-men apply a coating of thread compound, called pipe dope to the tool joint threads and shoulders. Thread compound is a sealant that acts like lubricant. Thread compound contains a soft metallic component like copper or zinc mixed into a grease base, and prevents metal-to-metal contact, reducing friction. It protects the threads from galling. It also makes it easier to screw the two joints together. You never dilute the thread compound. Diluting reduces the percentage of metallic component and Increases the chances of galling the threads and shoulders. Some cleaning fluids dilute the compound and keep it from staying on the surfaces it is meant to protect.

API recommends compounds containing from 40% to 60 % by weight of finely powdered metallic zinc for drill pipe and drill collar connections. The metallic component of the compound reduces the amount of torque applied to the thread and shoulders.

Other thread compounds, such as API-modified, are made especially for tubing and casing. They are not to be used on drill pipe and drill collar tool joints. These sealants are slick and allow the joint to be over tightened with low torque application. Drill pipe and drill collar tool joints can be severely damaged if tubing or casing compound are used.

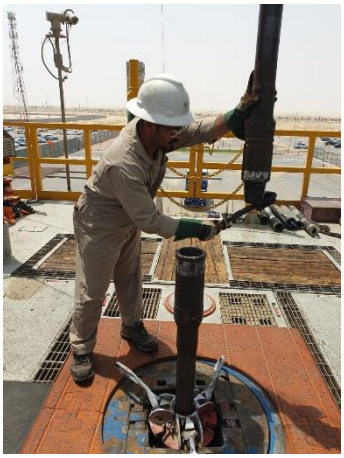


Figure 36 Dope application with dope brush

4.3.6 Color Coding of Tool Joints

The classification system for used DP included a color code designation to identify the DP class. The same system is recommended for tool joint class identification. In addition, it is recommended that the tool joint be identified as (1) field repairable, (2) scrap or shop repairable. This color code system for tool joints and DP is shown in Figure 3.

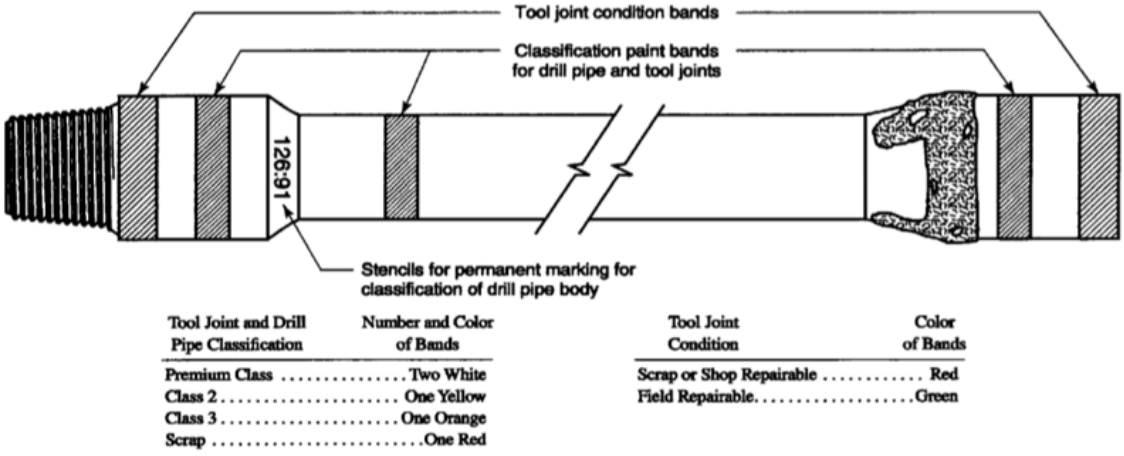


Figure 37 DP and tool joint color code identification

4.3.7 Measurement of Pipe Wall

Tube body conditions will be classified based on the lowest wall thickness measurement obtained and the remaining wall requirements Table 24. The only acceptable wall thickness measurement is those made with pipe-wall micrometers, ultrasonic instruments, or gamma-ray devices.

4.3.8 Instruments for Pipe and Thread Measurements

All the equipment used in the BHA and drilling string is strapped and calipered before going into the well. The main reason for recording these measurements is to have the necessary information to make a special fishing assembly. If the drill string breaks or separates, a fishing assembly has tools that can attach to, and retrieve the tubular that has been left downhole. The drilling string and downhole tools are calipered and drifted to ensure that the inner diameter of the tubular is large enough to pass special tools through them.

Several measurement instruments are being used to precisely the measure drill pipe, drill collar, BHA and tool joint properties.

1- You place the thread gauge on the pipe threads to verify the number of threads per inch (Figure 4).

Figure 38 Tool joint identifier

2- The inside and outside calipers are used to find the tubular ID and OD (Figure 5).

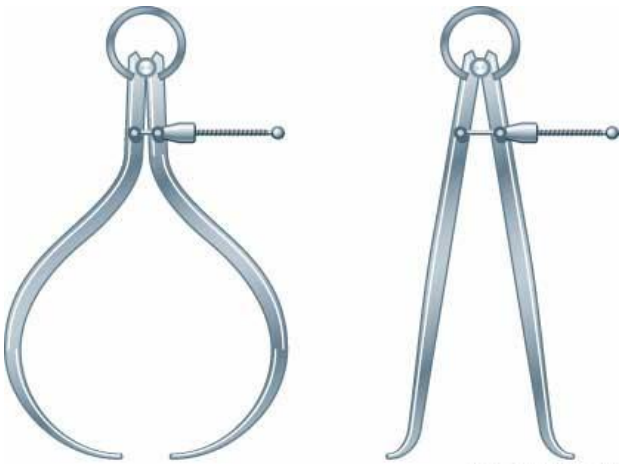


Figure 39 Caliper

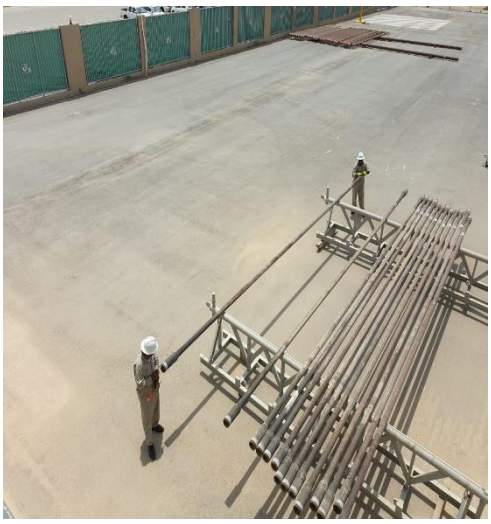
3- The Length of Drill String components are measured carefully by the following measurement tools (Figure 6)

Figure 40 Measuring tape

Box end

Pin end

Using measuring stick on drill floor



Measuring pipe accuracy

Using Calipers to measure internal diameter, outside diameter and threads

4.4 BOTTOM HOLE ASSEMBLY (BHA)

The drill bit, drill pipe, and any other equipment that goes in the hole to drill is what makes up the drill string.

To drill the well, the drill string is rotated by the rig from the surface.

The drill string consists of two main parts

A- BHA "Bottom Hole Assembly"

1- Drill Bit.

2- Drill Collar.

3- Stabilizer.

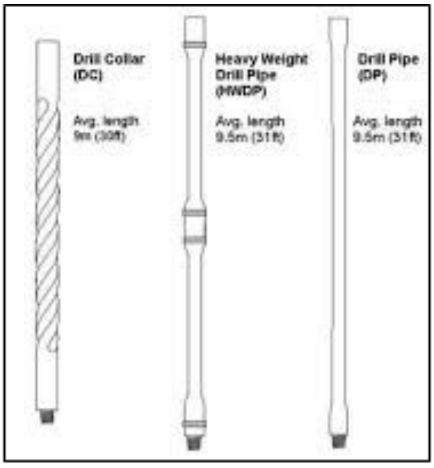
4- Reamer.

5- Jar.

6- Heavy weight drill pipe (HWDP)

7- Subs.

B- Drill pipes



The lower portion of the drill string, consisting of bit, bit sub, stabilizers, reamers, drill collars, jarring devices ("jars"), heavy-weight drill pipes and crossovers for various thread forms. A mud motor could be used sometimes, and it is placed in this case above bit and bit sub is removed.

The bottom hole assembly must provide force for the bit to break the rock (weight on bit), survive a hostile mechanical environment and provide the driller with directional control of the well.

The Information for each component of BHA such as

a. Outer diameter (OD)
b. Inside diameter (ID)
c. Length (L)
d. Serial number (Sr. No.)
e. Fish neck OD & Length (F.N)
f. Cumulative length of BHA.

Should be recorded in BHA Tally sheet and to be presented to Senior tool pusher (S.T.P) and Rig Foreman.

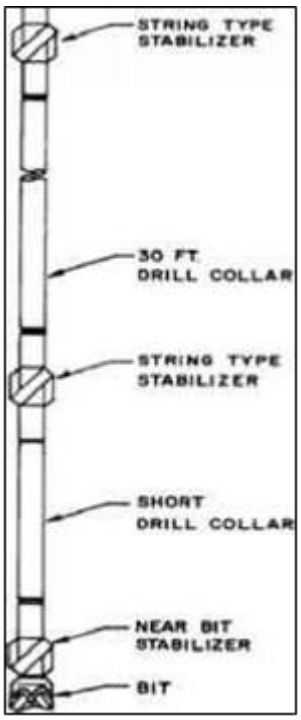
BHA Sheet.

DATE: _____ WELL: _____

BIT No. _____ TOTAL WEIGHT OF BHA : _____

BHA No. _____ WEIGHT BELOW JARS : _____

BHA ITEM	LENGTH	TOTAL LENGTH	OD	ID	F/N LENGTH	F/N OD	REMARKS - S/No



Running a Bottom Hole Assembly (BHA):

Running a new BHA in the well must be well planned in order to avoid any non-productive time (NPT). The preparation involves many actions:

- Checking the availability of all the equipment and components which will be used in the next run.
- Making sure that the stabilizers are in good state and their gauges are adequate to be run.
- Checking the threads and that all the components are adapted to be screwed together.
- Making sure that the number of operating hours of the drilling jar will not exceed the maximum operating hours while drilling the next section.

The drilling bit has also to be prepared:

- Check the gauge of the drilling bit.
- Check the nozzles that they are well set, and they are not plugged.
- Check the threads of the drilling bit.

Before running the BHA in the hole, some precautions must be carried out:

- Close the well when making up the drilling bit to avoid losing anything in the well which can lead to fishing operations.
- Make sure that the safety valve (float valve) is set in good position.

- Measure the length of the make-up tongs.
- Check the make-up torque before screwing the bit.

4.4.1 Drill Bit

The tool used to crush or cut rock, everything on a drilling rig directly or indirectly assists the bit in crushing or cutting the rock. The diameter of the bit determines the diameter of the hole. The drill bit cuts the rock as it rotates at the bottom of the hole. The bit is on the bottom of the drill string and must be changed when it becomes excessively dull or stops making progress. Most bits work by scraping or crushing the rock, or both, usually as part of a rotational motion.

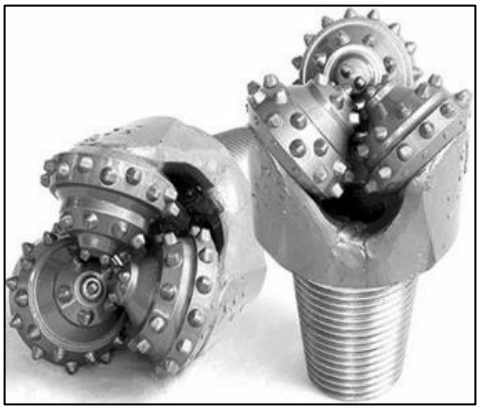


Figure 41 Drill Bits

Running New Drilling Bit

Running a new drilling bit can seem a simple task during the drilling operations. Forget or miss some simple details can affect enormously the operations and lead to non-productive time. The drilling bit is the masterpiece of equipment in the drilling bottom hole assembly. It must be chosen adequately to get the best performances.

First, the drilling bit which must be run has to be on site before pulling out the drill string. The needed drilling bits which are recommended in the drilling program must be available. For this reason, the material inventory has to be checked and updated periodically.

The drilling bit must be verified physically. Check the bit diameter with the adequate gauge, be sure that the gauge is in good condition. The threads must be checked also to avoid getting any wash out at this level. Look for any cracks on drilling bit body and on the cutters.

Hydraulics issue is very important for the operations optimization; the bit nozzles sizes are mentioned in the drilling program. The size is chosen to get better hydraulics performance; on site the bit must be run with the mentioned size. In the case when running a Re-Run bit, be sure that the nozzles are not plugged, this can be done by using a hose of water and look for water flow from the nozzles, you can determine which nozzle is plugged, do this as last action before making-up the bit.

When using a tri-cone bit, check the cones and the sealing

In some cases, it must be sure that the drilling bit can be made up on the drill string. The bit sub has to available on site.

Bit Nozzle

The part of the bit that includes a hole or opening for drilling fluid to exit. The hole is usually small (around 0.25 in. in diameter) and the pressure of the fluid inside the bit is usually high, leading to a high exit velocity through the nozzles that creates a high-velocity jet below the nozzles. This high-velocity jet of fluid cleans both the bit teeth and the bottom of the hole. The sizes of the nozzles are usually measured in 1/32-in. increments (although some are recorded in millimeters), are always reported in "thirty-seconds" of size (i.e., fractional denominators are not reduced), and usually range from 6/32 to 32/32.

Bit Breaker

A special tool used (Figure 42) by the rig crew to prevent the drill bit from turning while the bit sub on top of it is tightened or loosened. Bits have noncylindrical shapes, so the conventional wrenches used by the rig crew to tighten cylindrical shapes like pipes do not fit the bits properly. In addition, some bits, such as PDC bits, have a wide range of unusual and asymmetric shapes or profiles. The bit breaker must match the bit profile, or the bit may be ruined before ever being used.

Figure 42 Bit breaker

Worn/*Damaged* ***Bit***

Drilling uses weight and rotation to make a hole in the rock formation. This creates a lot of friction between the bit and the formation. Heat is created from the friction. The heat combined with the friction causes the bit to wear out over time. When the bit is worn or damaged it will not cut the rock as well as a new bit. Bit damage can also be caused by objects accidently dropped in the well. This is one reason to keep tools and other equipment away from the rotary table (Figure 7).

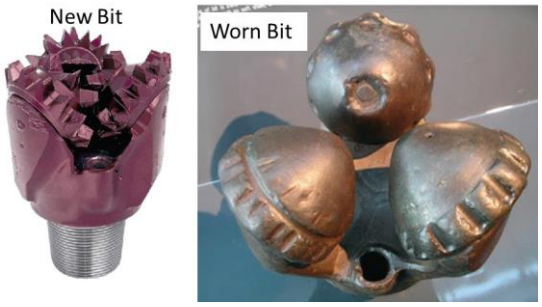


Figure 43 New and Worn Bits

4.4.2 Float Valve (NRV)

A Float Valve or non-return valve (NRV) is a valve that is used to prevent backflow during a drilling operation. The float valve is inserted into the bit sub before running the drill string into the hole. It allows the mud to flow from up to down and it prevents the opposite flow. There're two common types of NRV:

1-Flapper type

2-Plunger type

It prevents back flow of mud or any other fluid from drill string and prevent the bit plugging.

Figure 44 Float valve

4.4.3 Stabilizer

A drilling stabilizer is a piece of downhole equipment used in the bottom hole assembly (BHA) of a drill string.

It mechanically stabilizes the BHA in the borehole to avoid unintentional sidetracking, vibrations, and ensure the quality of the hole being drilled (Control hole deviation).

It is composed of a hollow cylindrical body and stabilizing blades, both made of high-strength steel. The blades can be either straight or spiraled and are hard faced for wear resistance.

It is composed of a hollow cylindrical body and stabilizing blades, both made of high-strength steel. The blades can be either straight or spiraled and are hard-faced for wear resistance.

Several types of drilling stabilizers are used in the oilfield today. While integral stabilizers (fully machined out of a single piece of steel) tend to be the norm, other types can be used, such as:

- Replaceable sleeve stabilizer, where the blades are located on a sleeve, which is then screwed on the body. This type can be economical when no repair facilities are available close to the well being drilled and air freight must be used.
- Welded blades stabilizer, where blades are welded onto the body. This type is usually not advised on oil wells due to the risks of losing blades but is regularly used when drilling water wells or on low-cost oilfields.

Usually 2 to 3 stabilizers are fitted into the BHA, including one just above the drill bit (near-bit stabilizer) and one or two among the drill collars (string stabilizers).

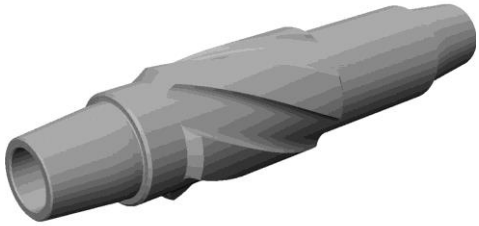


Figure 45 Drilling Stabilizer

4.4.4 Reamer

A reamer is a piece of equipment attached to drill string.

The purpose of the reamer is to keep hole in gauge and enlarge a pilot hole to accommodate the required pipe size.

There're two main types of reamers:

- Near bit reamer "Between bit and drill collar"

It used to keep the hole full gauge and protect gauge of tools above it.

- String reamer "Between drill collar and drill pipe"

It used to ream out dog legs, key seat and ledges.

4.4.5 Drill Collar

A component of a drill string that provides weight on bit (WOB) for drilling.

Drill collars are thick-walled tubular pieces machined from solid bars of steel, usually plain carbon steel but sometimes of non-magnetic nickel-copper alloy or other non-magnetic premium alloys.

Drill collar have a threaded connection on the top and bottom, so they can be joined together it called Pin & box.

Drill collar is identified by the following:

DC - 9 1/2" - #217 ib./ft. - 30’ -7 5/8" REG - Spiral -789
Drill collar outer diameter: 9 ½ inch.
Drill collar nominal weight: 217 ib./ft. Drill collar length: 30 feet.
Drill collar thread connection size & type: 7 5/8’’ Regular.
Drill collar type: Spiral.
Drill collar Serial number: 789

Pin end of drill collar

Drill Collar Inspection Procedure

The following inspection procedure for used DC is recommended:

a) Visually inspect full length to determine obvious damage and overall condition.
b) Measure OD and ID of both ends.
c) Thoroughly clean box and pin threads. Follow immediately with wet fluorescent magnetic particle inspection for detection of cracks. A magnifying mirror may be used in crack detection of the box threads. Drill collars found to contain cracks should be considered unfit for further drilling service. Shop repair of cracked drill collars is typically possible if the unaffected area of the DC permits.
d) Use a profile gauge to check thread form and to check for stretch pins.
e) Check box counterbore diameter for swelling. In addition, use a straight edge on the crests of the threads in the box checking for rocking due to swelling of the box. Some machine shops may cut box counterbores largen than API standards, therefore, a check of the diameter of the counterbore may give a misleading result.
f) Check box and pin shoulders for damage. All field repairable damage shall be repaired by refacing and beveling. Excessive damage to shoulders should be repaired in reputable machine shops with API standard gauges.

4.4.6 Drilling Jar

A mechanical device used downhole to deliver an impact load to another downhole component, especially when that component is stuck.

There are two primary types, hydraulic and mechanical jars.

While their respective designs are quite different, their operation is similar. Energy is stored in the drill string and suddenly released by the jar when it fires.

Figure 46 Jar

Drilling jar is installed in the drill string is immediately available to apply jarring action and release the stuck portion of the drill string.

Jars are placed in the BHA to generate upward or downward impact loads to free stuck pipe or release a fish. There are many factors which affect the decision of when to use jars and where to position them for maximum benefit. Jars should be used when:

- There are sloughing formations in a given area or at a particular depth.
- There are sensitive swelling shales.
- The mud system used does not have good suspension properties to suspend cuttings.

- There is costly equipment in the bottom hole assembly, such as Monel drill collars, downhole motor or MWD tools that need to be recovered.

Jars can be run in compression or tension according to manufacturer recommendation. There are two types of Jars.

Hydraulic jars: -The most common type of hydraulic jars operates on a time delay sequence wherein hydraulic fluid is metered through a small opening for the initial extension of the mandrel. After moving a small distance over several minutes, the fluid opening size increases dramatically, and the jar opens unrestrained.

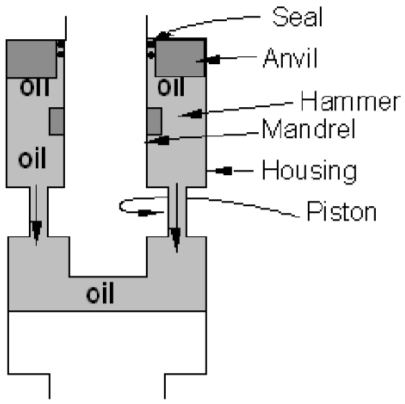


Figure 47 Hydraulic Jar

Mechanical jars: These are preset at surface or in the shop to fire at a given tension

4.4.7 Heavy Weight Drill Pipe (HWDP)

Heavy Weight Drill Pipe (HWDP) is used to make the transaction between the drill collars and the drill pipe. The function of the HWDP is to provide a flexible transaction between the drill collars and the drill pipe. This helps to reduce the number of fatigue failures seen directly above the BHA. A secondary use of HWDP is to add additional weight to the drill bit.

A type of drill pipes whose walls are thicker and collars are longer than conventional drill pipe.

HWDP tends to be stronger and has higher tensile strength than conventional drill pipe, so it is placed near the top of a long drill string for additional support.

HWDP is work as transition pipe between BHA and drill pipe.

Figure 48 Heavy weight drill pipe

4.4.8 Subs

A short, threaded piece of pipe used to adapt parts of the drill string that cannot otherwise be screwed together because of difference in thread size or design.

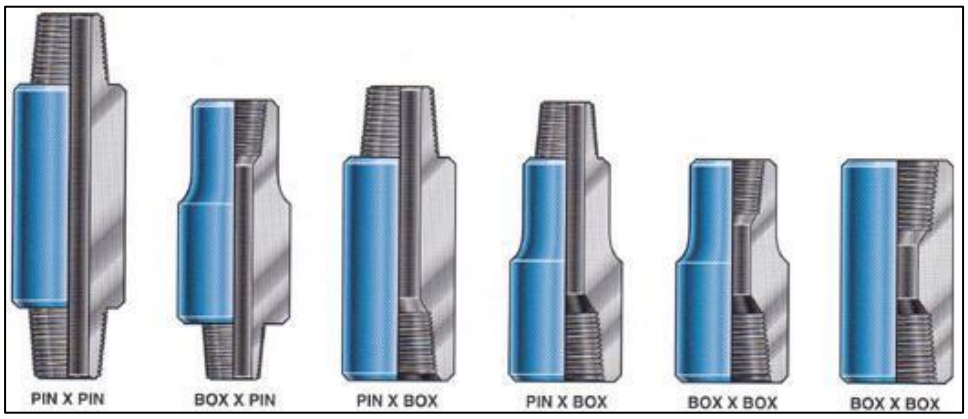


Figure 49 Different types of subs

There're many different types of subs such as:

Bit Sub

A short drill string component ("sub") has double box sub used to connect the drill bit with drill collar and contain the float valve inside.

For example

This bit sub is 7 5/8'' Reg Box X 7 5/8''

Crossover Sub

A short drill string component ("sub") has pin & box ends and used to connect two different types of tubular (different size or thread type).

Kelly Saver Sub

A short drill string component ("sub") attached at the end of Kelly to protect Kelly from wearing due to frequent connection/disconnection of drill pipes.

Lifting Sub

A short drill string component that is temporarily connected to the top of a tool assembly that is to be lifted vertically.

Figure 50 Lifting sub

Shock Sub

The Shock Sub impact and vibration reduction sub is a drill string component that absorbs and dampens the variable axial dynamic loads produced by the drill bit during routine drilling and milling operations. It is most beneficial when drilling in hard rock, broken formations, and intermittent hard and soft streaks. Reducing the impact loads helps to increase ROP; improve borehole quality; and extend the life of the cutting structure, bearings, connections, and surface equipment—all translating to a lower cost of drilling per foot.

Figure 51 Shock sub

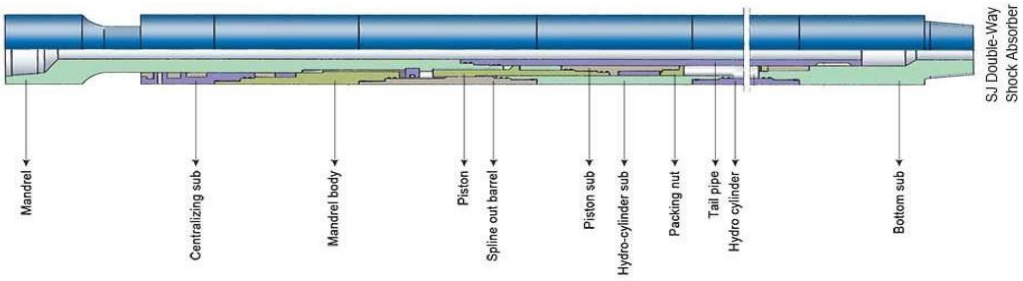


Figure 52 Shock sub components

4.4.9 Drill Pipe

Tubular steel conduit fitted with special threaded ends called **tool joints**.

The drill pipe connects the rig surface equipment with the bottom hole assembly, both to pump drilling fluid to the bit and to be able to raise, lower and rotate the bottom hole assembly (BHA) and bit.

The drill pipe comes in different sizes, strengths, and weight for drilling different sizes and depth of hole.

The drill pipe grades are identified by symbols and number and refers to minimum yield strength.

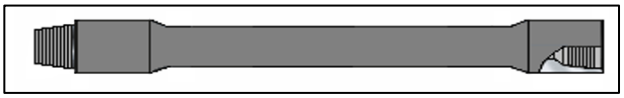
The drill pipe grade for example: D-55, E-75, X-95, G-105 and S-135.

The Number refers to the minimum yield strength in thousands psi it measures drill pipe strength.

A larger diameter hole requires a larger diameter drill pipe, as the hole is drilled deeper, more drill pipes are added to the drill string on the rig floor.

If the well is deeper, then the drill pipe needs to be stronger.

The drill pipe length usually varied from 29 to 33 feet, to save the time of rig we connect three joints of drill pipe together and treated as one part (one stand = 3 drill pipes which is approximately 91 feet).



Single Joint of drill pipe

Stand of drill pipe = 3 joints of drill pipes

Figure 53 Drill pipe single and stands

Drill pipe is identified by the following:

DP – 5'' - X 95 - #19.50 ib./ft - 32' -3 1/2" IF -1789

Drill pipe outer diameter: 5 inches. Drill pipe grade: X-95

Drill pipe nominal weight: 19.50 lb/ft. Drill pipe length: 32 feet.

Drill pipe thread connection size & type: 3 ½'' IF. Drill pipe Serial number: 1789

❖ Drill String Identification

1. In the below image the drill pipe is shown on the right side. Drill pipe is used to transmit rotation of the top drive. It is not used for weight on the bit. The pipe is lighter than the drill collars.
2. Drill Collars on the left side are heavy walled metal tubes made from steel and always run near the bit to provide weight on the bit.
3. Most components in a drill string are manufactured in 31 feet length (range 2), although they can

also be manufactured in 45 feet lengths (range 3). Each 31 feet component is referred as a joint. Typically, 2 or 3 joints are joined together to make a stand.

