DESCRIBE AND OPERATE BEAM PUMP  
Module C  
Describe Beam Pump Operation

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♦ Training Module and Self-Check  ♦ Blank Answer Sheet
♦ Knowledge Check and Answer Key  ♦ Job Aid

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Beam pumps are used to lift a variety of liquids from subsurface wells to the surface. Beam pumps are commonly used at:

- oil wells to lift the oil to the surface
- gas wells to remove accumulated water which would prevent the gas from entering the wellbore
- coal bed methane wells to remove water from coal seams

While HDC’s *Describe and Operate Beam Pump* series of training kits addresses beam pumping oil wells, the content applies to any beam pumping application.

The series consists of four modules, listed below. These modules are designed to address the needs of oil well operators responsible for operating, monitoring, and optimizing existing beam pumping oil wells. The modules are task focused (i.e., center around *what* the operator does, *why* he/she does it, *when* he/she does it, and *how*). The modules are sequential: Module A is a prerequisite to Module B and so on.

The four modules in the series are:

- Module A—Describe and Monitor Wellhead, Sucker Rod String, and Subsurface Pump
- Module B—Describe and Monitor Pumpjack and Prime Mover
- Module C—Describe Beam Pump Operation
- Module D—Optimize Beam Pump Operation

**Modules A and B** include:

- descriptions and principles of operation of typical surface and subsurface beam pumping oil well equipment
- operating variables
- reasons for specific operating requirements
- causes for variables to change, consequences, symptoms, and operator responses to abnormal operations
- monitoring tasks related to the equipment
- a walkthrough where the operator identifies the equipment at his/her site
- self-check review questions
- a stand-alone knowledge check
Module C provides:
- a description of a typical beam pump wellsite
- an overview of beam pump oil well safety
- production monitoring and record keeping
- a description of routine beam pumping tasks:
  - respond to oil well shutdowns
  - start up pumpjack oil well (engine)
  - start up pumpjack oil well (motor)
  - check pressure safety switch
  - pig flowlines
  - put sucker rod pump on tap
  - shut down pumpjack oil well; lock out; secure for maintenance
  - change pumpjack stuffing box
- self-check review questions
- a stand-alone knowledge check
- a stand-alone checklist for monitoring beam pump operation

Module D provides:
- a description of well performance analysis
- a description of pumping system analysis
- a description of pumping oil well diagnostics:
  - fluid level detector
  - dynamometer
  - pumpjack load analysis
- a description of pumping unit adjustments:
  - balance the pumping unit
  - change pumping speed
  - change stroke length
  - lower/raise sucker rod string
  - adjust casing gas or downstream pressure
- a description of the operator’s role in optimization
- self-check review questions
- a stand-alone knowledge check
- a stand-alone troubleshooting table for beam pump operation
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Prerequisites

- Module A—Describe and Monitor Wellhead, Sucker Rod String, and Subsurface Pump
- Module B—Describe and Monitor Pumpjack and Prime Mover

Training Objectives

Upon completion of this training kit, you will be able to:

- Describe equipment at a typical oil wellsite equipped with a beam pumping system
- Describe beam pump wellsite hazards and precautions for working safely
- Describe well and equipment monitoring and record keeping
- Describe the well operator’s response to an unplanned shutdown
- Describe tasks operators routinely perform at oil wells equipped with beam pumping systems:
  - shut down and lock out beam pumping system (prime mover and pumpjack)
  - start up engine-driven beam pumping system
  - start up motor-driven beam pumping system
  - check (test) pressure safety switch
  - pig wellsite flowlines
  - put downhole sucker rod pump on/off tap
  - change stuffing box packing

1 Introduction

This module describes equipment operation and operator roles and responsibilities for oil wells equipped with beam pumping systems.

A beam pumping system consists of (see Figure 1):

- a pumpjack (beam pumping unit) at the surface
- a downhole pump (sucker rod pump at the bottom of the well)
- a sucker rod string (including polished rod) which connects the pumpjack and downhole pump
- a prime mover (internal combustion engine or electric motor) which provides the energy for pumping the well
Figure 1— Beam Pumping System at a Cased Oil Well

- Beam Pumping Unit
- Horsehead
- Carrier Bar
- Polished Rod
- Wellhead
- Prime Mover
- Surface Casing
- Gas Flow
- Oil Flow
- Intermediate Casing
- Production Casing
- Production Tubing
- Sucker Rod String
- Tubing Anchor
- Pump
- Perforations
This module provides:

- an overview of equipment often installed at wellsites with beam pumping systems
- information about tasks that beam pump oil well operators commonly perform, including:
  - shutting down and locking out the beam pumping system (prime mover and pumpjack)
  - starting up an engine-driven beam pumping system
  - starting up a motor-driven beam pumping system
  - checking (testing) the pressure safety switch
  - pigging wellsite flowlines
  - putting the downhole sucker rod pump on/off tap
  - changing the stuffing box packing

For each of the above tasks, key hazards and operating issues are identified and *generic* procedures for performing the tasks are provided. The importance of working safely, monitoring equipment, and keeping good records is emphasized throughout this module.