4. The common types of drill collars are Spiral and Slick.

❖ Preparation for Connection Break-In

Remove any storage or rust preventative coatings. Make sure that the connections are free of dirt or other debris. Thoroughly coat the threads and shoulders of both pin and box connections with a thread compound suitable for rotary shouldered connections. Determine the recommended make-up torque of the connection. Make note of the friction factor of the thread compound and any adjustment required to the applied make up torque.

❖ Connection Break-In at The Rig

Taking care to align the connection, stab and make-up the connection slowly. Spinning in with a chain or high-speed power spinner may cause galling. Using a calibrated torque gage or line pull indicator, slowly make-up to the recommended make-up torque. With manual tongs, use both sets of tongs and keep lines at 90 degrees for the final torque. Slowly break-out the connection. During both make-up and break-out, watch for excessive resistance or other signs that could indicate the possibility of galling. Wipe clean the pin and box connection and visually inspect for evidence of galling in the threads or sealing shoulders. If galling occurs, rework the connection prior to use.

Makeup torque table

Recommended Make-Up Torques	
2⅜ I.F.	3400 Ft-lbs
2⅜ Reg.	3700 Ft-lbs
2⅞ I.F.	5900 Ft-lbs
2⅞ Reg.	6500 Ft-lbs
3½ Reg.	7500 Ft-lbs
4 F.H.	11800 Ft-lbs
4 ½ Reg.	15000 Ft-lbs
4 ½ F.H.	17700 Ft-lbs
6⅝ Reg.	43000 Ft-lbs

4.5 TASKS

1. Show how to identify the different size, grade, weight, and color-coding classification of drill pipe used on your rig.
2. Show how to safely rack tubulars.
3. Demonstrate how to clean tool joints and apply pipe dope.
4. Install and remove drill pipe thread protectors.
5. Explain how to apply corrosion inhibitor to drill pipe and why this done.
6. Show how to rabbit tubulars and explain the reason for doing this.
7. Identify the different elevators used on your and explain how to use each of them.

8. Demonstrate how to use chain tongs to make-up and back-out tubulars such as line pipe, drill pipe, subs.
9. Assist during the inspection of drill pipe, drill collars, and subs.
10. Assist in the pick-up and lay-down operations for drill pipe, drill collars, and tubing.
11. Show how to identify typical tool joints and rotary shouldered connections.
12. Show how to recognize damaged tool joints and rotary shouldered connections.
13. Show how to clean and visually inspect tool joints and drill pipe body for damage.
14. Explain why it is important to use the correct drill string dope for each type of connection.
15. Identify the different tubular thread compounds (dope) used on your rig and show how to use each of them.
16. Show how to number and strap stands of drill pipe from the drill floor.
17. Show how to rabbit stands of drill pipe from the drill floor.
18. Show how to install and remove corrosion rings and explain why these are used.
19. Assist at the Monkey board and relieve the Derrickman during a routine trip and under close supervision for a limited period.
20. Demonstrate each Floorman job position when picking up drill pipe from catwalk such as: rigging up, drifting and check tubulars, measuring and marking tenths, tailing pipe at V-door.
21. Demonstrate each Floorman job position when laying down drill pipe such as: rigging up, installing protectors and working at V-door.
22. Show how to clean and store thread protectors.
23. Show how to install and remove rubber drill pipe protectors.
24. Show how to pick up and lay down drill collars of each size used on your rig.
25. Show how to make up and break out drill collars, using lead and backup tongs, for each size used on rig.
26. Show how to use drill collar lifting subs.
27. Show how to use, adjust, maintain and store the multipurpose safety (dog collar) clamp.
28. Show how to select or adjust drill collar slips for each size of drill collar used on your rig.
29. Assist in making up and breaking out typical bits used on your rig.
30. Assist in installing and removing a bit sub float valve and Totco ring.
31. Assist in using a gauge ring for typical bits and stabilizers used on your rig.
32. Assist in installing and removing jets in typical bits used on your rig.
33. Assist in making up and breaking out a hole opener.
34. Assist in making up and breaking out a large diameter stabilizer.
35. Assist in making up and breaking out typical subs used on your rig.
36. Assist in making up and breaking out a downhole motor.
37. Explain why we use Monel non-magnetic collars.
38. Assist in making up and breaking out drilling jars and explain precautions to take when handling jars.
39. Assist in dressing a sleeve-type stabilizer.
40. Relieve the Rotary Helper on the drill floor during a routine operation and under close supervision.

5. DRILLING FLUID & CIRCULATING SYSTEM

5.1 OBJECTIVES

To make trainees knowledgeable about the following:-

- Drilling fluid types.
- Additives.
- Properties.
- Mud weight and viscosity testing procedures.
- Mixing the drilling fluids.
- Mud System.

5.2 OUTCOMES

Upon completing this section, trainees should be able to:

- Recognize drilling fluid types.
- Be familiar with the additives and their use.
- Know important mud properties.
- Measure mud weight and drilling fluid viscosity.
- Mix and prepare drilling fluid.
- Perform routine maintenance on mud system components.

5.3 DRILLING FLUID

5.3.1 INTRODUCTION

The drilling fluid is the key success of drilling operation and well control.

Drilling fluid also called drilling mud, used to aid the drilling of boreholes into the earth. Often used while drilling oil, natural gas wells and on exploration drilling rigs. Drilling fluids are also used for much simpler boreholes, such as water wells.

The three main categories of drilling fluids are: water-based mud (WBM), which can be dispersed and non-dispersed. Non-aqueous mud, usually called oil-based mud (OBM). A gaseous drilling fluid, in which a wide range of gases can be used. Along with their formatives, these are used along with appropriate polymer and clay additives for drilling various oil and gas formations.

5.3.2 Drilling Fluid Functions

Drilling fluid is used to:

- Remove cuttings from the well.
- Control formation pressure.
- Seal permeable formations.
- Maintain wellbore stability.
- Minimize reservoir damage.
- Cool, lubricate & support bit and drilling string.
- Facilitate cementing & completion.
- Gather data about downhole formations/reservoir from the collected cuttings.

5.3.3 Types of Drilling Fluids:

There are 2 major types of drilling fluid:

- Water Base Mud (WBM).
- Oil Base Mud (OBM).

Drilling fluid consists of:

The Base Liquid:

- Water - fresh or saline.
- Oil - diesel or safra oil.

Dispersed Solids:

- Colloidal particles, which are suspended particles of various sizes.

Dissolved Solids:

- Usually salts, and their effects on colloids most is important.

5.3.4 Drilling Fluid Additives

Many substances, both reactive and inert, are added to drilling fluids to perform specialized functions.

The most common functions are:

Weighting Materials:

- Used to increase mud weight (m.wt).
- A) Hematite … Increases m.wt to 188 PCF.
- B) Barite … Increases m.wt to 155 PCF.
- C) Marble Fine … Increases m.wt to 90 PCF.
- D) Calcium Chloride … Increases m.wt to 85 PCF.
- E) Sodium Chloride … Increases m.wt to 75 PCF.
- F) Potassium Chloride … Increase m.wt to 72 PCF.

Viscosifiers:

- Used to increase viscosity.
- A) Bentonite … For WBM.
- B) XC Polymer … For WBM.
- C) VG-69 … For OBM.

Thinners:

- Used to decrease viscosity.
- A) Tackle … For WBM.
- B) Drill Thin … For WBM.
- C) Drill Treat … For OBM.

PH Control:

We have 2 main categories

- A) Increasing pH:
  Caustic Soda
  Lime
- B) Decreasing pH:
  Sodium Bicarbonate
  Citric Acid

Fluid Loss Reducer:

Used to reduce the amount of water lost to the formations.

- A) Poly Sal & starch:
  Used at surface before bottom hole temperature reaches 250 F.
- B) Mil Pac & Flo Trol:
  Used after bottom hole temperature reaches 250 F.
- C) Resinex & Dris Temp:
  Used for HTHP sections when bottom hole temperature is more than 300 F.
- D) Duratone & Carbotrol:
  Used for HTHP while using OBM.

Lost Circulation Materials: (LCM)

Used in case of losses, by plugging any crack or fracture in formation. Also used to prevent losses while drilling formations with expected losses.

LCM are:

- Marble Medium & Marble Coarse.
- Mica Fine & Mica Coarse.
- Nut Plug.
- Cotton Seed Hulls
- Super Sweep.

Bridging Materials:

Used to seal & strength permeable formations.

Bridging materials are:

- Marble Medium
- Barofibre
- Steel Seal
- Soluflake
- LC Lube

Lubricants:

Used to decrease torque. **EX:** ME Lube & E-24.

Shale Inhibitors:

Used to avoid swelling of shale to prevent stuck. **EX:** KCl, Asphasol Supreme & Black Fury.

Free from Stuck:

Used to mix free from stuck pills.

Chemicals are:

- Glycol
- EZ Spot
- Pipe Lax
- Coastal Spot

Scavengers:

- <u>A) Oxygen Scavengers:</u>
  Sodium Sulfide (Hydrex)
- <u>B) Hydrogen Sulfide Scavengers:</u>
  Zinc Oxide & Sourscav

Defoamers:

Used in case of foams in mud. **EX:** Reda Defoamer & Gem GP.

Emulsifiers:

Used to create a homogeneous mixture of two different liquids

(Water & Oil).

- A) WBM Emulsifiers:
  Tana Mul & Safe Surf
- B) OBM Emulsifiers:
  Primary Emulsifier … **EX:** Cristol PE & Invermul
  Secondary Emulsifier … **EX:** Cristol SE & Versa Coat

Hardness Reducers:

Used to decrease Calcium content. **EX:** Soda Ash.

Bit Balling:

Used to prevent bit balling. **EX:** Condet, Penetrex & Drill Zone.

Bacteriocides:

Used to prevent fermentation. **EX:** B-54.

Completion Materials:

- A) Casing Pickle:
  Used to clean Casing. **EX:** CCT-3000 D, Super Pickle, Rinse Aid & Hog Wash.
- B) Tubing Pickle:
  Used to clean Tubing. **EX:** CCT 8051 & Super Pickle.
- C) Water Inhibitor:
  Used to prevent metal corrosion. **EX:** Coat B-1400.
- D) Diesel Inhibitor:
  EX: Coat 415 & SA-193.

5.3.5 Mixing of Drilling Fluid

Always start drilling at surface sections with spud mud, keep it as clean as possible during drilling to minimize subsequent well development problems. It can be advantageous to use synthetic muds (polymers) when drilling into marginal aquifers. Because it is environmentally friendly.

After the fluid is mixed, enough time must be allowed to elapse to ensure complete hydration of the clay prior to it being circulated into the hole. If this is not done, the clays may swell in the hole or in the aquifer itself. If this happens, it may be impossible to remove them after the casing is installed and the well may never reach its potential yield.

Figure 54 Mud mixing hopper

Drilling fluids must be mixed thick (viscous) enough to bring formation cuttings up from the bottom of the hole to the surface, yet not so viscous as to prevent their settling out in the mud pits. It is, therefore, very important to understand the properties of drilling fluid and their proper use.

EX: Mixing Spud Mud

- 1st we need to check hardness before mixing to ensure that Calcium content is below 400 Mg/L.
- Mixing Procedure:
  Water
  Soda Ash … For Hardness
  Caustic Soda … For pH Control
  Bentonite … As Viscosifier

5.3.6 Mud Properties & Testing Equipment

- **A) Mud Density (M.wt)**
  Unit … PCF.
  Checked by atmospheric mud balance & pressurized mud balance.

- **B) Viscosity**
  Unit … Sec/Qrt.
  Checked by March Funnel.

- **C) Rheology**
  Checked by VG Meter.
  Used to determine PV, YP, LSYP & Gel Strength.
  PV = R600 – R300
  YP = R300 – PV
  LSYP = 2 X R3 – R6
  Gel Strength = Gel 10 sec / Gel 10 min

- **D) Water Loss (Filtrate)**
  Unit … 30 Ml/30 min
  Used to check Fluid loss (30 minute filtrate).
  Checked by API Filter Press & HTHP Filter Press.

HPHT Filter Press

API Filter Press

- **E) pH**
  Use pH Meter to determine Mud pH.

- **F) Salinity**
  Unit … Mg/Liter
  Use API filtrate & Potassium Chromate reagent to determine mud salinity.

- **G) Hardness**
  Unit … Mg/Liter
  Use API filtrate, distilled water, Sodium Hydroxide, Caliver II & EDTA reagents to determine Calcium content.

- **H) Solid Content**
  Used to determine Oil%, Water%, Solids% & Oil/Water Ratio.

- **I) Electrical Stability**
  Unit … Volt.
  For OBM only.
  Checked by electrical Stability Meter.

5.4 CIRCULATING SYSTEM

The circulating system is used to circulate drilling fluid from mud tanks, down through the drill string and up the annulus, carrying the drilled cuttings from the face of the bit to surface, and delivering it to the SCE (Solid Control Equipment) area, until the drilling fluid returns back to mud tanks.

The main components of the circulating system are shown in Figure below:

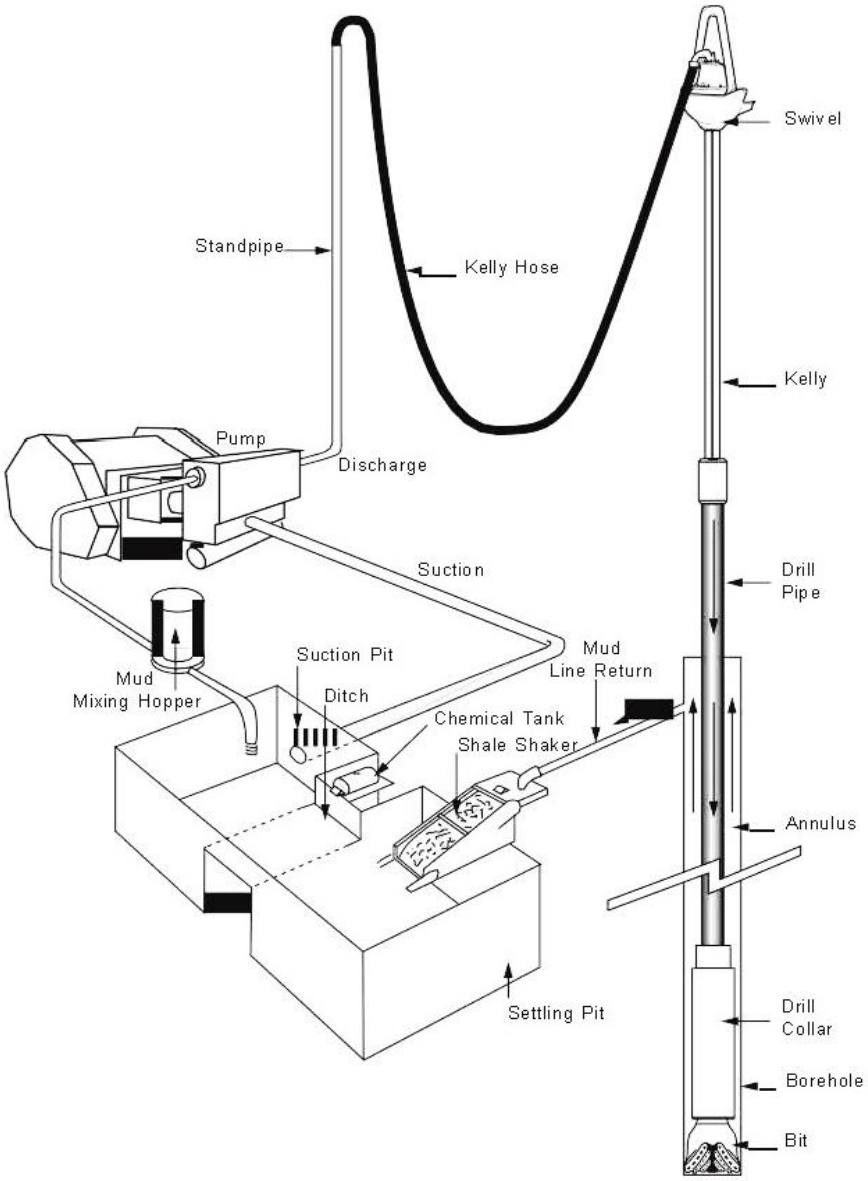


Figure 55 Circulating System

Mud is mixed and conditioned in the mud pits then circulated downhole by large pumps (slush pumps). The mud is pumped through the standpipe, Kelly hose, swivel, Kelly and down the drill string. At the bottom of the hole the mud passes through the bit and then up the annulus, carrying cuttings up to surface. On surface the mud is directed from the annulus, through the flow line (or mud return line) and before it re-enters the mud pits the drilled cuttings are removed from the drilling mud by the solids control equipment.

Once the drilled cuttings have been removed from the mud it is re-circulated down the hole. The mud is therefore in a continuous circulating system. The properties of the mud are checked continuously to ensure that the desired properties of the mud are maintained. If the properties of the mud change then chemicals will be added to the mud to bring the properties back to those that are required to fulfill the functions of the fluid. These chemicals will be added whilst circulating through the mud pits or mud with

the required properties will be mixed in separate mud pits and slowly transferred in with the circulating mud.

When the mud pumps are switched off, the mud will stop flowing through the system and the level of the mud inside the drill string will equal the level in the annulus.

The level in the annulus will be equal to the height of the mud return flow line. If the mud continues to flow from the annulus when the mud pumps are switched off, then an influx from the formation is occurring and the well should be closed in with the Blowout preventer stack. If the level of fluid in the well falls below the flow line when the mud pumps are shut down losses are occurring (the mud is flowing into the formations downhole). Losses will be discussed at length in a subsequent chapter.

5.4.1 Mud Tanks (Mud System/Mud Pit)

There are two main categories for mud system classification:

- A) Physically
- B) By usage

A) Physically Classification:

- **Active Tanks**
  Tanks which used while drilling or circulation. We can mix & pump through them.
- **Reserve Tanks**
  Tanks which used to mix & store mud. We can mix & pump through them if needed.
- **Non Active Tanks**
  Tanks which used for storing mud only. We can't mix or pump through them.
- **Slug Tank**
  Small tank which used for preparing slug (m.wt > regular m.wt by 15 – 20 PCF). Also, can be used for preparing some pills.

B) By Usage:

- **Long System (Closed System)**
  Used while drilling long sections to avoid solids contamination with dumping sand trap.
- **Short System**
  Used while drilling small sections. Also used while using certain types of mud. While loss of circulation occurs to re-build mud volume.
  Return mud bypass shaker tanks through ditch line.

The mud pits are usually a series of large steel tanks, all interconnected and fitted with agitators to maintain the solids, used to maintain the density of the drilling fluid, in suspension. Some pits are used for circulating (e.g. suction pit) and others for mixing and storing fresh mud. Most modern rigs have equipment for storing and mixing bulk additives (e.g. barite) as well as chemicals (both granular and liquid). The mixing pumps are generally high volume, low pressure centrifugal pumps.

5.4.2 Mud Pumps

Mud pump is made up of power and fluid ends. At shallow depths they are usually connected in parallel to deliver high flow rates. As the well goes deeper the pumps may act in series to provide high pressure and lower flow rates.

Positive displacement type pumps are used (reciprocating pistons) to deliver the high volumes and high pressures required to circulate mud through the drill string and up the annulus.

There are **two** types of positive displacement pumps in common use:

(A) Duplex (2 cylinders) - double acting
(B) Triplex (3 cylinders) - single acting

Triplex pumps:
Are generally used in offshore rigs.
Duplex pumps
Are used in land rigs. Duplex pumps have two cylinders and are double-acting (i.e. pump on the up-stroke

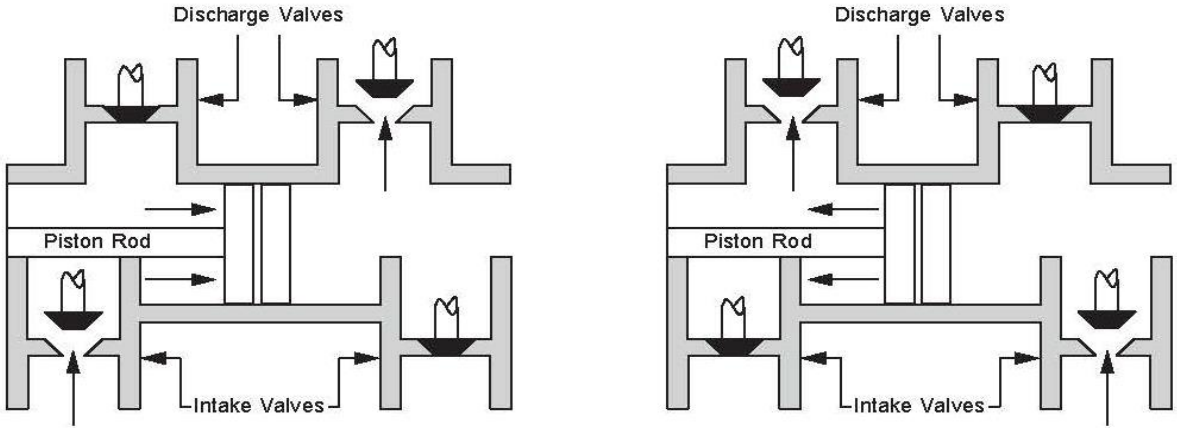


Figure 56 Duplex pump

and the down-stroke). Triplex pumps have three cylinders and are single-acting (i.e. pump on the up-stroke only).
Triplex pumps have the advantages of being lighter, give smoother discharge and have lower maintenance costs.

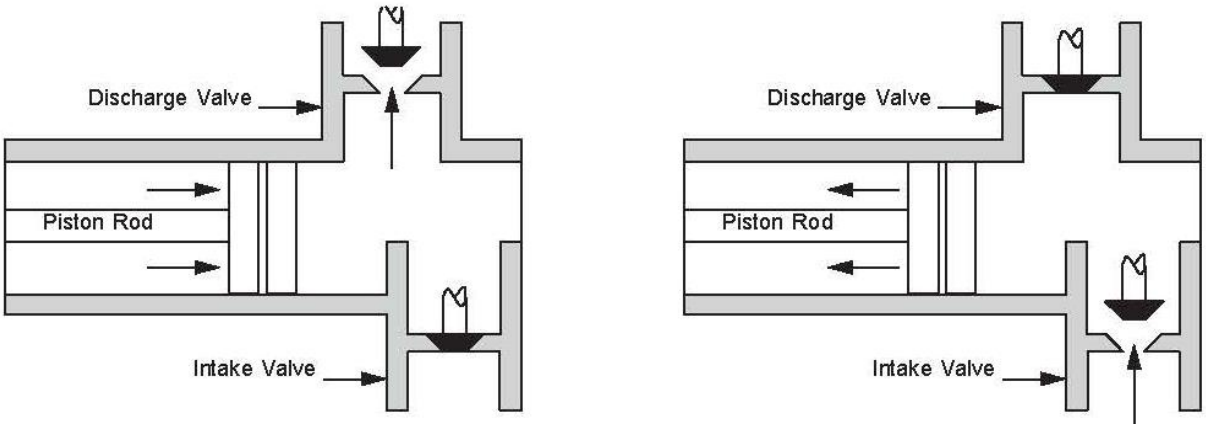


Figure 57 Triplex pump

The discharge line from the mud pumps is connected to the **standpipe** - a steel pipe mounted vertically on one leg of the derrick. A flexible rubber hose (**Kelly hose**) connects the top of the standpipe to the **swivel** via the **gooseneck**. The swivel will be discussed in the section on rotary system.

Once the mud has been circulated round the system it will contain suspended drilled cuttings, perhaps some gas and other contaminants. These must be removed before the mud is recycled.
The mud passes over a shale shaker, which is basically a vibrating screen. This will remove the larger particles, while allowing the residue (underflow) to pass into settling tanks. The finer material can be removed using other solids removal equipment. If the mud contains gas from the formation it will be passed through a degasser which separates the gas from the liquid mud.
Having passed through all the mud processing equipment the mud is returned to the mud tanks for recycling.

There will be at least two pumps on the rig, and these will be connected by a mud manifold. When drilling large diameter hole near surface both pumps are connected in parallel to produce high flow rates. When drilling smaller size hole only one pump is usually necessary and the other is used as a back-up. The advantages of using reciprocating positive displacement pumps are that they can be used to:

- Pump fluids containing high solids content.
- Operate over a wide range of pressures and flow rates.

Pump Output Calculations:

Pump Output Calculation for Triples Single Acting Mud Pump:

Pump out put in bbl/stk = $\frac{D^2}{1029.4} \times 3 \times \frac{L}{12} \times eff$

Where:

D = Liner diameter in inches

L = Stroke length in inches

Eff = Pump efficiency

Pulsation Dampeners:

At this point, the resulting pulses have been created and will have to be absorbed in part by some system, such as a pulsation dampener. A pulsation dampener relies on differential pressure and moving parts to absorb the instantaneous changes in the flow rate resulting from changing piston speed. (It works much like a shock absorber in a car). Because of the flow rate change during one piston stroke and the exponential pressure that results, pulsation dampeners are generally large, heavy, and difficult to handle and time consuming to service.

Figure 58 Mud Pulsation Dampeners

Although a pulsation dampener can absorb much of the pump's pulse, its effectiveness depends upon the following factors:

- Location.
- Distance from the source of the pulse.
- Not being compromised by flow barriers.
- Not being dampened by the strainer cross; with the dampener on top of the strainer cross some of the pulse will escape down hole rather than being removed by the dampener.
- Regularity of pulses, to assist with proper dampener calibration.
- Proper calibration.

There has been little evolution in triplex pumps and their pulsation dampeners for many years but one thing that seems to be constant with conventional triplex pumps, is that a pulse and vibration will be noticed.

5.4.3 Solid Control Equipment (SCE)

The removal of drilled solids requires 3 techniques; screening, centrifuging & combination of (screening & centrifuging). Proper set up & sequence of SCE is essential to a successful solids removal program. Proper sequencing includes returning the desired fraction of the processed mud to the next under flow pit & corresponding piece of equipment otherwise the use of the equipment is less effective.

SCE types:

A) <u>Shale Shaker (Screens)</u>

The shale shaker has a set of trays with a filter, or screens that vibrate. As the screens vibrate mud filters through them and flows onto the next solid control and mud conditioning equipment. The screens remove cuttings from the mud and deposit them into waste pit.

B) <u>Mud Cleaner (Desilter & Desander)</u>

Shale shakers remove large cuttings from the mud returns, but not smaller solid particles. The returning mud is heavier than the mud that is pumped into the well. The solids must be removed or "cleaned" from the mud to maintain a desired mud weight. To do its job correctly, the mud must not be allowed to get too heavy. To clean the mud, drillers use filtering devices known as Desander, Desilter and mud cleaners. These separate the sand and shale from the mud and dump them into the waste pit.

C) <u>Centrifuge</u>

Centrifuge is used to remove more solids from mud. Working in two modes; **Solid Removal Mode** & **Barite Recovery Mode**.

D) Degasser

Degasser is used to remove gases from mud in case of gas contamination or kick.

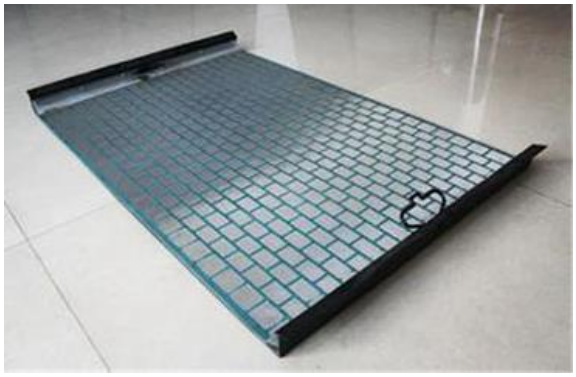
E) Mud Gas Separator (Gas Puster)

Mud gas separator is used to remove gases from mud while kick.

Cleaning Shale Shaker Screens

After operating the solids control equipment while drilling, to save cost, lengthen the life of shaker screen is very important. The essential thing is an active screen maintenance program.

Screen panel flexing caused by dirty, missing or worn deck rubbers. Clean dirty deck rubbers or replace missing or worn deck rubbers. Always change all deck rubbers in the affected section of the shaker.



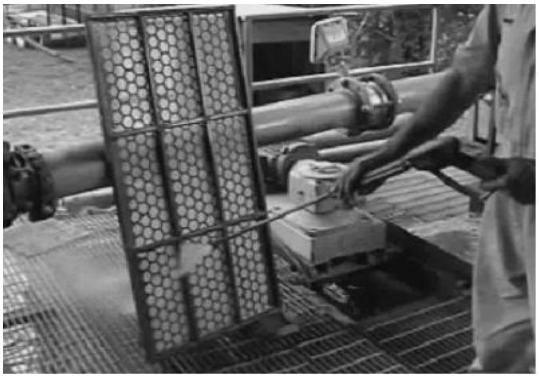


Figure 59 Cleaning shaker screens

Procedure of cleaning screens:

- Remove any solids that become adhered to the screen cloth. Use a water hose or pressure washer to clean screens. **NEVER** clean screens with a wire brush. If screens become blinded with near size particles it is best to remove and wash with a pressure washer from the back side.
- Always clean screens if the shaker will be idle for a long period of time. Mud and cuttings that can dry on screens will eventually lead to premature failure. When replacing the shaker screen, another important part came to eyes, and it's the rubber. It is also an essential step to ensure the security of the system.
- Once the worn or damaged screen panel is removed from the screen deck, always clean and inspect deck rubbers. If deck rubbers are worn or missing, always replace all four deck rubbers in that section of the screen deck. Replace any missing fasteners.

NEVER install screens over worn or missing deck rubbers.

ALWAYS ensure that screen wedge locks are properly installed and firmly in place.

NEVER walk or stand on the screen panel(s). Take care not to drop anything on the screen panel(s).

Changing Shaker screens depends on:

- Formation properties.
- Mud properties

For example, if the formation tends to produce small size cuttings; we tend to use smaller mesh screens. Likewise, if mud builds up viscosity, we go for smaller mesh screens.

Also screen visual inspection is very important; any torn screen should be **replaced immediately.**

5.5 TASKS

1. Handling & Mixing the different mud chemicals used on your rig.
2. Practice how to clean the mud tanks.
3. Show how to mix typical mud chemicals.
4. Show how to handle hazardous drilling fluid products.
5. Assist in routine servicing of the Desander and Desilter.
6. Assist in routine servicing of the mud cleaner.
7. Assist in routine servicing of the vacuum degasser.
8. Show how to clean the shale shaker screens while drilling.
9. Identify and report typical shale shaker malfunctions.
10. Changing shale shaker screens.
11. Assist in routine servicing of the mud centrifuge.
12. High pressure pipe and hose connections.

6. MUD PUMP MAINTENANCE

6.1 OBJECTIVES

- Mud pump maintenance and service.
- Calculate different types of volumes.
- Understanding measuring units and technic.

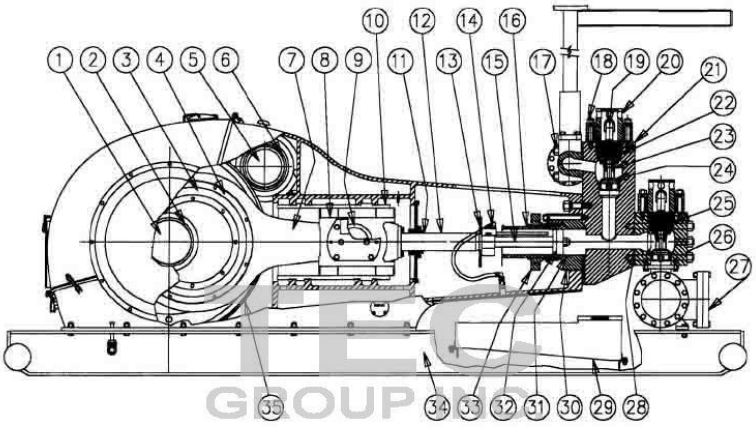
6.2 OUTCOMES

- Perform routine maintenance on mud system components.
- Understanding the mud pump's parts, piston/liner cooling fluid, spray nozzles, cooling pump, and suction pump filters.
- More hands-on mud pump liner, piston, suction and discharge valves.
- Calculate different types of volumes.
- Understanding measuring units and technic.

6.3 MUD PUMPS MAINTENANCE

Mud pump is made up of power and fluid ends. The fluid end components are illustrated in The piston, liner and some spare parts of a mud pump are illustrated in .

Figure 60 Mud Pumps



	DESCRIPTION		DESCRIPTION		DESCRIPTION
1	CRANKSHAFT	13	BAFFLE, MUD	25	PLUG, VALVE
2	BEARING, MAIN	14	CLAMP. ROD, PISTON	26	MODULE, SUCTION
3	BEARING, ECCENTRIC	15	ROD, PISTON	27	MANIFOLD, SUCTION
4	RETAINER, BEARING	16	LINER	28	SEAL, MODULE
5	SHAFT, PINION	17	MANIFOLD, DISCHARGE	29	TANK, LINER WASH
6	BEARING, PINION	18	RING, THREAD	30	RING, WEAR
7	ROD, CONNECTING	19	PLUG, VALVE	31	SEAL, LINER
8	CROSSHEAD	20	RETAINER, PLUG	32	PISTON
9	BEARING, CROSSHEAD	21	MODULE, DISCHARGE	33	RETAINER, LINER
10	GUIDE , CROSSHEAD	22	PACKING, PLUG, VALVE	34	SKID
11	BOX, STRIPPER	23	GUIDE, VALVE	35	GEAR, BULL
12	EXTENSION, CROSSHEAD	24	VALVE AND SEAT		

Figure 61 Mud pump fluid end components

Figure 62 Liners and rubber parts

Liner types:

- Premium Chrome Liners (Bimetal Liners).
- Chrome-Plated Liners.
- Hardened Steel Liners.
- Ceramic Liners (Zirconia Liners).

Piston types:

- Renewable Pistons.
- Rubber Pistons.
- Piston Hubs.
- Urethane Bonded Piston.

Valves and seats:

- Upper and Lower valve guide.
- 3-Web Style.
- 4-Web Style.
- Full Open Style.
- G2 Style.
- Wing Type.
- Hydraulic Seat Pullers.

6.3.1 Pistons and Liner Systems

The piston and liner system of a mud pump fluid end consist of the piston, liner, liner seal, wear plate, wear plate seal, liner retainer, the piston rods and rod clamps. Of these items, the piston will experience the most wear and will typically be replaced the most. Routine piston maintenance presents an excellent opportunity to inspect other components in the system. For example, because of high levels of vibration during operation, rod clamps can loosen, which causes excess wear to the clamp and the rod. Additionally, a worn rod clamp can cause damage to the rod that would affect its alignment with respect to the centerline of the liner bore. Any misalignment of this type would cause accelerated wear of the piston and liner. In respect to addressing loose rod clamps, it is important to note that over torqueing rod clamp bolts can have adverse effects as well. The recommended tightening torque for a rod clamp bolt is significantly less than the same size bolt used in a flanged connection application. A small gap should be between the two halves of a typical rod clamp when it is properly tightened ().

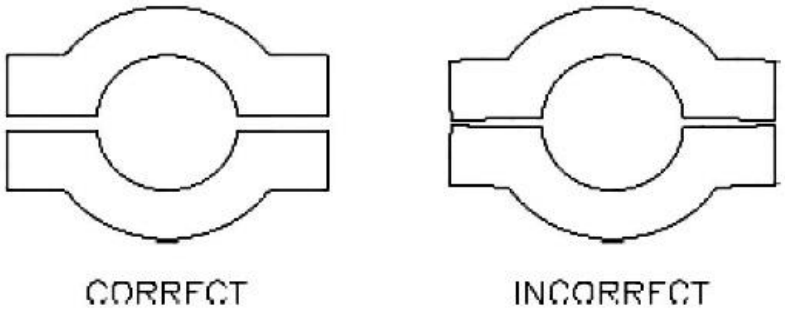


Figure 63 Correct and incorrect tightening of rod clamps

Over tightening the clamp causes the two halves to meet and runs the risk of overloading the clamp, which can lead to permanent damage of the rod and clamp.

Pistons generally provide longer service life when they are engineered for the environment in which they will operate. Therefore, operators must know the properties of the drilling mud that is being used as well as the drilling conditions. For example, if the mud temperature is more than 180 F, the operator needs to consider a piston that is designed for high-temperature service. The performance of all elastomers will degrade as temperature rises, but new elastomers are available on the market that will yield longer run times in high temperature environments. Generally, urethane pistons do not perform as well when running in water-based muds as nitrile or hydrogenated nitrile butadiene rubber pistons. Conversely, nitrile pistons do not perform as well in oil-based muds as urethane pistons.

6.3.2 Valves and Seat Systems

The valve and seat system consist of the valve, valve seat, valve spring, valve guide and bushing, valve cover, and valve cover seal. One of the most overlooked components of the fluid end is the valve spring. This inexpensive, small item can wreak havoc on the mud pump fluid end if it is not in proper running order. When the piston transitions from its suction stroke to its discharge stroke, the valve spring is supposed to push the suction valve down on the seat, closing the valve. A weak valve spring allows the valve to dwell in the open position longer than it should. This results in reduced efficiency because of mud flow reversal as well as the valve being slammed down on the valve seat by the returning piston stroke.

If a valve runs for 500 hours at 100 strokes per minute, the spring will experience 3,000,000 cycles. Considering its high cycling function, the valve spring should be replaced with every valve replacement.

As with all operations, safety is first and needs to be given a tremendous amount of consideration when performing valve and seat maintenance. The full open valve seat has become more popular in recent years due to improved flow and ease of maintenance. In valve over valve fluid ends, the full open valve seat allows easy access to the suction valve without having to remove the discharge valve seat. This was previously not an option with webbed seat designs. However, webbed seats are easier and safer to remove from the module because of their design and anchor points with the removal tools.

Split puller heads are used to pull full open seats. Split puller heads are designed to collapse to allow insertion into the full open seat. The puller screw is then threaded into the puller head to keep the puller head halves spread and allow the seat to be pulled.

A common problem arises when the puller screw is not completely threaded into the puller head. When attempting to pull the seat, the pulling action collapses the puller head halves and exerts a strong force on the puller head retaining ring resulting in a catastrophic puller head failure.

When this occurs, force is released, and the tool can severely injure anyone standing nearby. Standing clear when performing this operation is critical for personnel safety.

When replacing valve seats, care must be taken. The seat deck taper must be inspected for corrosive pitting. Areas of corrosive pitting can progress inward from the top and bottom of the seat. If they meet, they will create a fluid path for a wash to occur. When a valve seat becomes pitted, it must be lapped to remove the pitting. Some companies make tools for this. However, a simple way to do this is to use a three- or four-web seat as the lapping tool.

Another part that is often overlooked in the valve and seat system is the valve guide bushing. When performing valve or seat maintenance, the valve guide bushing should be inspected for excess wear or damage. The valve guide bushing should be replaced if necessary.

A worn or damaged valve guide bushing can cause the valve to stick or become misaligned and not engage the seat properly. This malfunction can lead to a module washout, a catastrophic failure of the module because of the high-pressure fluids.

Figure 64 Valve and seat spare parts

6.3.3 Fluid End Modules

When a wash occurs in a fluid end module, little can be done in the field to repair it other than the lapping of the seat deck tapers that was previously mentioned. The module must be sent to a repair facility that is familiar with the proper weld procedure required to repair the washed-out area. The repair shop must have a way to apply the proper preheating, post-weld stress relieving and the machining capability to perform suitable repairs to fluid end modules.

Figure 65 Eroded valve cover seal

Keep an eye on valve cover seal areas. Normally, valve covers are not supposed to “breath” or move during operation. However, if a loose valve cover gland allows this to happen, wear in the seal area will occur. If left unchecked the valve cover will eventually leak.

Seals are an inexpensive item, and if an opportunity presents itself, a seal should be changed if an operator has the slightest doubt about its condition or age. All elastomeric parts have a shelf life, and heat and humidity will drastically reduce the part’s condition.

6.3.4 Replacement Parts

Along with performing routine maintenance, selecting high quality replacement parts is equally important because this has a direct impact on the overall performance of a mud system. As the adage goes, “You get what you pay for.”

Depending on the drilling environment, some operators who have chosen to run lower quality replacement parts report a decreased life cycle of their consumable items and a reduction in the overall performance of their mud pump systems.

In conclusion, a disciplined preventive maintenance program in conjunction with using high quality replacement parts is crucial for proper mud pump fluid end performance.

6.3.5 Pump Service

The most important thing you can do is service your pump, per the manufacturer's requirements. We get plenty of pumps in the shop for service work that look like they have been abused for years without having basic maintenance, such as regular oil changes. You wouldn't dream of treating your personal vehicle like that, so why would you treat your pump like that.

Check the oil daily and change the oil regularly. If you find water or drilling mud contamination in the oil, change the oil as soon as possible. Failure to do so will most likely leave you a substantial bill to rebuild the gear end, which could have been avoided if proper maintenance procedures would have been followed. Water in the oil does not allow the oil to perform correctly, which will burn up your gear end. Drilling mud in your gear end will act as a lapping compound and will wear out all of the bearing surfaces in your pump. Either way it will be costly. The main reasons for having water or drilling mud in the gear end of your pump is because your pony rod packing is failing and/or you have let your liners and pistons get severely worn. Indication of this is fluid that should be contained inside the fluid end of your pump is now moving past your piston and spraying into the cradle of the pump, which forces its way past the pony rod packing. Pony rod packing is meant to keep the oil in the gear end and the liner wash fluid out of the gear end. Even with brand new packing, you can have water or drilling fluid enter the gear end if it is sprayed with enough force, because a piston or liner is worn out.

Monitor your oil and keep your pistons, liners and pony rod packing in good condition. If a liner starts to leak, identify the problem and change it as soon as possible.

There is also usually a valve on the inlet of the spray bar. This valve should be closed enough so that liner wash fluid does not spray all over the top of the pump and other components.

6.3.6 Liner Wash Fluid

Liner wash fluid can be comprised of different fluids, but we recommend just using clean water. In extremely cold conditions, you can use RV antifreeze. The liner wash or rod wash system is usually a closed loop type of system, consisting of a tank, a small pump and a spray bar. The pump will move fluid from the tank through the spray bar, and onto the inside of the liner to cool the liner, preventing scorching. The fluid will then collect in the bottom of the cradle of the pump and drain back down into the collection tank below the cradle and repeat the cycle. It is important to have clean fluid no matter what fluid you use. If your liners are leaking and the tank is full of drilling fluid, you will not cool the liners properly — which will just make the situation worse. There is also usually a valve on the inlet of the spray bar. This valve should be closed enough so that liner wash fluid does not spray all over the top of the pump and other components. Ensure that the water is spraying inside the liner and that any overspray is not traveling out of the pump onto the ground or onto the pony rod packing where it could be pulled into the gear end. If the fluid is spraying out of the cradle area and falling onto the ground, it won't be long before your liner wash tank is empty. It only takes a minute without the cooling fluid being sprayed before the liners become scorched. You will then need to replace the pistons and liners, which is an avoidable costly repair. Make a point to check the liner wash fluid level several times a day.

Figure 66 Liner wash fluid

Liner wash fluid can be comprised of different fluids, but it is recommended to just using clean water. In extremely cold conditions, you can use RV antifreeze.

6.3.7 Drilling Fluid Cleanse

Drilling fluid — whether pumping drilling mud, straight water or some combination of fluid — needs to be clean. Clean meaning free of solids. If you are recycling your fluid, make sure you are using a quality mud recycling system and check the solids content often throughout the day to make sure the system is doing its job. A quality mud system being run correctly should be able to keep your solids content down to one quarter of 1 percent or lower. When filling your mud recycling system, be sure to screen the fluid coming into the tanks. If it is a mud recycling system, simply make sure the fluid is going over the scalping shaker with screens in the shaker. If using some other type of tank, use an inline filter or some other method of filtering. Pumping out of creeks, rivers, lakes and ponds can introduce plenty of solids into your tanks if you are not filtering this fluid. When obtaining water out of a fire hydrant, there can be a lot of sand in the line, so don't assume it's clean and ensure it's filtered before use.

Figure 67 Mud filter

6.3.8 Cavitation Prevention

Cavitation is a whole other detailed discussion, but all triplex pumps have a minimum amount of suction pressure that is required to run properly. Make sure this suction pressure is always maintained or your pump may cavitate. If you run a pump that is cavitating, it will shorten the life of all fluid end expendables and, in severe cases, can lead to gear end and fluid end destruction. If the pump is experiencing cavitation issues, the problem must be identified and corrected immediately.

The long and the short of it is to use clean drilling fluid and you will extend the life of your pumps expendables and downhole tooling and keep up with your maintenance on the gear end of your pump. always Avoid pump cavitation. Taking a few minutes, a day to inspect and maintain your pump can save you downtime and costly repair bills.

6.4 TASKS

1. Assist in maintaining the mud pump's piston/liner cooling fluid, spray nozzles, cooling pump, and suction pump filters.
2. Assist in changing out the mud pump liner, piston, suction and discharge valves.
3. Assist in resetting the pressure relief valve and explain its purpose.

7. TRIPPING IN (RIH), DRILLING, AND TRIPPING OUT (POOH) OPERATIONS

7.1 OBJECTIVES

To make trainees knowledgeable about following:-

- Understanding tripping operation.
- Making connections and running in hole.
- Understanding drilling parameters.
- Pulling out of hole and breaking out pipes.

7.2 OUTCOMES

Upon completing this section, Trainees should be able to:

- Understanding tripping operation techniques.
- Making connections and running in Hole.
- How to deal with drilling parameters and differentiate between them.
- Understanding pull out of hole hazards trying to avoid incidents.
- Practice breaking out most of drill string equipment by using the rig tong, pipe spanner and iron roughneck.

7.3 INTRODUCTION

The highest incidence of accidents occurs around the rotary table when workers are making a trip. The reason for this is worker exposure to the hazards for a greater length of time than they would experience while making a single connection. Trainees must be aware with all drilling operations techniques used daily at the rig. How to Make Connections, Running in Hole, pulling out of hole and breaking up as a daily routine practice.

Tripping pipe is a normal operation on the drilling rig. The pipe is either pulled out of or run into the hole. The pipe is pulled out in single, double, or triple drill pipe stands and stood on the rig floor. shows the bottom of a stand of drill pipe being stood on the rig floor while the top of the stand being on the derrick.

Figure 68 Stands of Pipe on the Rig Floor and Derrick

Drilling parameters and monitoring the well is a must to control the well while drilling.

7.4 TRIPPING IN OPERATIONS/RUNNING IN HOLE (RIH)

The BHA is assembled first and run into the hole. Then the stands of pipe in the derrick are connected. The components of the BHA require a higher torque for making up or breaking out the connections.

To pick up a stand of pipe, the driller runs the block up to the derrickman. The derrickman throws a drill pipe into the elevators as shown in figure below, while grabbing the handles and closing the elevators. The driller continues to raise the traveling block.

Figure 69

The crew gets ready to handle the stand as a stand of drill pipe is led across the rig floor for stabbing, the derrick man will break the swing of the pipe from aloft.

Figure 70 Iron roughneck

The pipe is lifted off the rig floor until the pin is at chest height. The crew then guides the bottom of the pipe to the rotary table. When the pipe is lined up as shown in Figure above, the driller lowers the traveling block.

The crew installs the pipe spinner onto the stand. They close the spinner and then spin the stand into the connection. They remove the pipe spinner when it has spun the stand in as far as it can. The crew installs

the make-up tong onto the pipe above the connection. The breakout tong goes onto the lower pipe. The driller torques the connection by pulling on the make-up tong line.

The driller picks up on the drilling string. This allows the crew to pull the slips out of the rotary table. The slips should be pulled far enough so they do not fall onto the rotary table while the driller lowers the pipe into the hole.

The driller continues lowering the pipe until the elevators get close to the rig floor. As shown in figure below, the crew then installs (sets) the slips into the rotary table. The crew then opens the elevators when the weight of the drill string is set into the slips. One man on the rig floor looks up at the derrickman to line up the elevators. After opening and lining up the elevators, the driller raises the elevators to the derrickman to repeat the process.

Figure 71 Setting the Slips

CAUTION

When the elevators are removed from the drill pipe in the rotary table the crew must line up the elevators. A Rig-man looks up to see what the derrickman is telling him. Sometimes it is easier for the derrickman to throw the pipe in when the elevators are turned slightly right or left. The derrickman can then throw in the pipe, as seen in figure below

Figure 72 Derrickman Throwing a Pipe into the Elevators

Iron roughneck:

Designed to make up drill pipe and drill collar connections to a maximum of torque and break out connections to a maximum. Although the iron roughneck was designed, tested, and field proven to achieve the maximum output torque

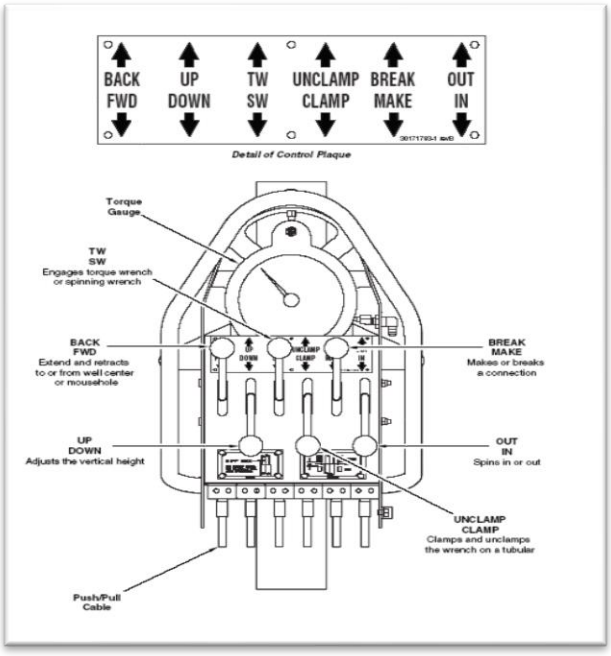


Figure 73 Iron roughneck

7.5 DRILLING OPERATION

- Operate at the weight on bit (WOB) /rotary speed (RPM) combination that gave the highest penetration rate (ROP) in the drill-off tests, unless significant losses problem is expected.
- Proper and correct drilling practices must be exercised to ensure that hole quality and prevention of washout and enlargement could be adequately managed at the rig site through instituting proper drilling practices.
- Do not apply excessive WOB if bit or BHA balling have been identified as potential problems.
- Use reduced pumping rate (GPM) immediately after spudding to avoid washout below conductor pipe, but after drilling 30 ft. increase pump rate to maximum. The use of viscous pills before connections will help clean the hole.
- The maximum allowable penetration rate, beyond which the Equivalent Circulating Density (ECD) exceeds the leak-off pressure, due to cuttings loading in the annulus, should not to be exceeded.
- Bit selection will be as outlined in ARAMCO well program.
- Maximize jet impact force to ensure that bit, teeth/inserts and bottom of hole are maintained cleaned. Use maximum available energy from mud pumps.
- Consider using center nozzle for better bit cleaning.
- Clearing drilled cuttings from the bits and hole openers is paramount in large hole sizes.
- Sweeps must be pumped often and of sufficient size to keep bit and BHA clean.
- Do not drill with one pump.
- Utilize ROP log from nearby wells for ROP and formations tops references.
- Rotate pipes at suitable speeds (RPM) as lower speeds can be used in small hole sizes.
- Avoid BHA components that will not allow the hydraulic and hole cleaning procedures to occur.
- Don’t POOH while pumping out at higher rate than the circulation rate being used.
- Rotate at high RPM, and work pipe slowly, while pumping at maximum flow rate to clean up hole prior to tripping.
- Minimum use of back reaming and down reaming.
- If tight hole is encountered on a trip, first assumption should be cuttings.
- Monitor hole conditions using torque, drag and pressure data to ensure that ROP does not exceed hole-cleaning rate.
- Focus on daily penetration rate, not instantaneous ROP.
- Monitor fill and report on check trip.

7.6 TRIPPING OUT OPERATIONS/PULLING OUT OF HOLE (POOH)

“POOH” or Pulling Out of the Hole. Each stand of drill pipe being hoisted from the well will be held back as the pipe is lifted, so it will not be swing freely across the floor. Several reasons for pulling out of the hole could be that the bit is worn out, the bottom hole assembly needs to be changed, the rig has drilled to casing point or total depth, or the well needs to be logged.

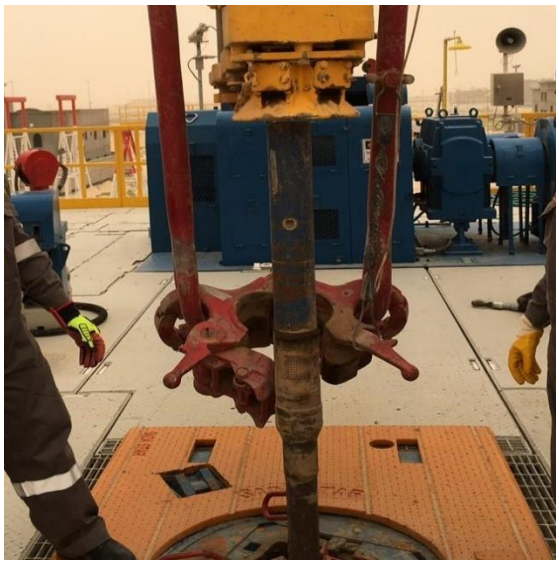


Figure 74 Closing the Elevator

Elevators are used to hold the Drill Pipe and Drill Collars while Pulling Out of the Hole (POOH) Or while Running into the Hole (RIH). There are different sizes for each size of pipe.

Figure 75 Removing the Slips

Note: Make sure to bend at the waist and bend your knees and pull together.

The floor hand can move the drill pipe with a pipe jack. It is used to move the pipe around and keep it straight. The pipe jack protects the pipe's threads and shoulders from being damaged.

Note: Don't use a hammer to move pipe!

Figure 76 Racking drill pipe – pipe will be racked by pushing against the pipe.

Note:

- Feet and hands must be kept clear of the pipe as it is being set down.
- Be aware of the pinch point between the pipes.