Because wellsite equipment varies widely, procedures for a given task may vary from one wellsite to another. Your company may use different or equipment-specific procedures for the tasks described in this module. Always use your company’s procedures to perform the tasks.

You can use the *Job Aid* which accompanies this module to monitor beam pumping systems at one or more of your company’s oil wellsites.

## 2 Typical Beam Pump Wellsite

Beam pumping system operation is closely integrated with the operation of other wellsite equipment. Oil well operation is most effective when the operation of all site equipment is carefully coordinated. Each piece of equipment affects, but should not interfere with or impair, the operation of any other equipment on site.
Depending on the formation, the well fluids that the beam pumping system lifts to the surface may include:

- produced fluids:
  - oil
  - water (brine) (free and/or entrained)
  - dissolved gas (associated gas)
- sediment (solids contaminants such as sand)

At some wellsites, the non-separated well fluid is shipped via pipeline directly to an offsite tank battery. At the tank battery, the fluid is separated into individual components (e.g., oil, gas, water, and sand). The oil and gas are collected for sales; the water and sand are disposed according to regulatory requirements.

At other wellsites, the well fluids are separated into individual components right at the wellsite. Operation of this downstream equipment may affect the beam pumping system operation. For example, if downstream equipment is shut down for any reason, the pressure buildup will cause the beam pumping system to shut down.

End of Sample One—Introduction
Sample Two—Pumpjack Tasks starts on next page
Start of Sample Two—Pumpjack Tasks

5 Respond to Unplanned Shutdowns

Operators are responsible for keeping their oil wells producing continuously, 365 days a year. When an oil well unexpectedly shuts down, the operator is responsible for getting the well back on line as soon as possible.

There may be no remote indication of an oil well shutdown. The operator may only discover the shutdown when arriving on site. When not on site, the operator may have to rely on other information to determine if a well is down, for example, reports from truckers or reduced flow to downstream equipment.

This section:
- lists typical causes for unplanned shutdowns
- overviews the operator’s role and responsibilities for responding to an unplanned shutdown

Generally, if well operation cannot readily be restored, the operator notifies company maintenance personnel or contracted specialists to investigate further.

The information that follows may not apply to your company’s equipment. Always follow your company’s policies and procedures for troubleshooting and responding to unplanned oil well shutdowns.
5.1 Typical Causes for Unplanned Shutdowns

Typical causes for unplanned oil well shutdowns include:

- **downstream ESD valve closure**, which in turn causes the pressure safety switch at the wellhead to close and shut down the prime mover.

- **high or low pressure shutdown**, which occurs when high or low pressure in the well discharge line triggers the pressure safety switch to close. The closure shuts down the prime mover.
  - High pressure could be caused by:
    - waxed off flowline
    - closed ESD valve
    - closed manual block valve
    - pressure safety switch failure
  - Low pressure could be caused by a leak in the piping downstream of the pressure safety switch.

- **prime mover shutdown**:
  - A **motor** shutdown could be caused by:
    - utility power failure, such as ground faults, phase loss, phase imbalance, phase reversal, undervoltage, overvoltage, transformer high temperature
    - motor protective shutdowns, such as motor overload, ground fault, high temperatures
  - An **engine** shutdown could be caused by:
    - low engine coolant level
    - high engine temperature
    - low lube oil level
    - spark plug failure
    - ignition system failure
    - condenser fan failure
    - coolant concentration too high (i.e., the coolant is not evaporating enough)
    - loss of fuel gas/propane (check liquid level in fuel gas scrubber)
    - disengaged or failed clutch

---

**NOTE**

Engine shutdowns can be kept to a minimum by regular engine inspection, fluid top-ups, and preventive maintenance.
• inadequate maintenance
• equipment failure, including:
  – V-belt failure
  – pumpjack mechanical or structural failure
  – downhole equipment failure (e.g., broken rods, jammed valves)

Equipment failure can be caused by:
• operating equipment outside the recommended limits (e.g., when undersized equipment is used)
• using equipment/components that do not meet specifications
• misaligned components
• frost
• a change in well conditions

Some possible causes for an oil well shutdown are easier to identify and solve than others. Whether well operation can be readily restored depends on the cause and extent of the problem, the operator’s training and experience, and availability of parts or specialized personnel (if needed).

5.2 Operator’s Role and Responsibilities for Responding to an Unplanned Shutdown

The operator has a key role in responding to an unplanned shutdown and restoring well operation. The operator’s overall responsibilities include:
• troubleshooting
• ensuring the cause of the problem is rectified (by the operator or by others)
• monitoring to ensure production is effectively restored
• documenting the cause, actions taken, and effectiveness of the solution(s)

When an unplanned oil well shutdown is reported or suspected, the operator goes to the wellsite as soon as possible. At the wellsite, the operator tries to identify what caused the shutdown. If possible, the operator rectifies the problem without assistance.
Troubleshooting an unplanned shutdown can be difficult or beyond the scope of your knowledge, experience, or role as an operator. If you cannot readily identify and rectify the cause of the shutdown, ask another operator for advice/assistance or notify maintenance personnel.

If the problem cannot be rectified without assistance, the operator shuts down and locks out the well (refer to Section 6). The operator then notifies:
- other operations personnel, company maintenance personnel or contracted specialists for assistance (if a problem with surface equipment is suspected)
- company engineering personnel for assistance (if a problem with the well or downhole equipment is suspected)

Depending on company policy and the cause of the unplanned shutdown, the operator may have to:
- submit a work order
- issue a Safe Work Permit
- attend the wellsite to supervise, monitor, or assist contracted personnel performing the work

The operator also checks maintenance records to determine whether the problem has occurred before and, if so, how often. If the problem is a recurring one, the operator works with company maintenance/engineering personnel to identify the root cause(s) and find a permanent solution.

After the problem has been rectified, the operator ensures all lockouts are removed and valving is re-opened. The operator then:
- restarts the beam pumping system (refer to Sections 7 and 8).
- documents the problem, how it was rectified, and whether the solution was effective
- monitors to ensure the beam pumping system continues to operate and production is restored
Learning About Beam Pump Oil Well Tasks

Sections 6 to 12 of this module provide information about tasks that beam pump oil well operators commonly perform. Key issues and major steps are identified for each task. Learning about the key issues and major steps provides you with a framework for learning to perform the tasks according to your company’s site-specific procedures.

6 Shut Down Beam Pumping System

Shutting down the beam pumping system is one of the first tasks assigned to new oil well operators. The shutdown procedure varies, depending on the reason for the shutdown and the duration of the shutdown.

The following procedures are generic and may not apply to all types of equipment. Always follow your company’s specific procedures.

This section describes three types of beam pumping system shutdowns:
- temporary shutdown (no lockout)
- short-term shutdown and lockout
- long-term shutdown and lockout

6.1 Shutdown Overview and Hazards

The following procedures describe counterweight positions in conventional oilfield terms (i.e., as points on the twelve-hour clock). These terms assume that the operator is facing the side of the beam pumping unit with the horsehead on the right and the counterweights on the left.
Shutdown Overview
For all types of beam pumping system shutdowns, consider the preferred positions of the counterweights and horsehead after the shutdown. Find out your company’s preference:

- Some companies prefer to stop the pumpjack when the counterweights are at the bottom (6 o’clock position). In this position, the horsehead is at the top of its stroke and the polished rod is exposed.
- Other companies prefer to stop the pumpjack when the counterweights are at the top, just over the center (12 o’clock position), so that so that there is a mechanical advantage for starting. In this position, the horsehead is at the bottom of its stroke and the polished rod remains in the well tubing, protected from blowing dust and debris.

Regardless of company preferences, the type of work to be performed often dictates the counterweight and horsehead positions after the shutdown.

Shutdown Hazards
Hazards associated with shutting down beam pumping systems include:

- Hazardous concentrations of combustible and/or toxic gas may be present. Use the PPE, respiratory protection, and gas monitoring equipment recommended by your company.
- Flammable and/or toxic fluids could contact your skin or eyes. Use the PPE recommended by your company.
- Hazardous energy sources that are not locked out may be unexpectedly or accidentally released:
  - lock out and tag as many hazardous energy sources as necessary to prevent injury (listed in Table 2, Section 3.5)
  - post signs to identify hazardous energy sources that cannot be locked out and ensure you stay clear of these sources
- The engine operates at a high temperature; when shutting down the engine, allow time for:
  - the engine jacket to cool before working nearby
  - the coolant system to depressure before checking coolant levels
After the beam pumping system is shut down, residual pressure is still present at the wellhead. Personnel working near the wellhead could be injured if:
- a sudden pressure surge displaces/dislodges piping
- pressurized fluids are unexpectedly released

Working alone can be hazardous; be sure to maintain regular contact with the central control room operator.

6.2 Temporary Shutdown (No Lockout)

Sometimes the operator shuts down a beam pumping system very briefly (e.g., for a few minutes) to make routine checks or adjustments.

Shutting down the beam pumping system without locking out hazardous energy sources may endanger you or others. Stay clear of all components that:
- could be inadvertently started or opened
- could unexpectedly move or release hazardous energy

Temporarily Shut Down Engine-Driven System (No Lockout)

To shut down an engine-driven beam pumping system:
- disengage the clutch
- apply the brake, stopping the pumpjack with the counterweights in the 6 o’clock (bottom) position

To apply the brake, pull on the lever slowly and steadily. Setting the brake abruptly can damage the gears.

End of Sample

A full licensed copy of this kit includes:
- Training Module and Self-Check
- Knowledge Check and Answer Key
- Blank Answer Sheet
- Job Aid