To learn to trip the drill string, the Floor hand will learn to rack the pipe, tail, and stab drill pipe safely. Other tasks to be learned about tripping includes: maintaining an accurate count of pipe in or out of the hole, knowing what to look for when performing a flow check, responding to a kick drill, change slips, elevators, and tong jaws when necessary, and prepare the necessary equipment to make up a bottom hole assembly.

Floor hand keeping up with pipe stands by numbering them as they are pulled from the hole.

Pipes numbering is done with chalk.

Figure 77 Numbering Pipes

BREAK OUT:

Break out is the process of unscrewing drill string components which are coupled by various thread forms, or connections, including tool joints and other threaded connections. The break out process serves to perform the disconnecting of joints to allow for the removal of joints and other components from the drill string.

The drill string is composed of drill pipe, drill collars, the bottom hole assembly and the various tools to make the drill bit turn. The process of removing components from the drill string, such as when removing a steerable pilot to replace it with a reamer or drill bit, you break out the pilot.

Hazards associated with the break out process include being struck by drill pipe or other components as well as meeting drilling fluid.

7.7 TOOLS AND EQUIPMENT USED IN TRIPPING OPERATIONS

MUD BUCKET – is used when making connections during a wet trip on the drill floor, the floor hands will prevent mud from spraying all over the floor and equipment.

Figure 78 Mud bucket

Tong pull cables, snub lines, safety cables, cables used to suspend tongs in the derrick, clamps, thimbles, pulleys, and shackles are to be properly installed and maintained. Any signs of wear seen should be reported to the Driller. Proper counter weight balance will always be maintained. When not in use, the tongs are to be pulled away from the drill floor work area and hooked in the corner of the floor. The rotary table is NOT to be used for final make up or initial break out of pipe connection.

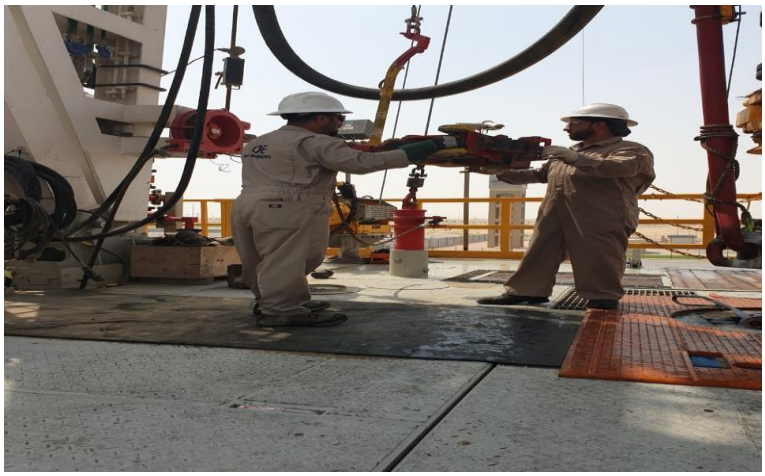


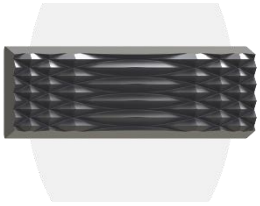
Figure 79 Rig Tong

Different types of pipe are used to drill a well. **The tong jaws** will need to be changed to fit the type of pipe being used.

Also, the drill pipe elevators will have to be changed out in order to fit the pipe being used. In addition, the slips will have to be changed out to fit the pipe being used.

Figure 80 Tong Jaws

Note: Tong dies is parts placed in the tong jaws that bite into the drill string. They should be checked for worn signs. If wear occurred to the dies they should be replaced, or the tong will slip around the string ; and the driller will not be able the proper amount of torque.



Slips hold the drill string in position for the crew to handle the connection with the tongs. The slips shown in the image below are in the master bushings.

Figure 81 Slips

Warning! Never use your foot to hold the slips in place. Never kick the slips in to the rotary table bowls. This can cause damage to the equipment or a possible injury.

Note: Slips inserts should be replaced if they showed any wear. If wear occurred, slips would be loose and couldn't hang the drill string.

The rubber cleaner is used to wipe the pipe clean while pulling the pipe out of the hole. They are made for various sizes of drill pipe, so you must know what size to use.

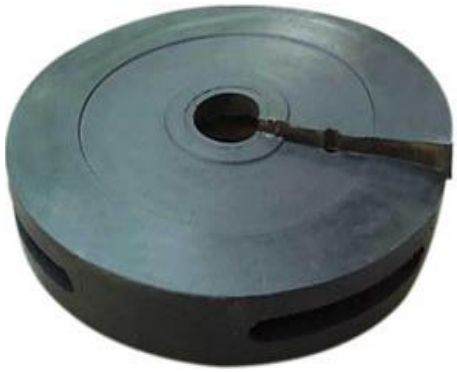
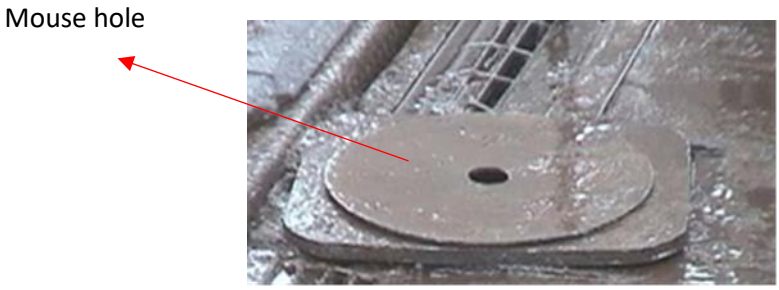


Figure 82 Rubber Cleaner

The Floor hand in this photo has installed **the hole cover**. Always keep the hole covered when not in use. The hole is always being protected. If anything goes down the hole, we call it a fish or junk in the hole, and we must go fishing for it! This takes rig time and effort by the rig crew to recover the fish as soon as possible.

Figure 83 Hole cover

Mouse hole is used for handling one joint of pipe during connections and when laying down pipe. Keep mouse hole and well bore covered when not in use.



The drill collar clamp is used to secure the drill collars and prevent them from falling down the well. Always use the clamp when tripping with drill collars and use the proper wrench made for the clamp. The clamp is placed above the drill collar slips.

Drill Collar clamps

Feet, knees and hands will not be placed on the underside of a drill collar clamp while the clamp is being tightened into a drill collar in the rotary table. A drill collar clamp secured to a drill collar will not be hoisted to overhead height into the derrick.

Drill collar slips are used to hold the collars in place in the rotary table. Make sure you have the right size slips for the collars you are pulling out of the hole. Drill collar slips have more segments than drill pipe slips.

Figure 84 Drill collar slips

Each drill collar **lift SUB** will be tightened into the collar before the collar is hoisted into the derrick to prevent the SUB from backing out while working with the drill collar.

Figure 85 Lifting sub for Drill collars

A drill collar is a heavy, thick-walled tube that is used between the drill pipe and the bit. It provides weight on the bit, holds the drill string in tension and causes the bit to drill a vertical hole. Drill collars are usually about 30 feet in length and 21 to 300 pounds in weight per foot. The buoyancy of the mud reduces the weight of the drill collars, so it might take 15-20 drill collars to be run in the drill string. The drill collars shown are spiral drill collars. Formation mud will be scraped off the drill collar stabilizer blades before the collars are hoisted and stood in the derrick to prevent the mud from drying and falling on the crew members.

The bit breaker is used to make up the bit and to break out the bit. Make sure you get help in carrying it to the rig floor. When setting the drill bit into a bit breaker, hands will not be placed on the bit breaker while the bit and collar are guided into the bit breaker opening. Feet are not to be used to adjust the lock on the bit breaker at that time.

Lifting caps are kept on the floor to put on subs, bits and drill string joints to help put them in the drill string or to put them in storage on the floor.

Below figure shows **the types of bits** used to drill with on the rig. On the left is a tungsten car- bide bit and on the right is a rotary cone bit. These bits are connected to the bottom of the drill string and rotated by the rotary table, top drive or a downhole motor at various speeds.

Figure 86 Bit lifting caps

Moving bit locker, the bit breaker fits into the bit plate and placed in the rotary

Installing a bit cap &Rock bit with lifting cap installed

The drill string is made up of drill pipe, drill collars, drilling jars, heavy weight drill pipe and all attached members including the subs, stabilizers, and specialty equipment. The drill string consists mainly of the drill pipe. Drill pipe is used to connect to the bottom hole assembly, helps rotate the string and transmit drilling fluids to the bottom of the hole. The Floor hands and Roustabouts inspect by looking and feeling. They maintain the drill string by cleaning the threads and connections, applying dope to them and keeping protectors on them while storing them on the decks. If protectors are not used, the pipe threads or pipe can be damaged. Visual inspection of the pipe includes looking for damage on the pin, box or tubing body of the pipe. Damage would look like cuts, holes in the

pipe, mashed threads, splits in the pipe, bent joints and cracks. Any defects that are detected should be reported to the Supervisor. Important tasks that the crew does with tubulars includes moving and handling, rolling, measuring, bundling, and racking it properly. Remember to never use a hammer on pipe as this will damage the pipe. Be extremely careful with rolling tubulars, and NEVER attempt to stop the tubular rolling with your foot, hands or other body parts.

Protector for the pin

Figure 87 Drill pipe protectors

Floor hand duties include taking care of the drill string components. The floor hand should clean the threads with a wire brush. A wire brush has stiff steel bristles and is used to clean rust, grease, dirt or paint from the drill string threads. The brush is usually used with pipe solvent to clean the threads thoroughly. Pipe that does not have clean threads should not be screwed together as it will damage the threads.

A dope brush is a soft-bristled brush used for applying pipe dope to pipe threads. Pipe dope is a special compound that protects the pipe threads and prevents leaks around them.

Using the proper dope, the floor hand will apply dope to only the pin of drill pipe, dill collars, stabilizers or any equipment that goes into the well.

Putting on protector before laying down the drill pipe ensures good drill string maintenance.

Drill pipe comes in different sizes, but the most often used is 5" drill pipe. The 30 feet joint weighs about 600 pounds and three joints of pipe are screwed together to make a "stand" of drill pipe. Drill pipe is coded as to weight and grade and can be identified on the pin tool joint shoulder. The weight codes are standard and heavy and the grade codes most commonly used are "S" and "G" pipe.

Figure 88 Protectors protect the threads from damage

Figure 89 Cleaning threads

Below figure shows the application of the dope to the pipe, drill collars and drill pipe using different type of dope.

Make sure to use right kind of dope for each kind of pipe.

A.P.I. (American Petroleum Institute) grades of drill pipe used in drilling a well. Most drill pipe is either e-75, x-95, g-105, or s-135. The grades refer to the amount of force at which the drill pipe will be damaged in some way. API has rating for yield and strength of the pipes and also includes a torsional yield strength, burst strength and a collapse strength.

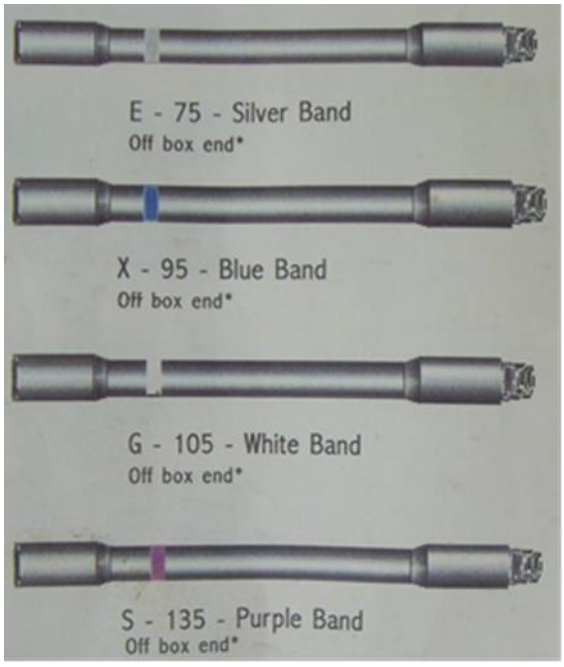


Figure 90 Pin

Figure 91 Box

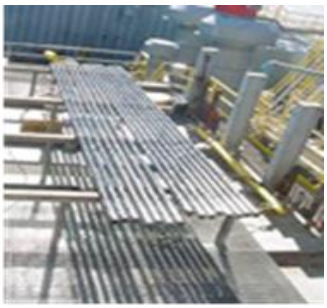


Figure 92 Racked Drill Pipe

Figure 93 Crooked Drill Pipe

The below figure shows a rabbit pipe tool that is used to drop through the drill pipe to make sure the pipe is not plugged or obstructed. The rabbit is run through the drill pipe before placing the pipe into the well. The Derrick man places the rabbit into the pipe while in the derrick and the rabbit falls through the pipe onto the drill floor. When rabbiting the drill pipe, be careful not to place feet beneath the pipe as the rabbit will be traveling quite fast and can cause injury to one's foot. If the rabbiting is done on the rig floor, always cover the well bore before letting the rabbit bounce on the drill floor. If the well bore is not covered, the rabbit may find its way to the hole and cause damage to the well.

Figure 94 Rabbit for the pipe

Damage to the drill string can be caused by the improper handling and transportation. Some of the examples include; using too much or not enough torque, poor stabbing procedures and using one tong to tighten the connection.

Measuring the drill string while it is on the rack is done by placing the end of the measuring tape on the box end and extending the tape to the pin end shoulder just before the threads. Calipers are used to measure the internal diameter, the outside diameter and the thread type as shown in the pictures above. Be sure to accurately measure all pipe and record the lengths of drill pipe, heavy weight, drill collars, stabilizers, etc. This is a vital information for the rig.

Below figure shows drilling jar being removed from the well. It must be handled very carefully by the floor hands and the driller.

A clamp must be installed on the sliding section of the jar. The clamp keeps the jar from jarring while being stored in the derrick or moved around the rig. Jars are run in the drill string to help prevent stuck pipe.

Figure 95 Drilling jar and clamps

When not in use, the V-door must have pipe, chain or other suitable device in place to prevent personnel from falling through while working. Always be careful around the V-door and keep good communication between personnel on the deck and personnel working on the floor.

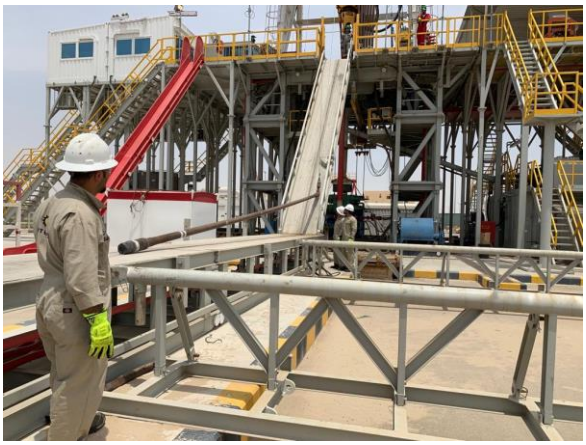
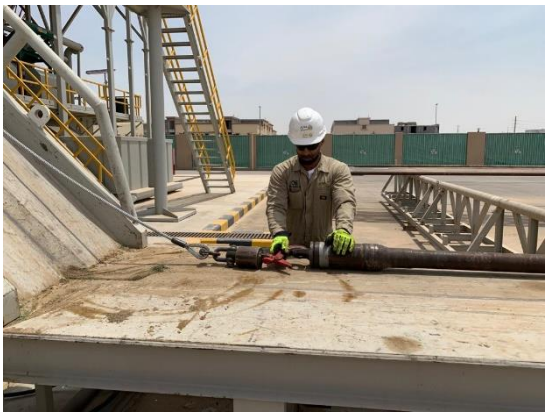


Figure 96 V-Door

During normal drilling operations the drill pipe is usually maintained in the V-door or on the pipe deck. The figure below shows the crews picking up a joint of drill pipe.

The drill pipe has protectors on both ends of the pipe to protect its threads. After protectors have been installed, the pipe is sent up to the rig floor via the V-door. Remember to always stand clear of the V-door and backstop while pipe is coming down the catwalk to avoid injuries. Floor hands are always using the v-door and catwalk to bring drilling tools back and forth to the rig floor.

The drill floor must be kept supplied with joints of drill pipe. This photo shows the crew inspecting the drill pipe that will be sent up to the Driller through the v-door.



7.8 THE PURPOSE AND MAIN PROCEDURES OF TRIPPING IN AND OUT OF A WELL

A required part of the drilling process is to pull the drill string out of the hole regularly. Pulling the drill string out of the hole (POOH) is also known as “trip out”. Running the drilling assembly back down to the bottom of the hole or run in hole (RIH) is known as “trip in”. A “round trip” operation of pulling the drill string out and returning it to the wellbore is called "tripping."

Pulling out of hole, or a trip out is necessary for several reasons that can include:

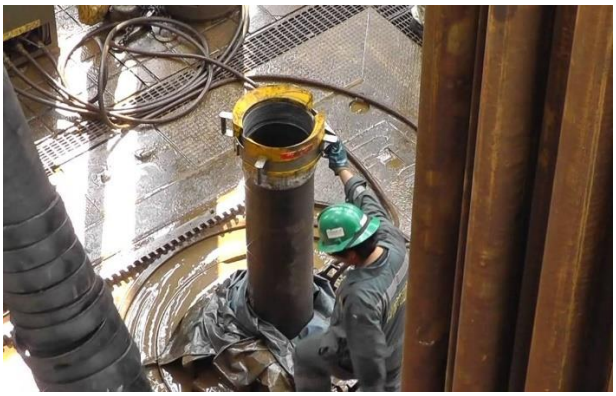
- Reached target depth (TD).
- Run casing.
- Worn/damaged bit.
- Equipment failure.

Reached TD

When the hole has been drilled to the target depth, then the drill string is tripped out. The casing can then be run into the hole.

Run Casing

Once the hole reaches a predetermined depth, the drill string is pulled out of hole in preparation to run casing. Casing is a steel pipe placed in the well to prevent the wall of the hole from caving in. Casing also prevents fluids from entering the wellbore.



Worn/damaged bit

A slow ROP is a sign for damaged or worn bit. Continuing drilling will be a waste of time and cost, so drill string is pulled out of hole, and the old bit is replaced with new one. We must check and record the damage in the old bit.

Equipment Failure

Equipment failure could be at surface or downhole. An example of surface equipment failure is the mud pumps. If drilling fluid cannot be circulated by the mud pumps, drilling cannot continue. It may be necessary to pull the drill string out of the hole until the bit is inside casing. This makes it less likely that the drill string will get stuck while the equipment is repaired. Any part of the drill string could cause a downhole failure. Drill pipe can separate, or other tools can develop problems that require them to be replaced.

7.9 TASKS

1. Identify the different elevators used on your and explain how to use each of them.
2. Show how to set and pull rotary slips as part of a team and describe the risks of doing this incorrectly.
3. Show how to identify, store and maintain slips for each size of drill pipe used on your rig.
4. Show how to use and maintain any spring or power-operated slips on your rig.
5. Show how to replace one set of rotary tongs with another and explain why this is done.
6. Show how to adjust the tong counterbalance weight.
7. Show how to clean and change tong dies.
8. Show how to change tong jaws for the different sized tubulars used on your rig.
9. Show how to visually inspect and change tong backup (snub) lines.
10. Show how to use lead tong, backup tong, slips and elevator for the typical sizes of tubulars when tripping in / out of the hole.
11. Complete a typical round trip using a pipe spinner.
12. Complete a typical round trip using an iron roughneck.
13. Show how to add singles while drilling.
14. Show to make up, break out and rack back the Kelly.
15. Show how to change the Kelly or top drive wear sub and explain why it is used.
16. Show how to unlock, position, and lock the hook.
17. Show how to install, use and remove a pipe wiper.

18. Show how to use the mud bucket during a wet trip.
19. Show how to number and strap stands of drill pipe from the drill floor.
20. Assist in the pick-up and lay-down operations for drill pipe, drill collars, and tubing.
21. Show how to pick up and lay down drill collars of each size used on your rig.
22. Show how to make up and break out drill collars, using lead and backup tongs, for each size used on rig.
23. Show how to use drill collar lifting subs.
24. Assist in making up and breaking out typical bits used on your rig.

8. RIG MATH

8.1 OBJECTIVES

- Get familiar with different equations used on rig.
- Knowing the different units of measurements and conversion factors.

8.2 OUTCOMES

- Calculate different types of volumes.
- Understanding measuring units and technic.
- Applying math in daily rig operation.

8.3 BASIC RIG MATHEMATIC

8.3.1 DENSITY

Density of any substance is the weight of a particular volume of that substance, i.e. density is the weight per unit volume.

$$Density = \frac{Weight}{Volume}$$

The most common volumes used in the oil field are barrel, cubic foot & gallon.

1 barrel = 5.614 cubic feet

1 cubic foot = 7.48 gallon

1 barrel = 42 gallon

So, we can get the density of any substance in 3 different units according to the used volume.

ppg: pound per gallon.

pcf: pound per cubic foot.

lb/bbl: pound per barrel.

Density of fresh water:

= 8.34 ppg

= 62.4 pcf

= 350.3 lb/bbl

Density of Steel:

= 65.44 ppg

= 489.5 pcf

= 2748 lb/bbl

Mud weight is the density of the drilling fluid and it is measured by the Mud Balance.

The Mud Balance is an apparatus used to measure the mud density, it has four scales: ppg, pcf, and SG & psi/1000 ft.

8.3.2 Specific Gravity

It is the ratio of the density of a substance to the density of fresh water. The specific gravity has is unit less and it expresses the number of times a substance is heavier than fresh water.

$$Specific\ Gravity = \frac{Substance\ Density}{Fresh\ Water\ Density}$$

$$= \frac{Substance\ Density\ (ppg)}{8.34}$$

Example:

Calculate the specific gravity of the barite if the barite density is 35 ppg.

$$Specific\ Gravity = \frac{Barite\ Density\ (ppg)}{8.34}$$

$$= \frac{35}{8.34} = 4.2$$

This means that the barite is heavier than fresh water by 4.2 times.

8.3.3 PRESSURE

Dynamic Pressure

Dynamic pressure is the force or weight per unit area.

$$Pressure = \frac{Force}{Area} \qquad psi$$

$$Force = Pressure \times Area \qquad lbs$$

Where:

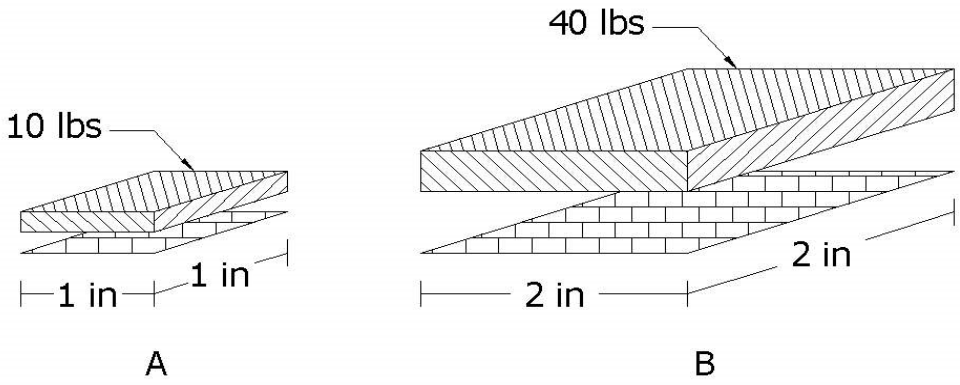
Force is measured in pounds (lbs).

Area is measured in square inches (sq.in).

Pressure is measured in pounds per square inch (psi).

Example:

Which square area has the greater pressure, A or B.



$$P_A = \frac{10}{1^2} = 10psi$$

$$P_A = \frac{40}{2^2} = \frac{40}{4} = 10psi$$

Both A & B have the same pressure.

Hydrostatic Pressure

Hydrostatic pressure is defined as the pressure due to the unit weight and vertical height of a column of fluid.

$$Hydrostatic\ pressure = Const. \times Fluid\ Density \times True\ Vertical\ Depth$$

Since:

Hydrostatic pressure is measured in psi

Fluid density is measured in ppg

True vertical depth is measured in feet

$$P_H(psi) = Const. \times Mwt(ppg) \times TVD(ft)$$

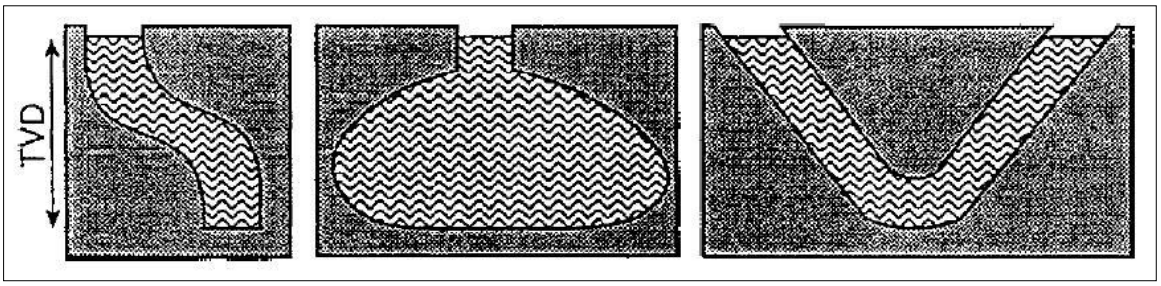
$$P_H(psi) = \frac{7.48 \times 12}{12 \times 12 \times 12} \times Mwt(ppg) \times TVD(ft)$$

$$P_H(psi) = 0.052 \times Mwt(ppg) \times TVD(ft)$$

$$P_H(psi) = 0.00694 \times Mwt(pcf) \times TVD(ft)$$

$$P_H(psi) = 0.433 \times Mwt(SG) \times TVD(ft)$$

Note: It is the vertical height/depth of the fluid column that matters, its shape is not important.



Pressure Gradient:

It is the pressure exerted by one foot of length of a column of liquid. Gradient of liquid is obtained by multiplying the weight measured in ppg by 0.052.

$$P_G(psi/ft) = 0.052 \times Mwt(ppg)$$

$$P_H(psi) = P_G(psi/ft) \times TVD(ft)$$

$$P_G(psi/ft) = \frac{P_H(psi)}{TVD(ft)}$$

Formation Pressure

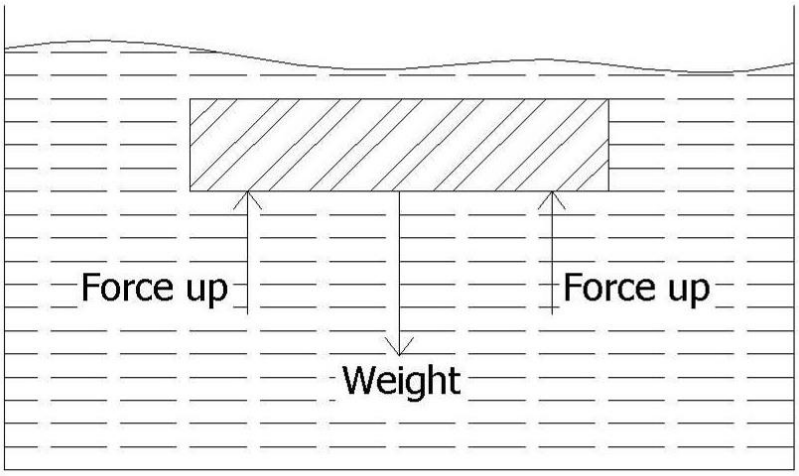
Formation pressure or pore pressure is said to be normal when it is caused by the hydrostatic head of the subsurface water contained in the formations and there is pore to pore pressure communication with the atmosphere.

Dividing this pressure by the true vertical depth gives an average pressure gradient of the formation fluid.

8.3.4 Buoyancy

If you put any object into fluid, the fluid tries to push that object to float while the objects weight tries to sink the object.

If the objects density is less than the fluid density the object will float, but if the objects density is greater than the fluid density the object will sink, but the weight of the object will decrease by the amount of the force which the fluid applies on the object to float it.



$$Weight\ in\ fluid\ = Weight\ in\ air - Forecup$$

Buoyancy Factor

It is the factor expressing the percentage of the weight of the object in fluid to its weight in air. Buoyancy Factor must be less than 1 and it is unit less.

$$Buoyancy\ Factor = \frac{Object\ density - Fluid\ density}{Object\ Density}$$

$$Weight\ in\ fluid = Weight\ in\ air \times Buoyancy\ Factor$$

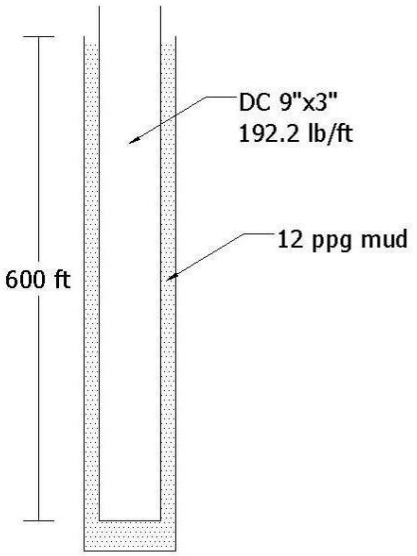
In drilling, the fluid is the drilling mud and the object is always steel having density of 65.44 ppg and the weight in mud is called hook load.

$$Buoyancy\ Factor = \frac{Steel\ density - Mud\ density}{Steel\ density} = \frac{65.44 - Mud\ density}{65.44}$$

$$Hook\ load\ = Weight\ in\ air \times B.F \quad lbs$$

Example:

We have 600 ft of 9" OD x 3" ID drill collars weighting 192.2 lb/ft. Calculate their weight in air and weight in mud (hook load) if the mud weight is 12 ppg.



Answer:

$$Weight\,in\,air = 600 \times 19.2 = 115{,}320 \quad lbs$$

$$Hook\,load = Weight\,in\,air - Force\,up$$

$$Force = pressure \times area$$

$$Force\,up = Hydrostatic\ pressure \times Cross\ Sectional\ area$$
$$= (0.052 \times Mwt \times TVD) \times ((OD^2 - ID^2) \times 0.7854)$$
$$= 0.052 \times 12 \times 600 \times (9^2 - 3^2) \times 0.7854$$
$$= 21{,}172 \quad lbs$$

$$Hook\,load = Weight\,in\,air - Force\,up$$
$$= 115{,}320 - 21{,}172$$
$$= 94{,}148 \quad lbs \qquad (A)$$

$$Buoyancy\,Factor = \frac{Steel\ density - Mud\ density}{Steel\ density}$$
$$= \frac{65.44 - 12}{65.44}$$
$$= 0.8166$$

$$Hook\,load = Weight\,in\,air \times B.F$$
$$= 115{,}320 \times 0.8166$$
$$= 94{,}170 \quad lbs \qquad (B)$$

By comparing (A) & (B), you can notice that there is only a slight difference between them.

9. WELL CONTROL (PRINCIPLE & PROCEDURE)

9.1 OBJECTIVES

- Principle & procedure of well control
- Formation fluid and properties.
- Types of drilling (overbalance, underbalance and balance).

9.2 OUTCOMES

- Well control in basic and general overview.
- Types of formation fluids and different properties.
- Overbalance, underbalance and balance drilling types.
- Different types of pressure in the hole.

9.3 INTRODUCTION

Well control is the technique used in oil and gas operations such as drilling, well workover, and well completions for maintaining the fluid column hydrostatic pressure and formation pressure to prevent influx of formation fluids into the wellbore. This technique involves the estimation of formation fluid pressures, the strength of the subsurface formations and the use of casing and mud density to offset those pressures in a predictable fashion. Understanding of pressure and pressure relationships are very important in well control.

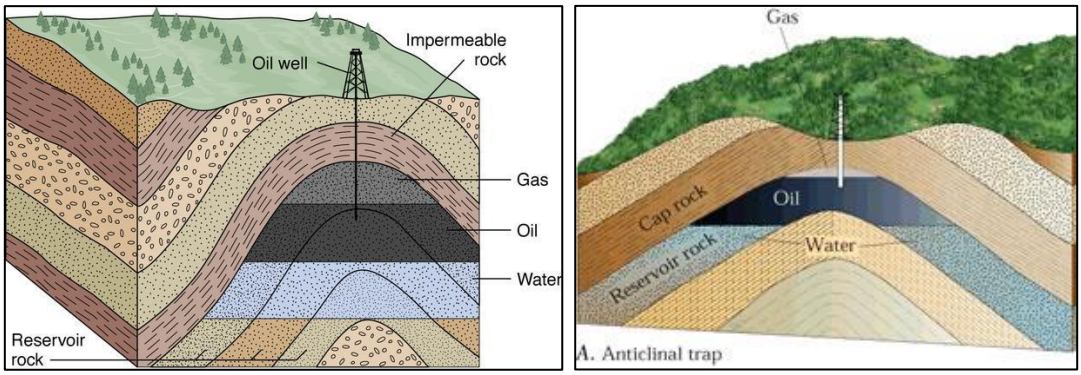
9.4 WELL CONTROL PRINCIPLE AND PROCEDURE

- Formation Fluid
- Formation Properties
  - Porosity
  - Permeability
- Hydrostatic Pressure
- Bottom Hole Pressure
- Pressure Gradient
- Formation Pressure
- Fracture Pressure
- Kick
- Blowout
- Well Control Barrier
  - Primary Well Control
  - Secondary Well Control

9.4.1 Formations Fluid

In order to understand the well control, we have to study some of keys definition.

- Formations fluid means any fluid that occurs in the pores of a rock, this fluid might be gas, oil or/and water.
- Strata containing different fluids, such as various saturations of oil, gas and water, may be encountered in the process of drilling an oil or gas well.
- Fluids found in the target reservoir formation are referred to as reservoir fluids.



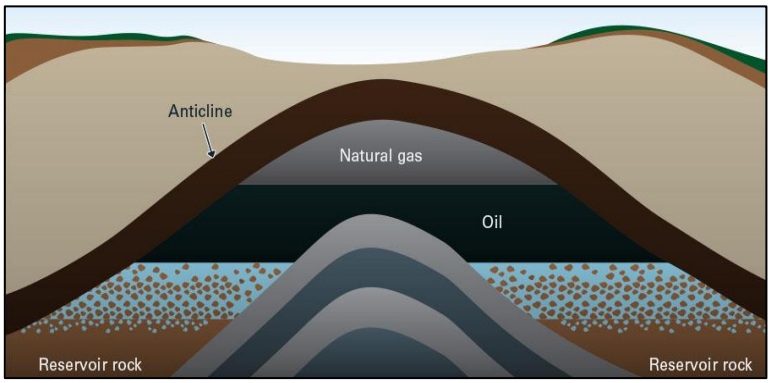


Figure 100 Formation fluid content

9.4.2 Formations Properties

- To understand the formation behavior, we've to learn the rock properties.
- There're two main rock properties that's very important regarding to well control.

Formation Porosity

- The percentage of pore volume or void space, or that volume within rock that can contain fluids.

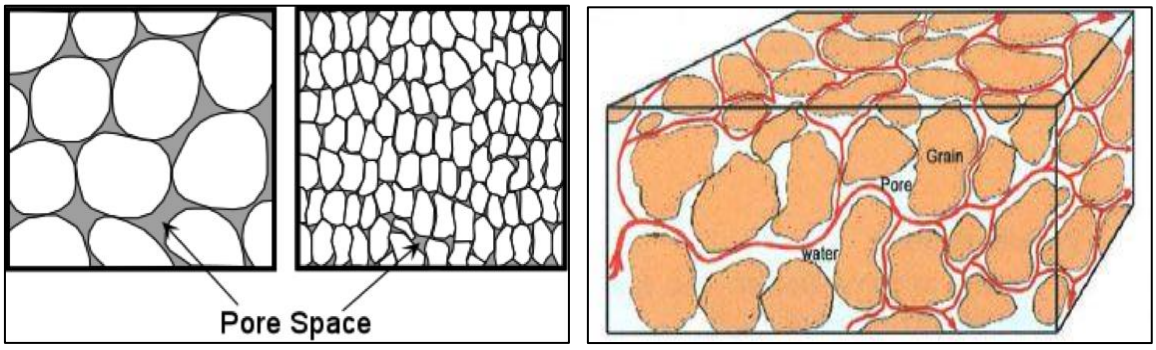


Figure 101 Formation Porosity

Formation Permeability

- The ability, or measurement of a rock's ability, to transmit fluids through its void spaces.
- Rock permeability is varied from formation to another and it measures in milli darcy.

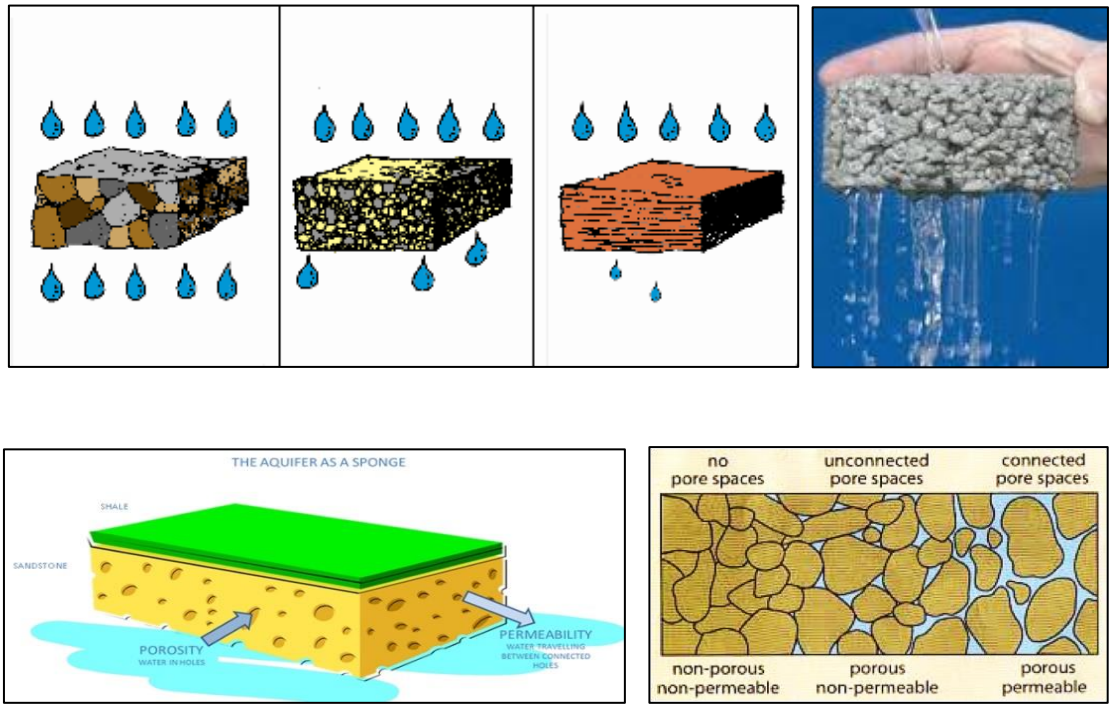


Figure 102 Formation Permeability

9.4.3 Hydrostatic Pressure (Ph)

- The pressure exerted by the weight of mud's column.
- The hydrostatic pressure used as primary well control which used to control the formations pressure.
- Hydrostatic pressure (P_h) = 0.052 x M.WT. x TVD

Where

- 0.052: Const. (conversion factor)
- M.WT: Mud weight in PPG.
- TVD: True vertical depth in feet. (is the vertical depth from surface to target)

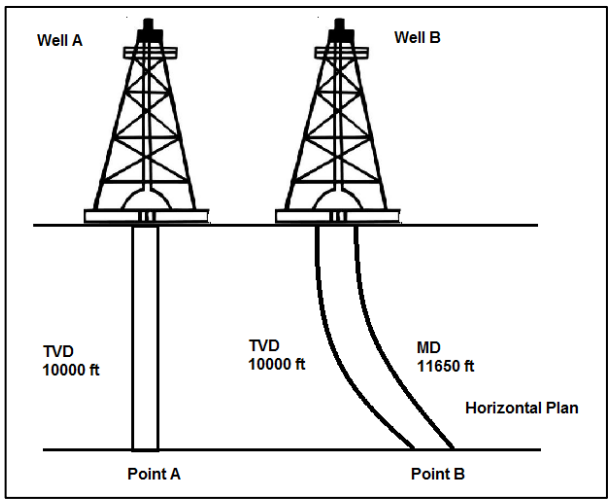


Figure 103 Hydrostatic Pressure

9.4.4 Bottom Home Pressure (BHP)

- The pressure, usually measured in pounds per square inch (psi), at the bottom of the hole. This pressure may be calculated in a static, fluid-filled wellbore with the equation:
  - BHP = P_h = M. WT * Depth * 0.052
- For circulating wellbores, the BHP increases by the amount of fluid friction in the annulus.
  - BHP = P_h + Annular Pressure Loss (APL) = (M. WT * Depth * 0.052) + APL

9.4.5 Pressure Gradient (PG)

- Pressure gradient is a term used to describe the pressure at specific depth, it's the change in pressure per unit of depth, typically in units of psi/ft.
- The pressure gradient can be determined by the following equation
  - PG = Pressure/depth
- Or it can be inferred from the hydrostatic pressure equation:
  - P_h = 0.052*MWT*TVD
  - P_h / TVD = 0.052*MWT

  So, the final equation determines the Pressure gradient (PG) is:

  - PG = P_h / TVD or PG= 0.052*MW

9.4.6 Formation Pressure

- The fluid pressure in the pore spaces of the formation.
- The formation is classified according to the pressure gradient.
- The normal formation pressure gradient is equal to weight of sea water column which is equals to **0.465** psi/ft.
- If the pressure gradient of formations is 0.465 psi/ft so the formation is considered as normal formations pressure.
- If the pressure gradient of the formation is higher than 0.465 psi/ft. so the formation is considered as abnormal formation pressure.

- If the pressure gradient of the formation is lower than 0.465 psi/ft. so the formation is considered as subnormal formation pressure.

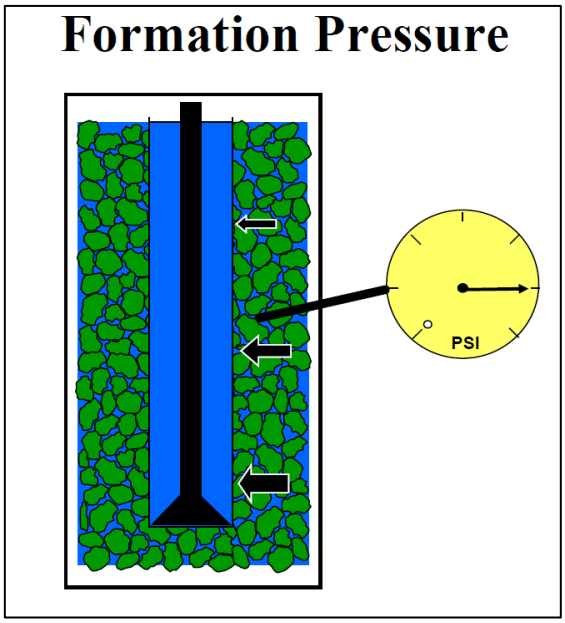


Figure 104 Formation Pressure

9.4.7 Fracture Pressure

- The Pressure above which circulation of fluids will cause the rock formation to fracture hydraulically.
- The fracture pressure is determined by Leak off test (LOT).
- If the hydrostatic pressure exceeds the fracture pressure loss of circulation will occur which means loss of the drilling fluid into the formation.

- The loss of circulation might be cured by pumping loss circulating material (LCM) or CMT plug.

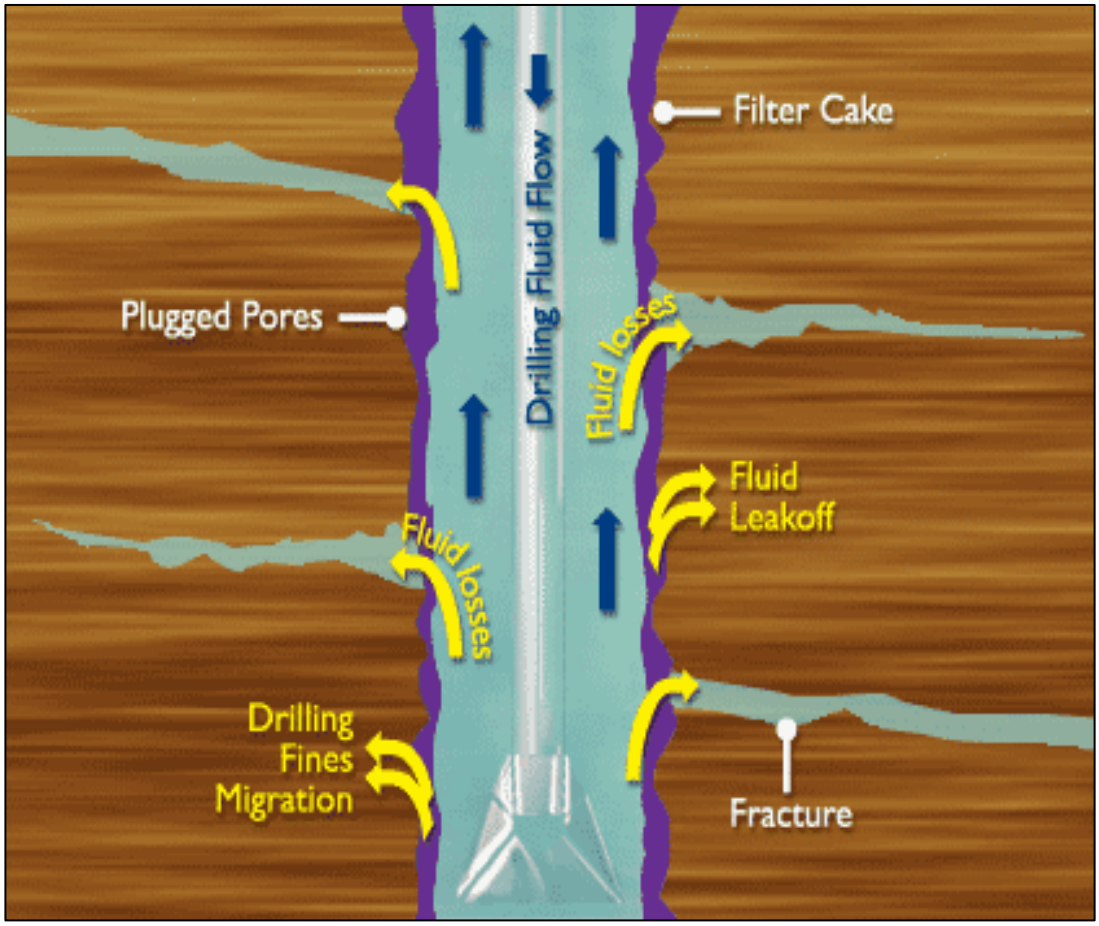


Figure 105 Fracture Pressure

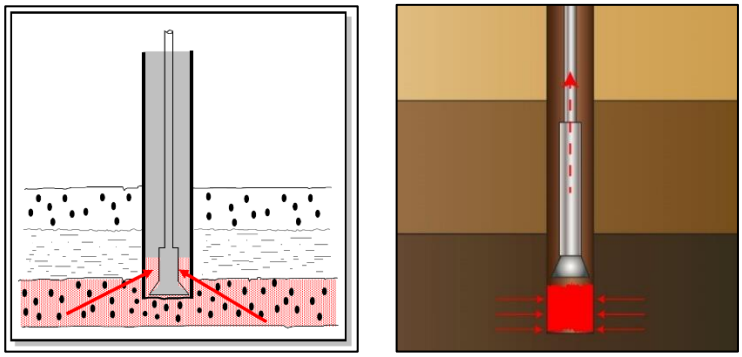
9.4.8 Kick

A “kick” is an undesirable flow of formation fluid into the well bore.

There’re many causes of kick such as: -

1- Failure to keep hole full.
2- Low density fluid.
3- Loss of circulation.
4- Gas cut mud.
5- Surging / Swabbing.
6- Abnormal Pressure zone.
7- Lack of crew knowledge & training.

Once detecting the kick, the driller shut in the well in order to start the killing operation to remove the influx (kick) from the well and re-store the control on the well by new killing mud weight.



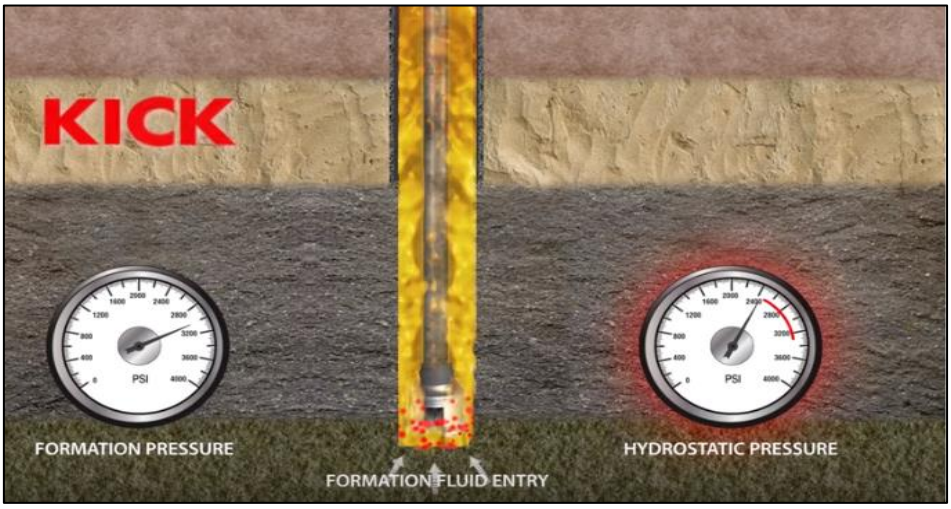


Figure 106 Kick

9.4.9 Blowout

- An uncontrolled exit of the formation fluids at the surface or into lower pressured subsurface zones (underground blowout).
- Uncontrolled flows cannot be contained using previously installed barriers and require specialized services intervention.
- A blowout may consist of water, oil, gas or a mixture of these.
- Blowouts may occur during all types of well activities and are not limited to drilling operations.

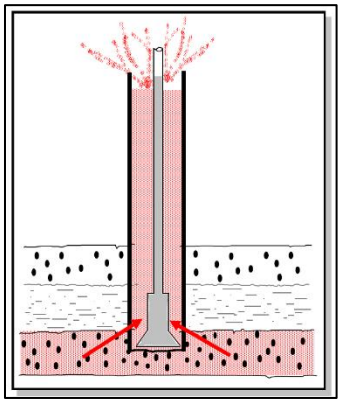


Figure 107 Blow out

9.4.10 Well Control Barrier

Primary Well Control

- Hydrostatic pressure (Mud) is the primary well control (the first defensive line in well).
- Mud hydrostatic prevents formation fluids entering the wellbore.
- Hydrostatic pressure should be kept all the time higher than the formation pressure to prevent kick and blowout of the well by closely monitoring the mud weight and mud level in the well and comparing by the formation pressure.
- Hydrostatic pressure should be higher than formation pressure and lower than fracture pressure

  Formation pressure < Hydrostatic pressure < Fracture pressure.

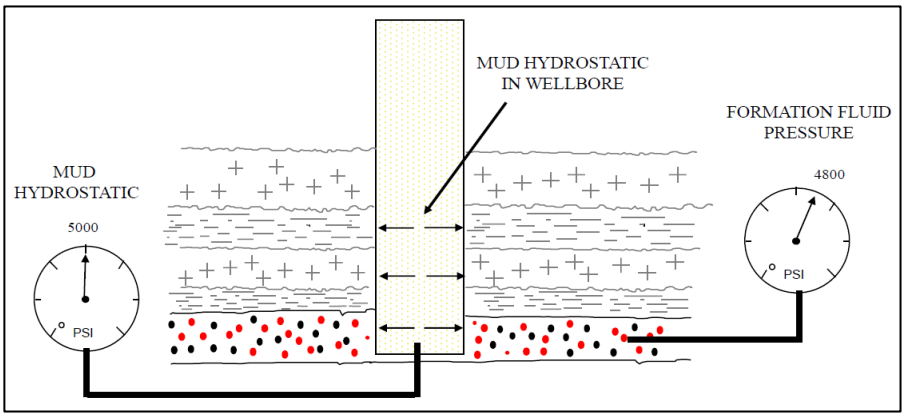


Figure 108 Primary well control

Secondary Well Control

- BOP or (Blowout preventer) is considered as secondary well control which is used in case the primary well control (mud) has failed to perform his function.
- BOP is activated to shut the well and prevent formation fluids flowing at the surface and cause harm to people or damage the rig and its equipment.
- The next operations are to record the pressure coming from the well and prepare new mud with higher mud weight to kill the well and restore the primary well control.

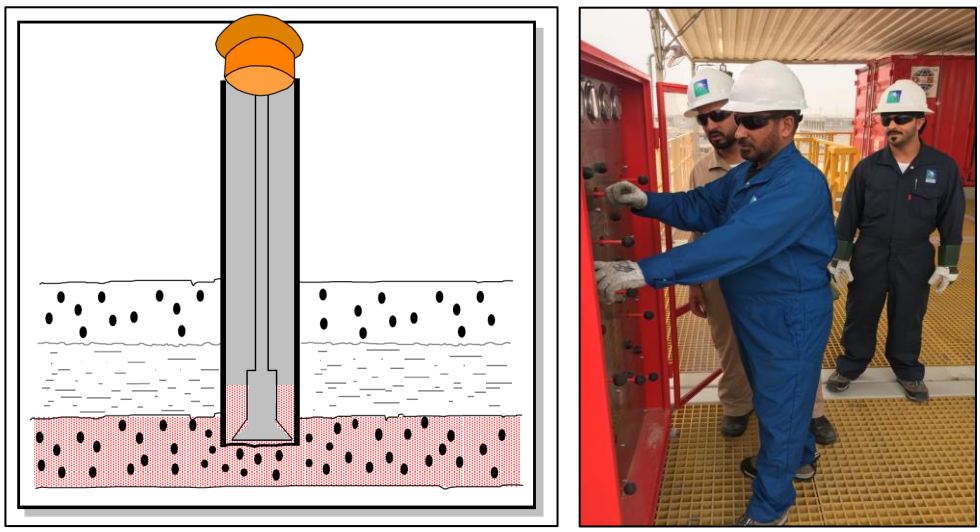


Figure 109 Secondary well control

9.5 TYPES OF DRILLING

Balance Drilling

- Which means drilling with hydrostatic pressure is approximately equals to formation pressure.
- It's too hard and very risky to achieve this type of drilling because there's possibility to lose some of the mud column which might cause kick situation.

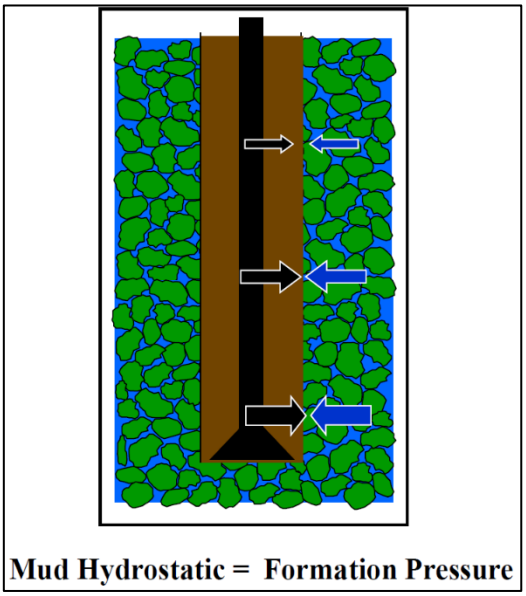


Figure 110 Balance drilling

Overbalance drilling

- Which means drilling with hydrostatic pressure is higher than to formation pressure.
- The most common type of drilling is used to drill the well safely (from well control side of view)
- In this case the hydrostatic pressure is higher than the formation pressure and less than fracture pressure.

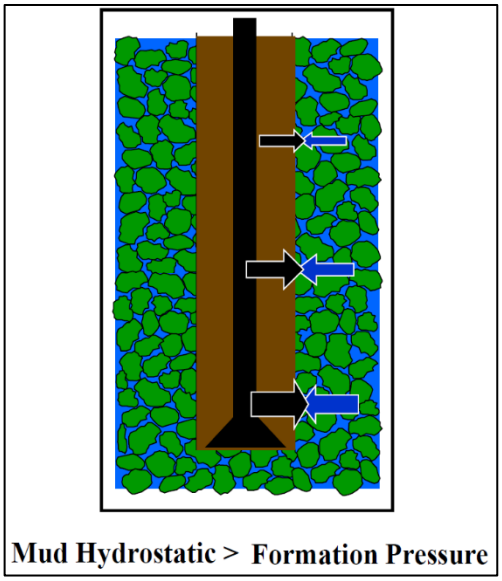


Figure 111 Over balance drilling

Underbalance drilling

- Which means drilling with hydrostatic pressure is less than formation pressure.
- As the well is being drilled, formation fluid flows into the wellbore and up to the surface. This is the opposite of the usual situation, where the wellbore is kept at a pressure above the formation to prevent formation fluid entering the well.
- The main advantage of using UBD is Increases rate of penetration (ROP) and eliminates the formation damage.

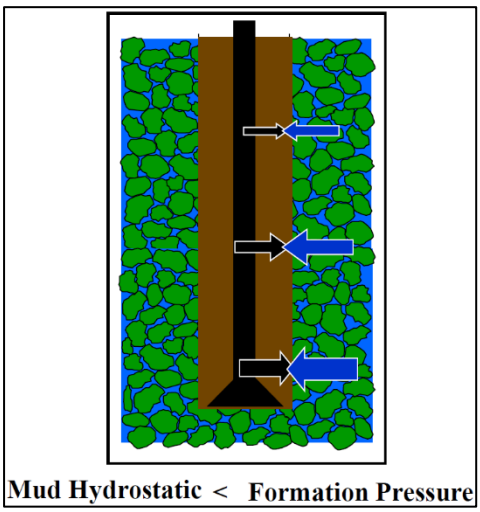


Figure 112 Under balance drilling

9.6 SUMMARY

Rotary drilling is a complicated process that involves in five major rig systems. These systems are rig power system, hoisting system, circulating system, rotating system and well control system. Each one of these systems has several components. The rig personnel are expected to be familiar not only, with the rotary drilling process but also, should be able to identify the five major rig systems, their components, as well as their functions.

10. WELL CONTROL EQUIPMENT (PART 1)

10.1 OBJECTIVES

To make trainees knowledgeable about following well control items:

- Understand the function of well control equipment.
- Limitations, maintenance and periodic testing.

10.2 OUTCOMES

Upon completing this section, they should be able to:

- Demonstrate the responsibilities of a Rig crew during a kick drill.
- Show what to do during a kick drill while tripping.
- Show what to do during a diverter drill.
- Show how to flow check the well and explain why this is done.
- Describe the use of the trip tank and the Floorman's role in making it work.
- Assist in changing and servicing BOP rams.
- Assist in changing the packing element of an annular BOP.
- Assist in a complete nipple up or nipple down operation on a surface BOP stack.
- Assist with a complete BOP and choke manifold pressure test.

10.3 INTRODUCTION

Drilling crews must be alert while drilling ahead and be on the lookout for indicators that the well is kicking or that the bit is penetrating abnormal pressure. The well must be shut in immediately when there is a positive indicator of a kick in the form of an increase in pit volume or flow rate. If a secondary indicator of a kick is recognized, then the well should be checked for flow before shutting in.

10.4 WELL CONTROL EQUIPMENT

- Diverter.
- BOP Stack.
    - Annular Preventer.
    - Single/double ram.
    - Types of rams.
- Drilling spool (mud cross).
- Kill line.
- Choke line.

10.4.1 Diverter

- The diverter is a low-pressure annular preventer with a large piping system underneath and it usually used in top hole drilling when shallow gas is expected, and it also depends on the regulations and operator policies.

- The diverter should be used only when the well cannot be shut in because of fear of formation breakdown or lost circulation.
- It's installed on Conductor casing prior to drill surface section.
- It is utilized to divert the kick from the rig (not shut in equipment) and it required the conductor pipe to be installed.
- The large diameter pipe typically has two directions diverting the wellbore fluid out of the rig (figure 81).
- The vent line should have large diameter, straight and short in length.
- When the shallow gas is detected the vent line (downwind) should be activated first then close the diverter.

Figure 126 Diverter

10.4.2 BOP Stack

- The blow-out preventer (BOP) is shown, the BOP is the largest part of the well control equipment. It prevents high pressure from escaping from the well and possibly causing a disaster.
- A set of two or more BOPs used to ensure pressure control of a well.
- A typical stack might consist of one to six ram-type preventers and, optionally, one or two annular-type preventers.
- The configuration of the stack preventers is optimized to provide maximum pressure integrity, safety and flexibility in the event of a well control incident.
- The most common BOP stack configuration is from top (Annular Preventer, Upper pipe ram, Blind shear ram, Mud cross, kill line, choke line, manual and hydraulic valves, Bottom pipe ram).
- The BOP is installed after drilling surface hole and setting surface casing.

Figure 127 BOP Stack

a) Annular Preventer

- A large valve used to control wellbore fluids. In this type of valve, the sealing element resembles a large rubber doughnut that is mechanically squeezed inward to seal on either pipe (drill collar, drill pipe, casing, or tubing) or the open hole.
- The ability to seal on a variety of pipe sizes is one advantage the annular blowout preventer has over the ram blowout preventer.
- Most blowout preventer (BOP) stacks contain at least one annular BOP at the top of the BOP stack.
- It can shut in the well on itself (in case of there is no tubular in hole) but the rubber should be replaced after.
- It cannot seal around the reamer and stabilizer.

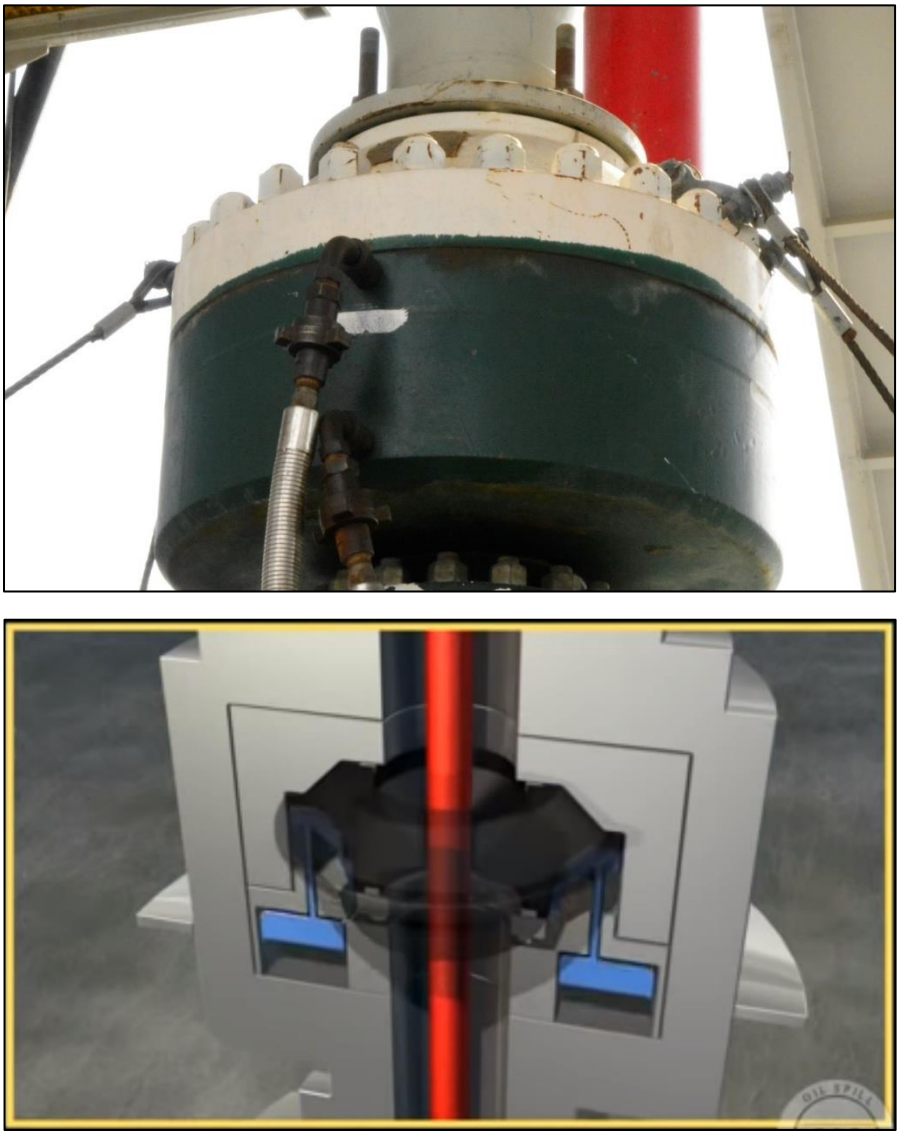


Figure 128 Annular BOP

b) Single / Double Ram BOP

- Ram preventers are commonly available in single-, double.
- Single Ram BOP is usually containing one pipe ram and it's usually installed at the bottom of BOP Stack (Lower Ram).
- Double Ram BOP is containing usually one pipe ram and one blind shear ram.
- Single ram BOP is distinguished by it has separate flange to be connected with BOP stack through it, but the double ram has two ram body is welded (doesn't have separate flange for every ram BOP body) it's considered as one part.

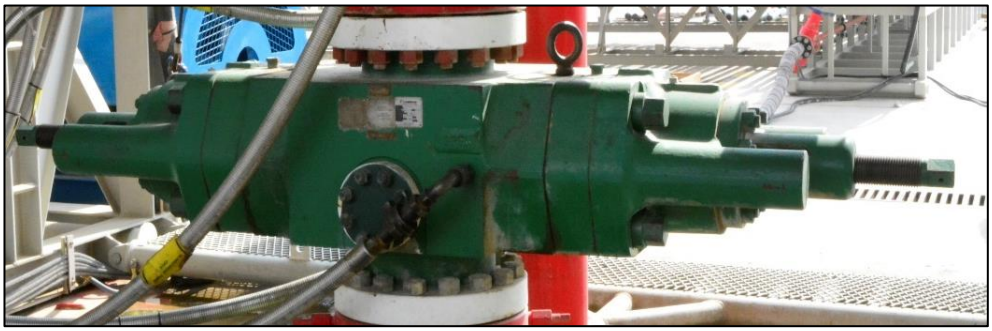


Figure 129 Single Ram BOP

Figure 130 Double Ram BOP

Types of Rams

A- Fixed Pipe Ram

- A type of sealing element in high-pressure split seal blowout preventers that is manufactured with a half-circle hole on the edge (to mate with another horizontally opposed pipe ram) sized to fit around drill pipe.
- Most pipe rams fit only one size or a small range of drill pipe sizes and do not close properly around drill pipe tool joints or drill collars.

Figure 131 Pipe Ram

B- Variable Bore Ram

- A relatively new style is the variable bore ram, which is designed and manufactured to properly seal on a wider range of pipe sizes. For example, VBR 3 ½'' to 7''

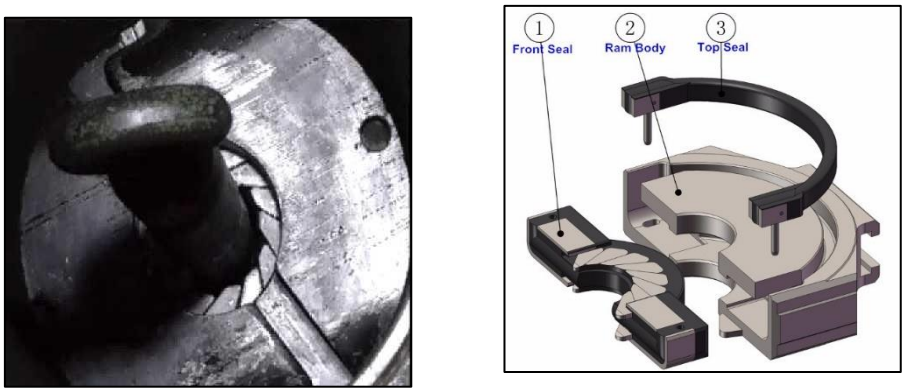


Figure 132 Variable Bore Ram

C- Blind Ram

- Two blocks of steel that meet in the center of the wellbore to seal the well have a hole.
- It used to seal off wellbore in case there's no pipe in the well.
- If the blind ram is activated with drill pipe in hole so it will cause collapse for the opposite body, but it will never seal / shut the well.

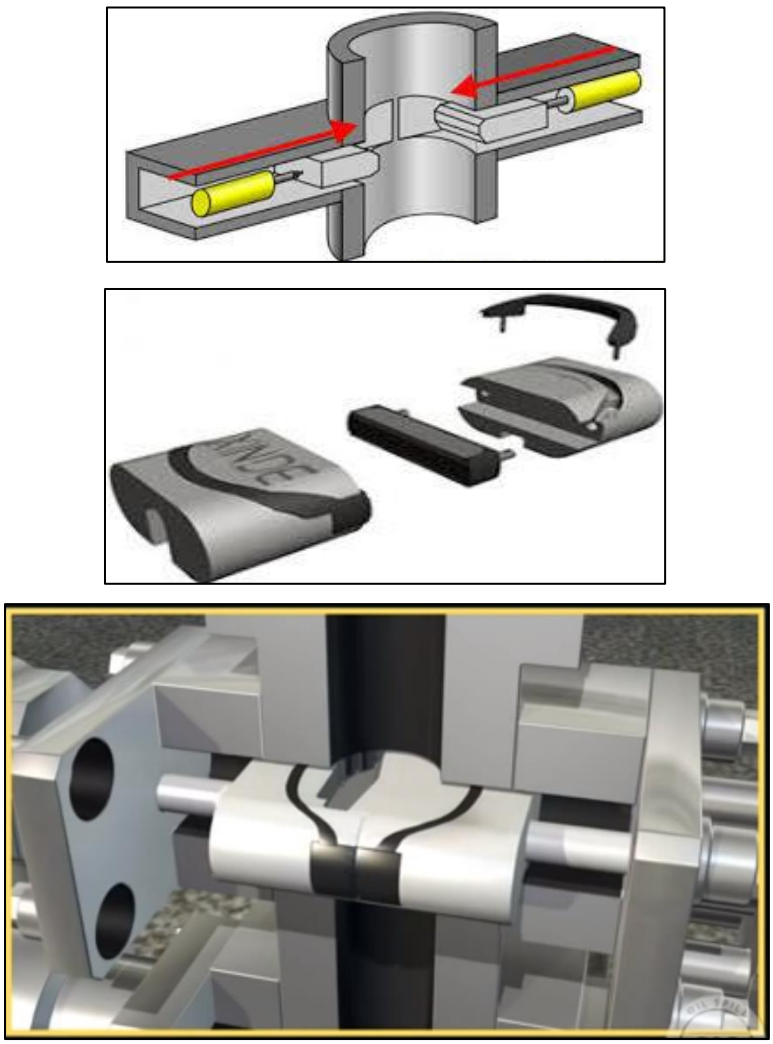


Figure 133 Blind Ram

D- Blind Shear Ram (BSR)

- A blowout preventer (BOP) closing element fitted with hardened tool steel blades designed to cut the drill pipe or tubing when the BOP is closed, and then fully close to provide isolation or sealing of the wellbore.
- This is the last resort of well control before evacuating the rig site.

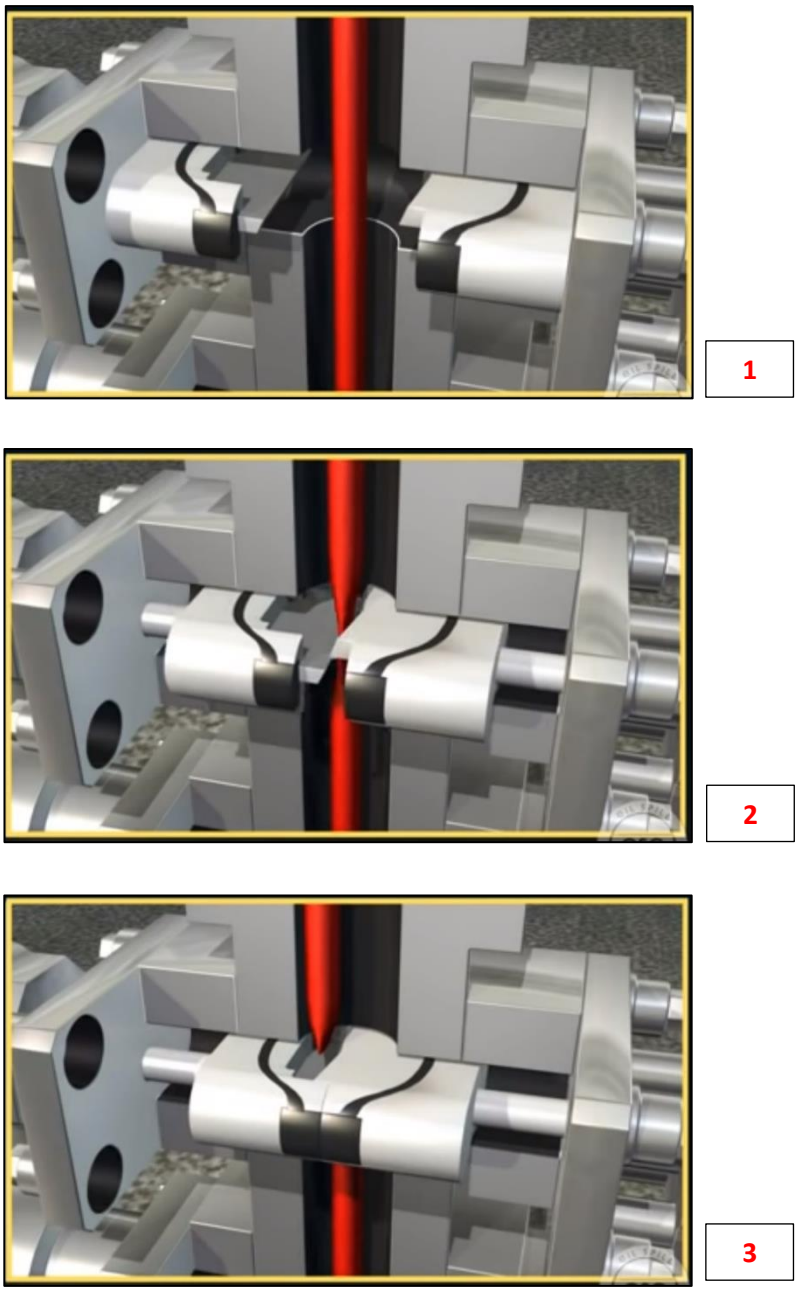


Figure 134 Blind Shear Ram

10.4.3 Drilling Spool (Mud Class)

- Pressure-containing piece of equipment having end connections with or without side outlet connections, used below or between drill-through equipment and it serve as a spacer or crossover.
- It is allowing the choke and kill lines to be connected to BOP Stack.
- This tool is characterized by size, end type (studded/flanged) and rate working pressure.
- For example, this connection of mud cross is 11'' x 5000 psi (flange end).
- Ring gasket is a mechanical seal which fills the space between two or more mating surfaces, generally to prevent leakage.
- There's specific ring gasket size is fits to specific size of flange.

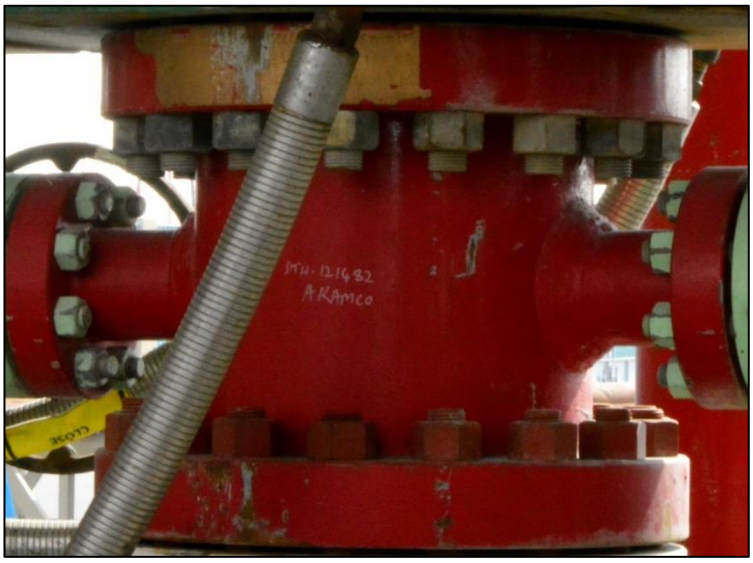


Figure 135 Mud Cross (Drilling Spool)

Figure 136 Ring Gasket

10.4.4 Kill Line

- A high-pressure pipe leading from an outlet on the BOP stack to the high-pressure rig pumps and it used If the drill pipe is inaccessible.
- During normal well control operations, kill fluid is pumped through the drill string and annular fluid is taken out of the well through the choke line to the choke, which drops the fluid pressure to atmospheric pressure.

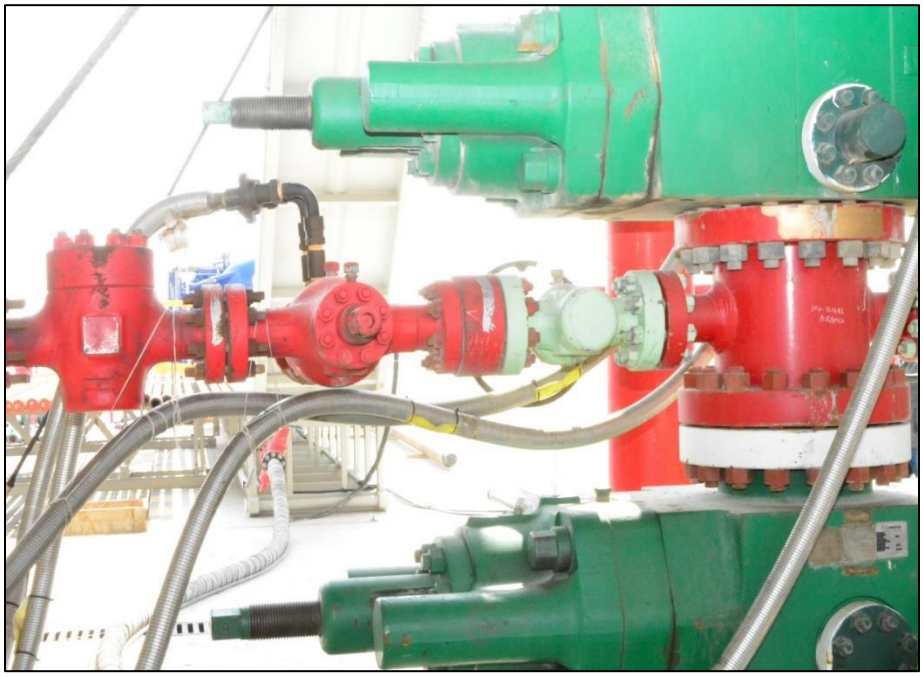


Figure 137 Kill line

10.4.5 Choke Line

- A high-pressure pipe leading from an outlet on the BOP stack to the backpressure choke and associated manifold.
- During well-control operations, the fluid under pressure in the wellbore flows out of the well through the choke line to the choke manifold, reducing the fluid pressure to atmospheric pressure.

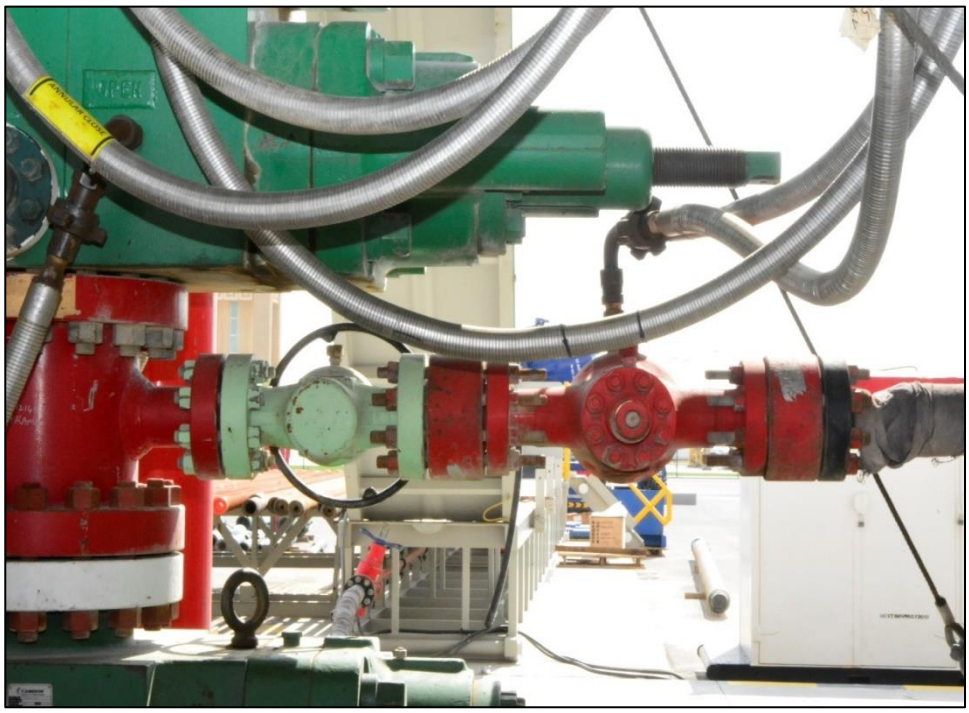


Figure 138 Choke line

10.5 TASKS

1. Show what to do during a diverter drill.
2. Show how to flow check the well and explain why this is done.
3. Assist in changing and servicing BOP rams.
4. Assist in changing the packing element of an annular BOP.
5. Assist in a complete nipple up or nipple down operation on a surface BOP stack
6. Assist with a complete BOP and choke manifold pressure test.
7. Assist with a complete IBOP and standpipe manifold pressure test.

11. WELL CONTROL EQUIPMENT (PART 2)

11.1 OBJECTIVES

To make trainees knowledgeable about following well control items:

- Well control equipment.
- What is needed and why is needed.
- Limitations.
- Maintenance and periodic testing.

11.2 OUTCOMES

Upon completing this section, they should be able to:

- Demonstrate the responsibilities of a Roustabout during a kick drill.
- Show what to do during a kick drill while tripping.
- Show what to do during a diverter drill.
- Show how to stab, make up and close a non-return “Gray” valve and explain when it is used.
- Explain why the hole must always be kept full of drilling fluid and describe what can happen if this is not done properly.
- Show how to flow check the well and explain why this is done.
- Describe the use of the trip tank and the Floorman’s role in making it work.
- Assist in changing and servicing BOP rams.
- Assist in changing the packing element of an annular BOP.
- Assist in a complete nipple up or nipple down operation on a surface BOP stack.
- Assist with a complete BOP and choke manifold pressure test.
- Assist with a complete IBOP and standpipe manifold pressure test.

11.3 INTRODUCTION

Drilling crews must be alert while drilling ahead and be on the lookout for indicators that the well is kicking or that the bit is penetrating abnormal pressure. The well must be shut in immediately when there is a positive indicator of a kick in the form of an increase in pit volume or flow rate. If a secondary indicator of a kick is recognized, then the well should be checked for flow before shutting in.

11.4 WELL CONTROL EQUIPMENT

- Accumulator unit (Koomey Unit).
- BOP Remote Control panel.
- Choke manifold.
- Remote choke control panel (SWACO).
- Mud Gas separator.
- Full opening safety valve.
- I-BOP.

11.4.1 Accumulator Unit (Koomey unit)

- An accumulator or Koomey unit is a unit used to hydraulically operate Rams BOP, Annular BOP, HCR and some hydraulic equipment.
- Energy is stored by compressing a pre-charged gas bladder with hydraulic fluid from the operating or charging system to allow accumulator to operate BOP in case of emergency. This gas is usually Nitrogen (N2), because it is considered as an inert gas; this means it will not react to external conditions such as heat and compression or react with other chemicals. Also, it is the cheapest gas because it is the most readily available; 78% of the earth's atmosphere is nitrogen.
- The accumulator stores pressurized hydraulic fluid that opens and closes the valves in the BOP. High pressure pumps in the accumulator pressurize the hydraulic fluid into vessels called bottles.
- Handles on the accumulator operate the BOP equipment. The BOP can also be operated from control panels located around the rig.

Figure 139 Accumulator Unit

11.4.2 BOP Remote Control Panel

- A device placed on the rig floor that can be operated by the driller to close BOP, it has control hand wheels all these controls operate the preventers on the BOP stack remotely by hydraulics from an accumulator unit.
- When the hand wheels are operated it direct air pressure to actuating cylinders that turn the control valves on the main BOP control unit, located a safe distance from the rig.
- A BOP control panel in located next to the doghouse and/or the tool-pusher and foreman office that the driller can access quickly.
- There may be other locations around the rig that the BOP can be controlled from in an emergency.
- The preventers can also be closed manually by using hand-wheels on the BOP.

Figure 140 BOP Remote Control Panel

11.4.3 Choke Manifold

- A set of high-pressure valves and associated piping that usually includes at least two adjustable chokes, arranged such that one adjustable choke may be isolated and taken out of service for repair and refurbishment while well flow is directed through the other one.
- The function of choke manifold is to hold back pressure while circulating up the kick, regulate the flow of gas or fluid escaping from the well through the BOP and then the flow is sent to equipment that removes the gas from the mud.

Figure 141 Choke Manifold

11.4.4 Remote Choke Control Panel (SWACO)

- A set of controls, usually placed on the rig floor, or elsewhere on location, that is manipulated to control the amount of drilling fluid being circulated through the choke manifold.

- This procedure is necessary when a kick is being circulated out of a well.

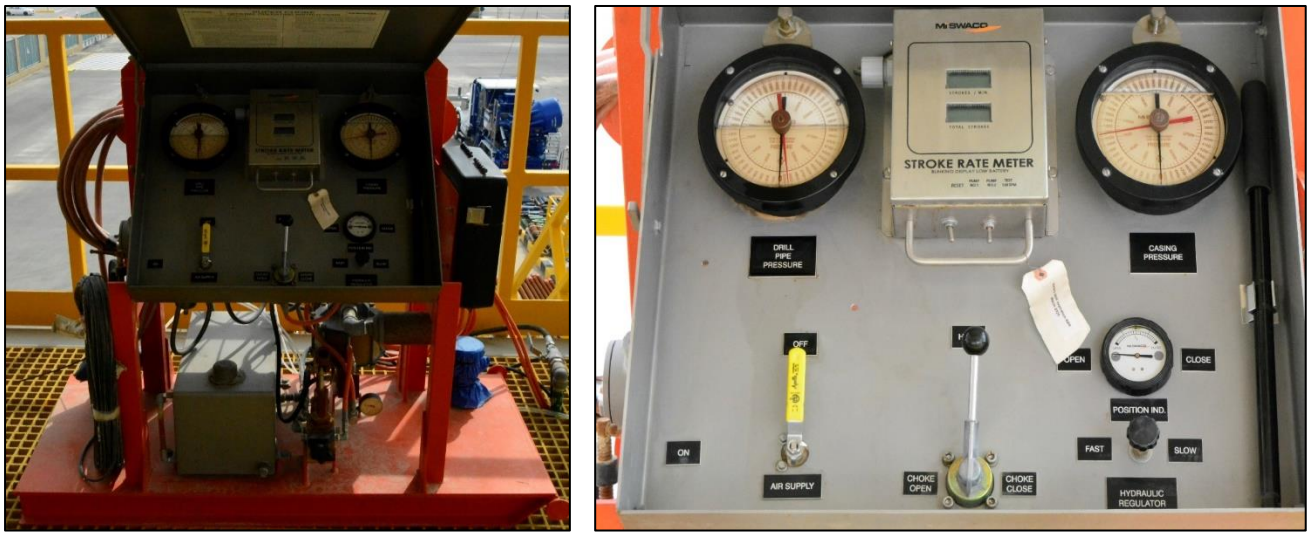


Figure 142 Remote choke control panel (SWACO)

11.4.5 Mud Gas Separator

- A device placed after choke manifold captures and separates the large volumes of free gas within the drilling fluid.
- If there is a "kick" situation, this vessel separates the mud and the gas by allowing it to flow over baffle plates.
- This equipment separates the gas from the mud as it exits the well, the mud flows into the MGS near the top. As the mud falls, it hits baffle plates inside the MGS. This agitates the mud and allows the gas to escape from the mud. The gas exits at the top of the MGS. The separated gas is sent to pits for burning off the gas, called flare pits.
- The gas then is forced to flow through a line, venting to a flare and the mud then is returned to tanks.
- Mud Gas Separator purpose is similar to **Degasser**; both of them are used to remove gas from drilling fluid, but mud gas separator can handle large amount of gas while degasser can't tolerate excessive volume of gas coming out with kick. Degasser is used as a part of solid control equipment **(SCE)** to prevent weight decreasing of the mud returning from the hole and keep it at the same value by removing any gas bubbles in the mud.

Warning! During well kill operation and at any circumstances, DO NOT USE degasser instead of mud gas separator while circulating kick out of hole.

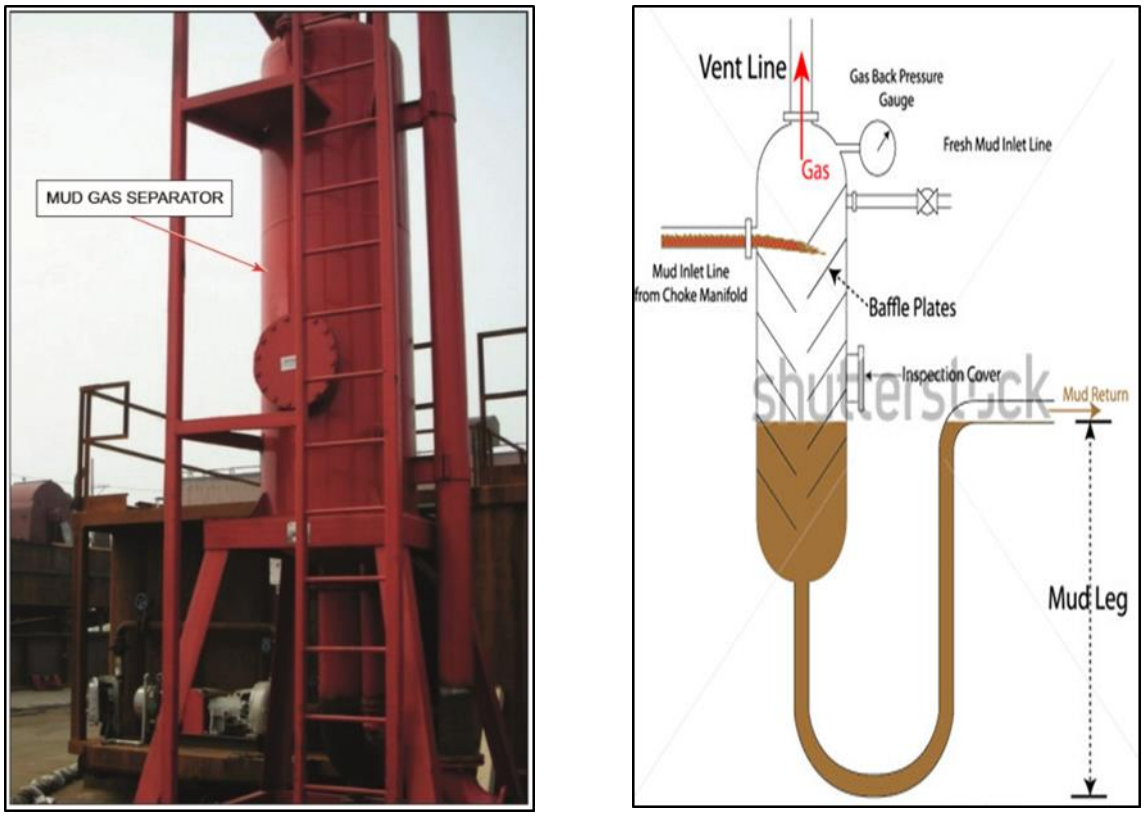


Figure 143 Mud Gas Separator

11.4.6 Full Opening Safety Valve

- It is a ball valve designed for high pressure condition and it can hold pressure from both directions.
- It used in well control situation if the well is kicks while tripping operations.
- It always kept in open position with its Alan-key.
- This is a manually operated ball valve that connects to the top of the drill string during well control operations.
- It is connected when there is a sign that there is gas or fluid entering the well. The stabbing valve is stored on the rig floor in the open position, ready for use. Once connected to the drill string, the ball valve is closed. The gray valve prevents gas or fluid from coming up through the drill string. Mud cannot be pumped through the stabbing valve when it is closed.

Figure 144 Full opening safety valve

11.5 I-BOP (GREY-VALVE)

- This valve is a non-return valve (check valve) installed above the FOSV allowing pumping drilling fluid through the valve into the drill string.
- Once IBOP is installed, FOSV can be opened, so that the driller can pump fluid into the well, I-BOP prevents upward flow and the more widely used type is "**dart-type**".
- With the IBOP valve installed in the drill string, it allows you to strip in hole without mud flowing through the drill sting.

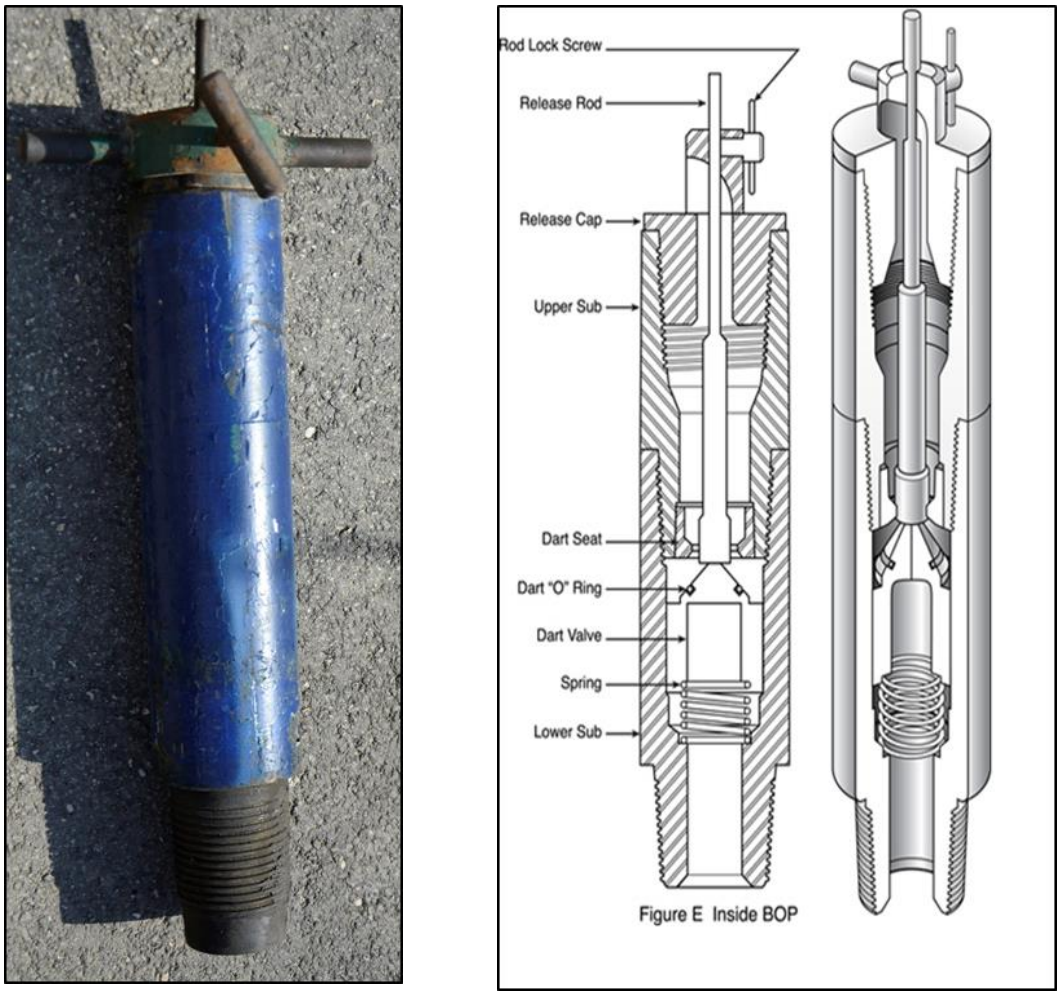


Figure 145 I-BOP (Gray-valve)

11.6 TASKS

1. Assist with a complete IBOP and standpipe manifold pressure test.
2. What is Accumulator or Koomey unit? How can be used?
3. How to use BOP control panel in emergency? Explain why?
4. What is the function of choke manifold?
5. Show how to use Remote choke control panel (SWACO).
6. What is Mud Gas Separator? How to use it?
7. Show how to use Full Opening Safety Valve?
8. Show how to stab, make up and close a non-return “Gray” valve and explain when it is used.

12. WELL HEAD & PRODUCTION TREE

12.1 OBJECTIVES

To introduce participants with the types of:

- Well Head, Production tree and its internal components.
- Casing Head, Casing Hanger and Casing Spool.
- Tubing Spool, Tubing Hanger and Production Tree.

12.2 OUTCOMES

Upon completing this section, they should be able to:

- Identify basic components of a typical wellhead and the function of each component.
- Assist in preparing and assembling wellhead components.
- Assist in assembling Casing Head, Casing Hanger and Casing Spool.
- Identify Tubing Spool, Tubing Hanger and Production Tree.

12.3 INTRODUCTION

A wellhead is the component at the surface of an oil or gas well that provides the structural and pressure-containing interface for the drilling and production equipment.

The primary purpose of a wellhead is to provide the suspension point and pressure seals for the casing strings that run from the bottom of the hole sections to the surface pressure control equipment.

12.3.1 Well Head Functions

- Provides connection and support for BOPs and other well control equipment.
- Provides a sealed connection and support for each tubular string.
- Provides a connection and support for the production tree.

12.3.2 Production Tree Functions

- Controls the flow of fluids from the well bore.
- Provides a means of shutting in the well.
- Provides a means of entering the well for servicing and workover.

12.3.3 Ring Joint flanges

Flanges are matching disks of metal bolted together and compressing a metal gasket between their faces.

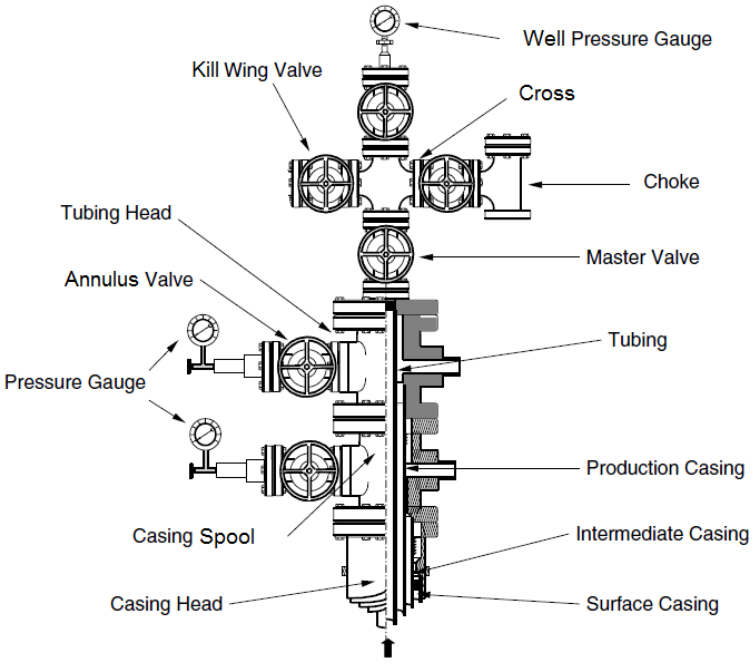
Figure 146 Ring Joint Flange

12.3.4 Ring Gasket

- Made of a special metal alloy.
- Placed between all flanged connections.
- The ring gasket fits into specially machined groove in the upper and lower flanges
- It serves to contain pressures in the wellhead
- Each ring gasket is designed to withstand maximum pressure that the tubulars will be exposed to.

12.4 TYPICAL WELL HEAD

- The Casing Head (Landing Base or Braden head).
- The Intermediate casing head (Casing Spool).
- The Tubing Head (Tubing Spool).
- The Tubing Bonnet (Tubing Head Adapter).
- The Tree.



12.4.1 Casing Head (Braden Head/Landing Base)

The casing head is the first connection between surface casing and any BOP equipment or wellhead equipment. The casing head is also called a Braden head or landing base. As shown in Figure 155, the top of the casing head is a flanged connection. The bottom of the landing base is welded (it can also be threaded) on to the surface casing. There is usually a threaded side outlet on the landing base. This threaded side outlet is for draining the BOP after it is installed.

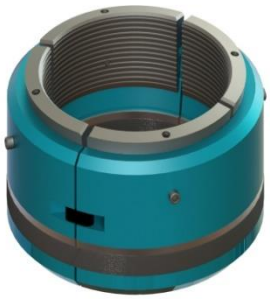
Figure 147 Casing Head

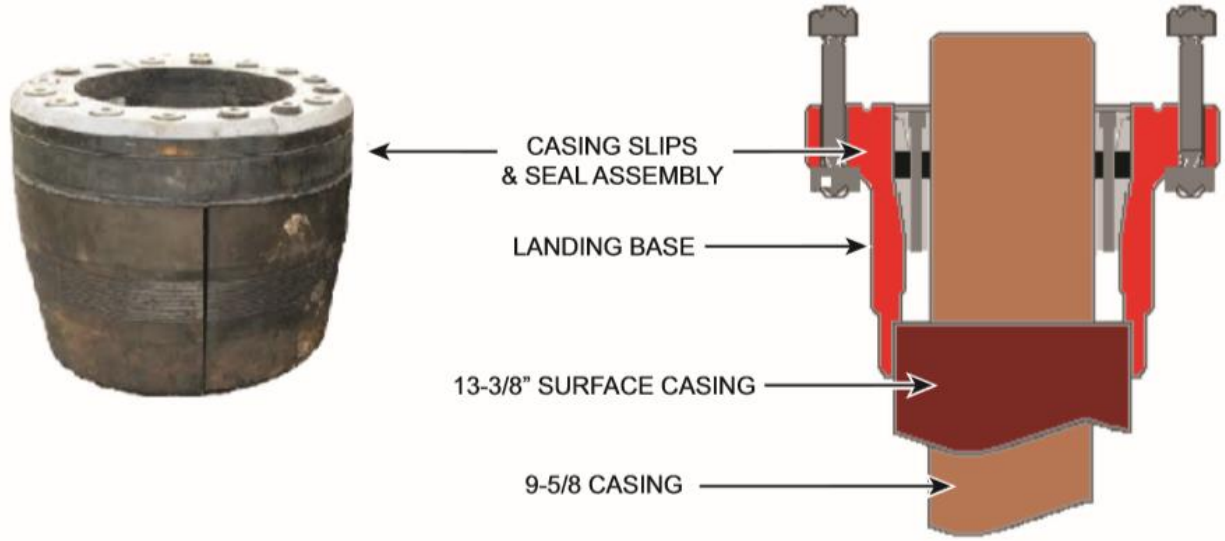
- Casing head is welded/screwed to the top of the surface casing after the completion of the cement job.
- Certified welders weld the casing head using special welding procedures.
- After the installation of the casing head, BOPE is installed and the well is deepened to the next casing point.
- The next casing is cemented in place and installed in the casing head a slip type casing hanger.

12.4.2 Casing Hanger

Is a two-piece slip and seal assembly inserted into a landing base. It can also be installed into every casing spool

- The slips suspend the casing so that the top of the casing can be cut above the slips.
- The seal part of the casing hanger prevents wellbore pressure from reaching the space between the outside of the casing, and the inside profile of the landing base or casing spool.





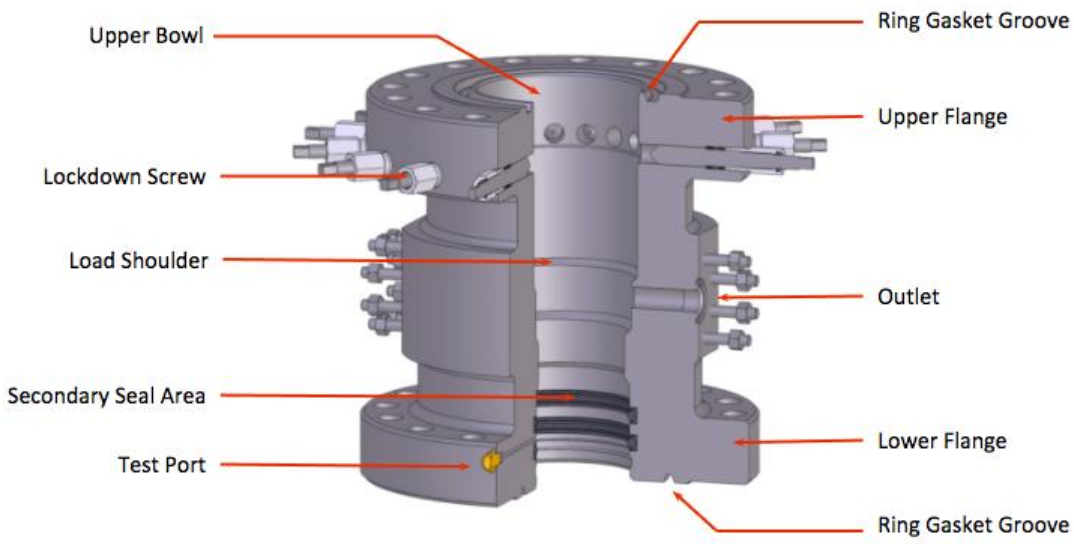
12.4.3 Casing Spool

- Casing spool consists of a lower flange to connect to the casing head and an upper flange to connect to the subsequent wellhead section.
- A cylindrical bore with shoulders is machined into the upper half to receive the casing hanger.
- It contains a primary seal (casing hanger) inside the top flange and a secondary seal (packoff) located inside the lower flange.

- Secondary seal performs the same function as the primary seal of the casing.
- Casing spool is installed on top of the casing head to accept the next casing string.

12.4.4 Tubing Spool

- Tubing head suspends the production tubing and seals off the tubing casing annulus.
- Like the casing spool, the tubing head includes a secondary seal and side outlets.
- Top flange of the tubing head is used to connect BOPE, Lower flange connects to the top flange of the section below.
- Tie-down pins secure tubing hanger in the spool.
- If tubing is attached to a downhole packer, there is a possibility that tubing will expand under flowing conditions causing a force large enough to break the seal between the hanger and the spool.
- Tubing spool is normally installed after cementing the last casing string.
- Pack off seals are pressure tested and BOPE are installed, the well is then deepened to the pay zone.



Side outlets:

Side outlets of the tubing head can be accessed to:

1) Inject a fluid into the tubing casing annulus.

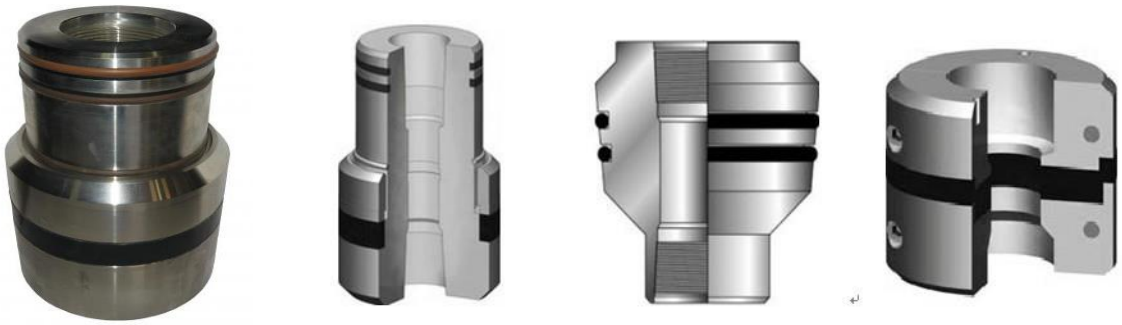
2) Monitor annulus pressure.

3) Test annulus for leaks.

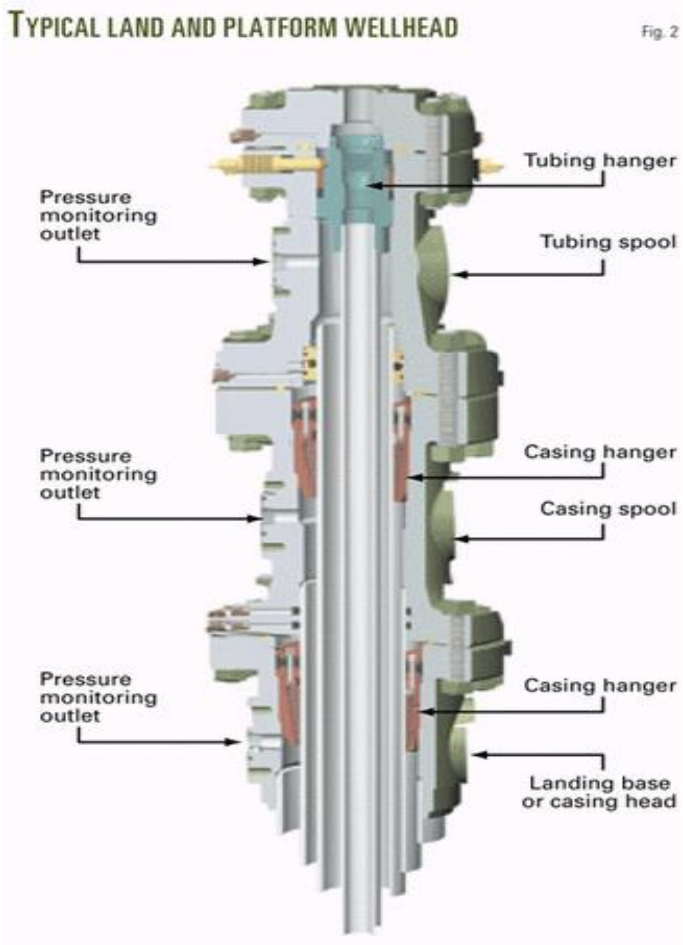
4) Relieve pressure in the tubing to casing annulus.

12.4.5 Tubing Hanger

- Tubing hanger performs the same function as the casing hanger; it suspends the tubing and seals off the tubing - casing annulus.
- Care must be taken not to damage the O.D. of either the hanger or the extended neck as deep scratches or gouges in this area can prevent the hanger from sealing.
- The lock screws are tightened after the hanger is installed.



12.4.6 Well Head Diagram:



12.4.7 Production Tree

- It is a system of gate valves regulating the flow of fluids from or into the well and provides entry into the well for servicing.
- The tree is connected to the uppermost flange of the wellhead that typically is the upper tubing head adapter (tubing bonnet) flange.
- The gate valves include the master valve, the wing valve, the kill valve and the crown / swab valve.

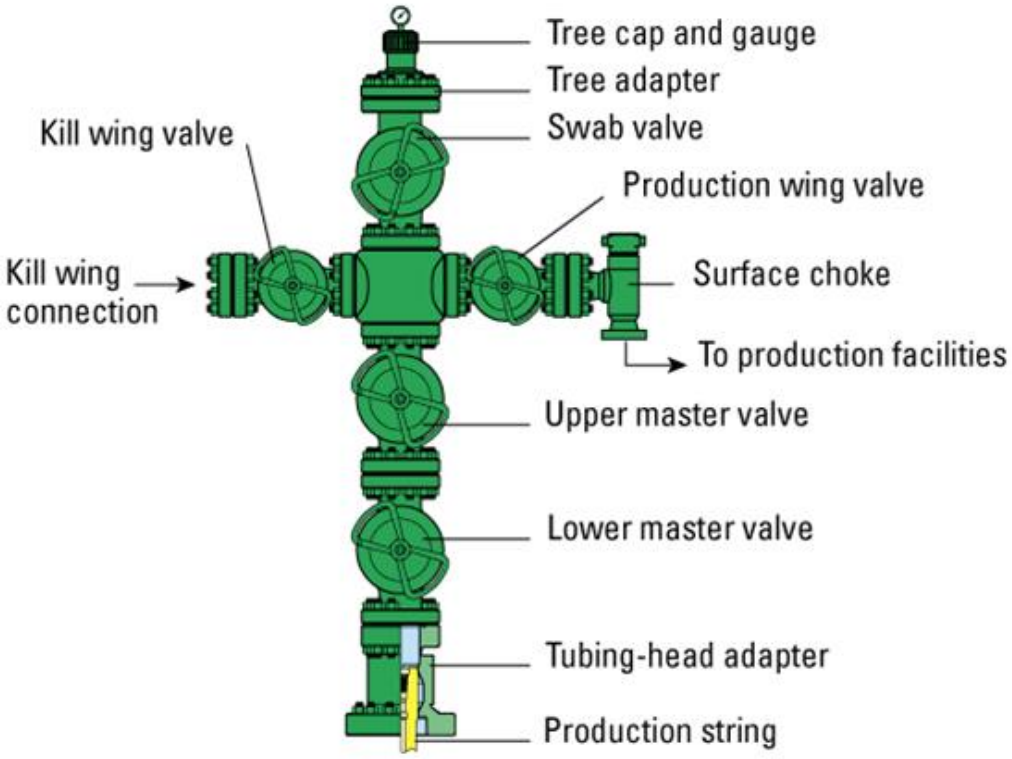


Figure 148 Production Tree

12.4.8 Back-Pressure and Two-Way Check Valves

- Back-pressure valve (BPV) is a safety plug installed in the tubing hanger to prevent the flow of wellbore fluids when removing the tree or the BOPE.
- The two-way check valve (TWCV) is used as a plug to pressure test the tree or the BOP.

Figure 149 Back-Pressure and Two-Way Check Valves

12.5 INSTALLING A CASING SPOOL

After the intermediate string of casing is run and cemented into the wellbore, the next step is to install a casing spool on top of the landing base. To do this, the BOP must be removed from the landing base. The detailed procedure for installing a casing spool includes:

- Nipple down BOP.
- Set casing hanger/slips.
- Cut the casing.
- Nipple up casing spool.
- Nipple up BOP.

12.5.1 Nipple Down BOP

Nipple down means to remove all the bolts on a flanged connection. When the bolts are removed, the BOP is lifted with the BOP hoist to access the inside of the landing base.

12.5.2 Set Casing Hanger/Slips

Once the BOP is lifted, a pressure washer is used to clean the inside of the landing base around the casing hanger profile as shown in Figure 160. Casing hangers/Slips are set, and the casings are landed as per the manufacturer's recommendations.

12.5.3 Cut the casing

Once the slips are set and the casing is suspended by the hanger in the landing base, then a welder cut the casing that is sticking up as in Figure 161.

Figure 150 *Cutting Casing*

12.5.4 Nipple Up the Casing Spool

Nipple up means making up all the bolts on a flanged connection. The casing spool attaches to the landing base with a flanged connection. The casing spool is lowered into place by using the bolt and chain sling and a hoist line through the rig floor. The seal areas of the casing spool and landing base have to be cleaned thoroughly and a new seal ring installed. The bolts are tightened, and the sling removed. The casing spool is tested as followings: The casing spool has a port on the side of the flange. The port allows the seals between the casing spool, hanger and the landing base to be pressure tested with hydraulic oil.

12.5.5 Pressure Test the Casing Spool

The casing spool has a port on the side of the flange. The port allows the seals between the casing spool, hanger and the landing base to be pressure tested with hydraulic oil.

12.5.6 Nipple Up the BOP

The BOP needs to be flanged to the top of the casing spool. Once the BOP has been tightened to the casing spool, the flanged connections are pressure tested before drilling operations can begin.

12.6 TASKS

1. What is Well Head, Production tree and its internal components?
2. What is the function of Well Head?
3. How to use Casing Head, Casing Hanger and Casing Spool.
4. Assist with Tubing Spool and Tubing Hanger.
5. What is the function of Production Tree?

13. FISHING, 3RD PARTY EQUIPMENT, WELL SERVICING

13.1 OBJECTIVES

To introduce participants with the types of:

- Drilling jars commonly being used.
- Fishing tools commonly being used.

13.2 OUTCOMES

Upon completing this section, they should be able to:

- Identify typical jars and fishing tools.
- Assist in dressing an overshot.
- Assist in making a core barrel.

13.3 INTRODUCTION

The fishing in oil field terminology refers to the process of attempting to recover a stuck pipe or tools that are left in the borehole.

13.4 FISHING TOOLS

- Drilling Jars.
- External catch fishing tools.
- Internal catch fishing tools.
- Junk retrieval fishing tools.
- Milling & cutting tools.
- Accessory tools.
- Repair & remedial tool.

Overshot

Overshot is an external catch fishing tool (Figure 77) during the engaging operation, as the Overshot is rotated to the right and lowered, the Grapple will expand when the fish is engaged; allowing the fish to enter the Grapple. Thereafter, with rotation stopped and upward pull exerted, the Grapple is contacted by the tapers in the Bowl and its deep wickers grip the fish firmly.

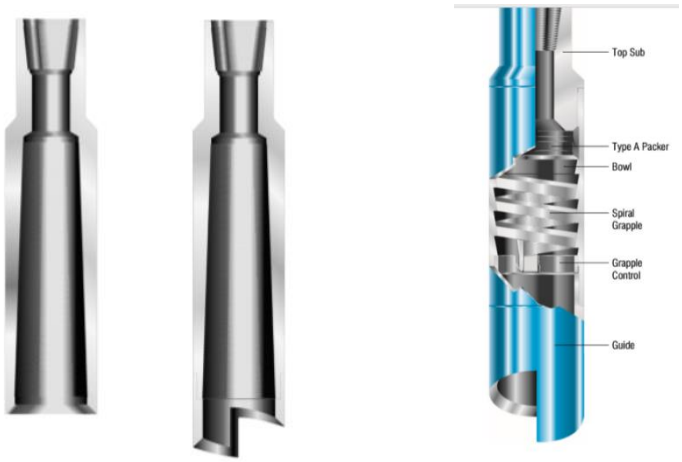


Figure 151 Overshot

Bowen Rotary Taper Taps

Bowen rotary taper taps are typical internally catch fishing tools (Figure 152). Run the taper tap in the hole to the top of the stuck fish, apply a specified weight, rotate the tap until the tapered threads have engaged the fish. Stop rotation and pull the fish from the hole.

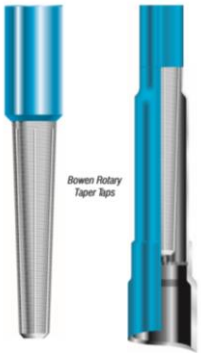


Figure 152 Taper Taps

Junk basket

Operation of the Junk Basket (Figure 153) is simple, requiring only slow rotation and circulating fluid, to retrieve junk, cores or both simultaneously. This Junk Basket may be easily converted to a fishing magnet by replacing the catchers with a magnet insert.

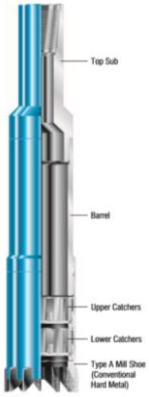


Figure 153 Junk basket

Fishing Magnets

Fishing Magnets are used to retrieve all types of small objects having magnetic attraction from bore hole bottoms. Such un-drillable objects as bit cones, bearings, slips, tong pins, and milling cuttings can often be retrieved only by magnetic attraction (Figure 154).

Figure 154 Fishing Magnet

Milling Tools

Milling tools are designed to mill away stuck fish that cannot be retrieved by conventional fishing methods (Figure 155).

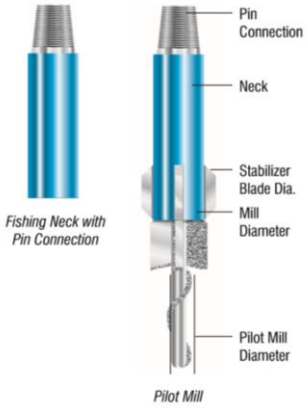


Figure 155 Milling tools

External Cutters

External cutters are hydraulically actuated mechanical tubing and drill pipe cutters. The cutter knives are fed entirely by pump pressure, thus giving the operator sensitive control (Figure 156).

Figure 156 External Cutters

To operate, assemble the cutter using the proper size and type of piston assembly. Run the cutter into the hole to cutting depth. When cutting depth is reached, open the fill-up and standpipe valves just enough to shear the shear pins. Begin slow rotation — 15 to 25 RPM. Slowly close the bypass valve again to pump fluid down the working string. This will begin feeding the knives to start the cut. The amount of pressure and gallons per minute required depends on the cutter size and piston assembly being used. Use extreme caution to avoid surging of pump pressure when starting a cut. Pressure surging causes the string length to contract and expand, moving the cutter up and down. This motion prevents the knives from remaining in one position when starting a cut.

13.5 DRILLER BRAKE

Some drilling companies offers a complete line of Friction Plate Brakes, both stand-alone and as a component of our many Draw works Control/Auto Drilling Systems. Friction Plate Brake systems provide smooth and reliable Draw works braking capability.

These companies manufacture, services and reconditions around 13 standard brake sizes suitable for drilling programs ranging from 8,000 ft to 45,000 ft. Elmagco brakes meet DNV, ABS and Lloyds registry safety and design standards are certified for use in hazardous environments.

Brakes are available in 2, 3 and 4 plate configurations, rated from 1050 to 3000 horsepower to be used as auxiliary brakes. Applied air pressure causes the actuator to clamp the rotating friction plates between stationary water jackets to generate braking torque. Varying the applied air pressure regulates brake torque in a precise and repeatable manner. Efficient heat dissipation is achieved by circulating a water-based coolant through the water jackets.

The driller is in charge of the crew and running the rig itself. Most of the time, his or her job is simply to running and monitor the rig's activity. Also, runs the breaks and drills the hole. The driller is responsible for interpreting the signals which the well gives regarding gas and fluids with high pressure. In an emergency, he is also responsible for taking the correct counter measures to stop an uncontrolled well control situation from emerging.

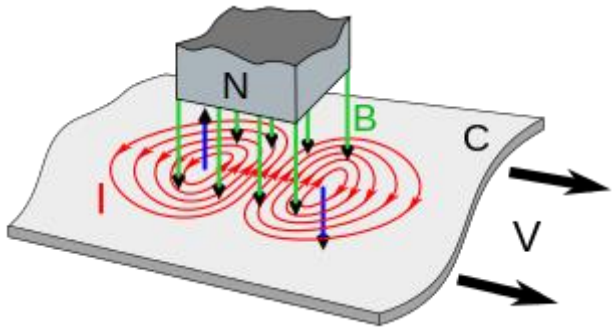
Eddy Current Brake

An eddy current brake, also known as an induction brake, electric brake or electric retarder, is a device used to slow or stop a moving object by dissipating its kinetic energy as heat. However, unlike friction brakes, in which the drag force that stops the moving object is provided by friction between two surfaces pressed together, the drag force in an eddy current brake is an electromagnetic force between a magnet and a nearby conductive object in relative motion, due to eddy currents induced in the conductor through electromagnetic induction.

A conductive surface moving past a stationary magnet develops circular electric currents called eddy currents induced in it by the magnetic field, as described by Faraday's law of induction. By Lenz's law, the circulating currents create their own magnetic field that opposes the field of the magnet. Thus, the moving conductor experiences a drag force from the magnet that opposes its motion, proportional to its velocity. The kinetic energy of the moving object is dissipated as heat generated by the current flowing through the electrical resistance of the conductor.

In an eddy current brake the magnetic field may be created by a permanent magnet or an electromagnet, so the braking force can be turned on and off or varied by varying the electric current in the electromagnet windings. Another advantage is that since the brake does not work by friction, there are no brake shoe surfaces to wear out, necessitating replacement, as with friction brakes. A disadvantage is that since the braking force is proportional to relative velocity of the brake, the brake has no holding force when the moving object is stationary, as it is provided by static friction in a friction brake, so in vehicles it must be supplemented by a friction brake.

Eddy current brakes are used to slow high-speed trains and roller coasters, as a complement for friction brakes in semi-trailer trucks to help prevent brake wear and overheating, to stop powered tools quickly when power is turned off, and in electric meters used by electric utilities.



A metal sheet moving to the right under a magnet, illustrating how a linear eddy current brake works. In this drawing the magnet is drawn spaced apart from the sheet to reveal the vectors; in an eddy current brake the magnet is normally located as close to the sheet as possible.

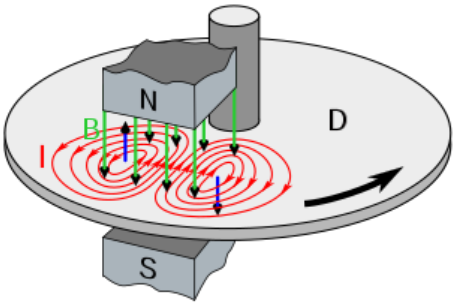


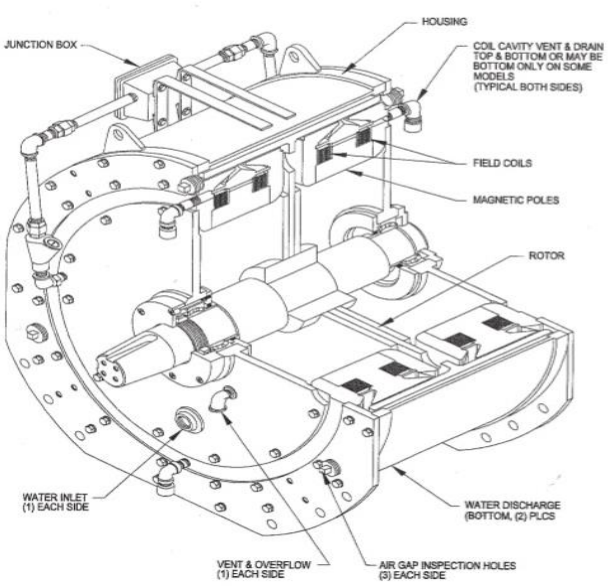
Figure 157 A circular or disk eddy current brake.

Features

- Electromagnetic braking system
- During operations, a magnetic field is generated by field coils in magnets mounted inside the brake's spinning rotor, which is coupled with the draw-works shaft. The magnetic field is used to create the braking torque.
- No overrunning clutch is required because brake is deactivated by simply turning it off
- The Eddy Current Brake Control systems accomplish braking through the movement of a single drillers control handle that varies the voltage input to the coils. This allows the driller to control the amount of braking torque applied to the spinning rotor and resultantly, the draw works spool.
- Air-cooled brake control systems

Benefits

- Smoother and quieter operations
- Extended preservation of brake life
- Braking produced electromagnetically without contact between spinning rotor and stationary magnets, resulting in no wear under normal circumstances
- Easy Control
- High breaking torque and horsepower absorption, giving driller positive, infinite variable control over drill string speed under various hook loads
- Brakes meet DNV, ABS, ATEX and Lloyds Registry safety and design standards
- Brakes are Factory Mutual certified for NEC Class 1, Division 1, Groups C & D hazardous environments.



13.6 BASIC WELL SERVICING OPERATION

13.6.1 Wireline Operation

- Rig Roustabouts receiving equipment and trucks. Load and unload cabins and boxes from the truck to the right location at the rig. Using tag lines while dealing with cabins and cranes. Taking extra precaution while moving cabins and tools due to sensitive sensors and equipment for wire line operation.
- Rig Electricians connecting power supply and ground cables to power up the Wire Line cabin. Power voltage depends on the cabin transformer voltage. Need to make sure of cabin voltage before connecting any power to avoid transformer or electrical equipment damage.
- Rig Mechanic connecting water or compressed air lines to their equipment or unit. Sometimes compressed air and/or water needed for their operation.
- Assistant Driller contacts Wire Line supervisor and assists him in any need for their operation.
- Driller assists Wire Line crew to lift the Wire Line equipment and sheaves to adjust it with required level.
- Usually Driller monitors pressure gages and equipment while Wire Line operation and pressure testing to avoid any out of control situations. Also corrects the mistakes in case of emergencies.

13.6.2 Cementing Operation

- Rig Roustabouts receiving Cementing equipment and trucks. Load and unload tanks, cabins and boxes from the truck to the right location at the rig. Using tag lines while dealing with cabins and cranes. Taking extra precaution while moving cabins and tanks due to sensitive sensors and equipment for cementing operation.
- Also, Roustabouts doing drifting using the Rabbit while casing preparation before cementing. Checking connection threads, centralizers and Shoe.
- Rig Electricians connecting ground cables and power supply to power up the cementing equipment. Power voltage depends on the equipment transformer voltage. Need to make sure of cabin voltage before connecting any power to avoid transformer or electrical equipment damage.
- Rig Mechanic connecting Diesel, Water or compressed air lines to their equipment or unit. Sometimes Compressed air and/or Water needed for their operation.
- Assistant Driller contacts Cementing supervisor and assists him in any need for their operation.
- Rig crew assists in installing cementing head and make sure is tested.
- Usually Driller works directly with Cementing crew. Controlling the TDS and draw works while casing and cementing operation. Also, monitor pressure gages and equipment while cementing operation to avoid any out of control situations. Also corrects mistakes in case of emergencies.

13.6.3 Coiled Tubing & Well Testing Operation

- Rig Roustabouts receiving equipment and trucks. Load and unload cabins, skids and boxes from the truck to the right location at the rig. Using tag lines while dealing with cabins and cranes. Taking extra precaution while moving cabins and tools due to sensitive sensors and equipment for Coiled Tubing & Well Testing operation.
- Rig Electricians connecting ground cables and power supply to power up the Coiled Tubing & Well Testing cabin. Power voltage depends on the cabin transformer voltage. Need to make sure of cabin voltage before connecting any power to avoid transformer or electrical equipment damage.
- Rig Mechanic connecting Diesel, Water or Compressed air lines to their equipment or unit. Sometimes Compressed air and/or water needed for their operation.
- Assistant Driller contacts Wire Line supervisor and assists him in any need for their operation.
- Same procedure done while Rig up and Rig down Equipment.
- Usually Driller monitors pressure gages and equipment while Coiled Tubing, Well Testing operation and Pressure Testing to avoid any out of control situations. Also corrects mistakes in case of emergencies.
- All rig crew and coiled tubing team must be aware of Well Control operation to avoid any barrier failure.

13.7 TASKS

1. Identify typical types of fishing tools used on your rig and show where each is stored.
2. Assist in dressing an overshot.
3. Assist in measuring downhole tool dimensions (including threads, OD, ID, length, fishing neck, and serial number) and explain why this is necessary.
4. Assist in making up a core barrel.
5. Assist in core recovery and handling.
6. Practice in Driller Brake Simulator and EDDY current break.
7. Show how rig crew helps while Wire Line Operation.
8. Assist in Cementing Rig up and Operation.
9. Show how to help while Coiled Tubing & Well Testing Operation.

14. ABBREVIATION LIST

ALARP	As Low As Reasonably Practical
BGG	Background Gas
BHA	Bottom Hole Assembly
BHST	Bottom Hole Static Temperature
BHT	Bottom Hole Temperature
BOCP	Blowout Contingency Plan
BOP	Blowout Preventer
BRT	Below Rotary Table
CG	Connection Gas
CQP	Cement Quality Parameters
CT	Coiled Tubing
DGM(O)	Deputy General Manager (Operations)
DM	Drilling Manager
DS	Drilling Supervisor
DST	Drill Stem Test
DTF	Drilling Task Force
DTL	Drilling Team Leader
DTM	Drilling Team Manager
ECD	Equivalent Circulating Density
EMW	Equivalent Mud Weight
ES	Electrical Survey
ESM	Emergency Support Team Manager
FME	Field Mud Engineer
GL	Ground Level
GM	General Manager
GPM	Gallon Per Minute
GWP	Generic Well Programme
H_2S	Hydrogen Sulphide Gas
HAZID	HAZard IDentification
HAZOP	HAZard and OPerability
HDO	Head of Drilling Operations

HSEIA	Health, Safety and Environment Impact Assessment
HSEMS	Health, Safety and Environment Management System
HTHP	High Temperature, High Pressure
IADC	International Association of Drilling Contractors
IBOP	Inside Blowout Preventer
ID	Internal Diameter
KTOL	Kick Tolerance
LCM	Lost Circulation Materials
LOT	Leak off Test
LSND	Low Solid Non Dispersed Mud
MAASP	Maximum Allowable Annular Surface Pressure
MEDEVAC	MEDical EVACuation
MSDS	Materials Specification Data Sheet
SDS	Safety Data Sheet
M.wt	Mud Weight
MWD	Measurement While Drilling
NB	Near Bit
NRV	Non Return Valve
WBM	Water Based Mud
OBM	Oil Based Mud
OD	Outside Diameter
OEDP	Open End Drill Pipe
PBR	Polished Bore Receptacle
PBTD	Plug Back Total Depth
Pcs	Pieces
PDC	Polycrystaline Diamond Compacts
PE(D)	Petroleum Engineer (Drilling)
POOH	Pull Out Of Hole
PPM	Parts Per Million
Psi	Pounds per square inch
PTW	Permit To Work
PV	Plastic Viscosity
RCJB	Reverse Circulating Junk Basket

RCV	Remotely Controlled Vehicle
Reg	Regular
RFT	Repeat Formation Tester
RIH	Run In Hole
RM	Rig Manager
ROP	Rate of Penetration
RPM	Revolutions Per Minute
RT	Rotary Table
RTTS	Retrievable-Test-Treat-Squeeze [packer]
SADA	Saudi Arabian Drilling Academy
SAP	Sustainable Annulus Pressure
SBT	Shoe Bond Test
SCR	Slow Circulating Rate
SCSSSV	Surface Controlled Subsurface Safety Valve
SDI	Standard Drilling Instructions
SG	Specific Gravity
SICP	Shut-in Casing Pressure
SIDPP	Shut-in Drill Pipe Pressure
SME	Senior Mud Engineer
SO_2	Sulfur dioxide
SOE	Senior Operations Engineer
SOE (D)	Senior Operations Engineer (Drilling)
SOP	Standard Operation Procedure
SPM	StandPipe Manifold
SPR	Slow Pump Rate
SWL	Safe Working Load
TD	Total Depth
TG	Trip Gas
TJ	Tool Joint
TOC	Top Of Cement
TVD	True Vertical Depth
TWCV	Two Way Check Valve
VDL	Variable Density Log

VMS	Vehicle Monitoring System
WBM	Water Based Mud
WOB	Weight On Bit
WOC	Waiting On Cement
WOW	Waiting On Weather
WPM	Wellbore Positioning Manual
XO	Crossover
X-over	Crossover
YP	Yield Point

صدى
SADA

أرامكو السعودية
saudi aramco

العربية
Arabian
شركة الحفر
Drilling Co.

SAIPEM

SANAD
Saudi Aramco Nabors Drilling

ENSCO

HALLIBURTON

Schlumberger

Sinopec
SINOPEC

Rawabi
روابي
للنفط والغاز
Oil & Gas

ARO
DRILLING
أرامكو روان للحفر

NOBLE

BAKER
HUGHES
a GE company

المؤسسة العامة للتدريب التقني والمهني
Technical and Vocational Training Corporation

DPS

شركة زي بي العربية للحفر المحدودة
ZP ARABIA DRILLING COMPANY LTD

SHELF
DRILLING

WDI™
A WEATHERFORD COMPANY

NPS
الشركة الوطنية للخدمات البترولية
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ADES
ADVANCED ENERGY SYSTEMS

Weatherford®

CAMERON
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NEFT ENERGIES
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