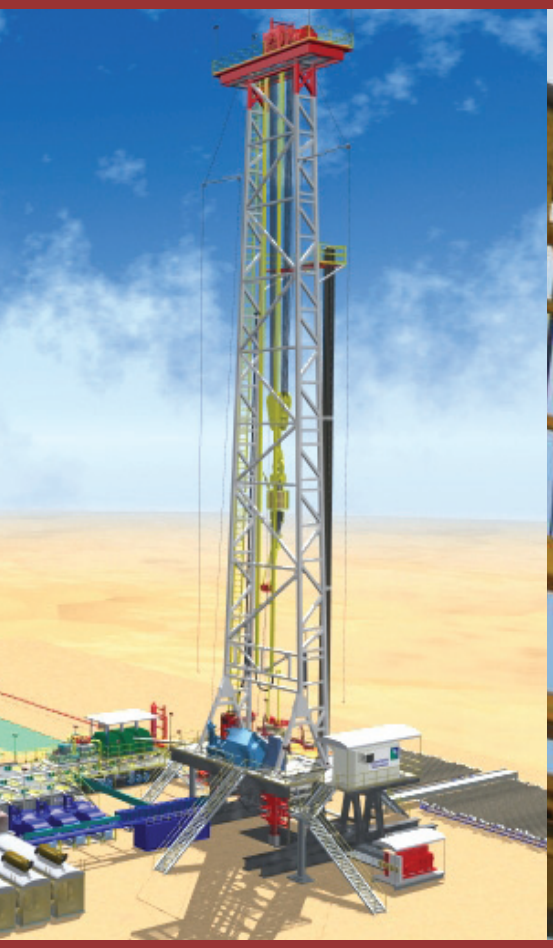
ارامكو السعودية
Saudi Aramco

Instructor Guide

INTRODUCTION TO DRILLING OPERATIONS



Module 5.3
Define the Function of the Choke Manifold

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

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Saudi Aramco

Trainee Handbook

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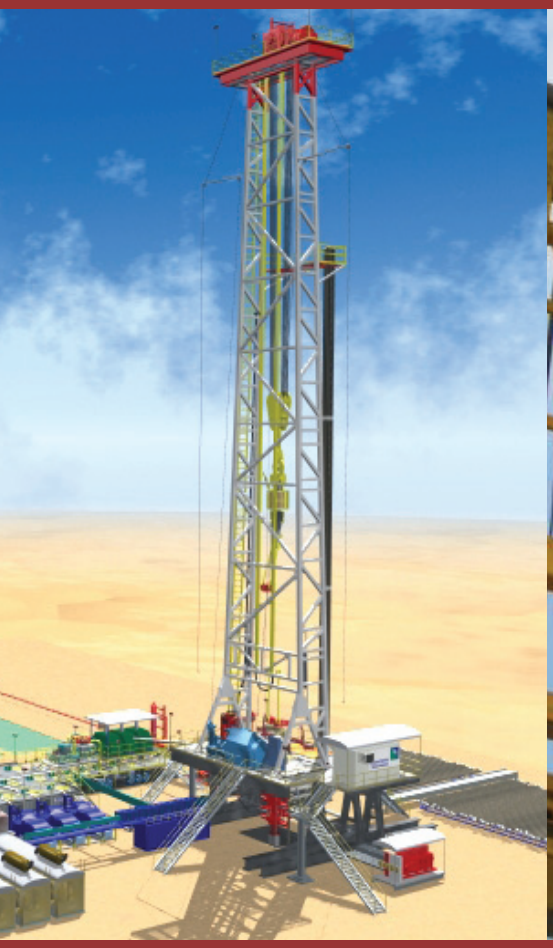

Module 5.3
Define the Function of the Choke Manifold

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Unit 5: State the Function and Operation of Wellhead and Well Control Equipment

Module 5.3
Define the Function of the Choke Manifold

INSTRUCTOR GUIDE

Unit 5: State the Function and Operation of Wellhead and Well Control Equipment

Module 5.3
Define the Function of the Choke Manifold

TRAINEE HANDBOOK

Item	Action	Aid	Time
PREPARATION	Before class, prepare the classroom. Distribute trainee handbooks.	Instructor Guide. Trainee Handbooks.	
INTRODUCTION	Identify and explain the module objectives. Explain new words.	Information Sheets. Glossary. Oil Industry Terms e-Glossary.	1 hr.
OBJECTIVE 5.3.1	Identify the function of the main components of the choke manifold. Have trainees complete the exercise.	Information Sheets, part I. Exercise A.	2 hr.
OBJECTIVE 5.3.2	Identify the function of the mud-gas separator and flare pits. Have trainees complete the exercise.	Information Sheets, part II. Exercise B.	2 hr.
RIG VISIT	Review the function and maintenance procedures for the choke manifold system.	Information Sheets.	4 hr.
REVIEW	Review objectives.	Information Sheets.	1 hr.
WRITTEN TEST	Administer the written test. Score and record the results. Counsel trainees whose performance is unsatisfactory and provide remedial training as required.	Test Sheets. Test Answer Key.	2 hr.
	Estimated time for a class of 8 trainees.		12 hr.

USING THIS MODULE

This module familiarizes trainees with the choke manifold and associated equipment function. Use the Saudi Aramco Oil Industry Terms e-Glossary and other online resources to explain new terms or concepts.

The key objectives to emphasize in this module are:

- ❏ function and components of the choke line
- ❏ function and components of the choke manifold
- ❏ function and main components of the mud gas separator and flare pit

RIG VISIT

Use the training rig as much as possible to show your trainees the areas and equipment discussed in the module. Also, use demonstrations in place of lectures wherever possible. Keep the Information Sheets as the core reference material for trainees to review information on the equipment that they have been learning about.

KEY TO EXERCISES

EXERCISE A

1. Diverts well fluids from the BOP to the choke manifold.
2. HCR.
3. Coflex hose.
4. Closed.
5. Hold back pressure on the well and direct mud to the gas separating equipment, flare pit or trip tank.
6. The choke valve is used to regulate shut-in pressure on the well.
7. It adjusts the size of the opening to allow more or less fluid through it.
8. The gate will get damaged and not hold pressure when closed.

EXERCISE B

1. Removes gas from drilling fluid.

2. Allows mud to be circulated through the poor boy degasser.

3. Prevents the gas from flowing into the mud tanks.

4. The fluid dropping onto the baffle plates.

5. Through the top of the degasser line and into the flare pit.

6. To have an alternative flare pit that won't allow the wind to blow the gas onto the rig.

Date	Reason
August 2014	First Printing

Enabling Objectives

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

5.3.1
Identify the function of the main components of the choke manifold.

5.3.2
Identify the function of the mud-gas separator and flare pits.

Terminal Objective

Define the function of the choke manifold.

INTRODUCTION

To control the well after a kick has been taken, the well control equipment must operate correctly. Rigmen maintain and test the equipment to confirm it is in good working condition.

Pressure testing the choke manifold and the BOP is a routine job on the rig. Replacement parts frequently need to be installed on the equipment.

In this module, you will learn about the function and the components of the choke manifold and mud degasser equipment.

PART I **OBJECTIVE 5.3.1**

Identify the Function of the Main Components of the Choke Manifold

You learned that when a preventer on the BOP is closed, mud returns are diverted to the choke manifold through a choke line. The choke manifold controls the flow and pressure of the fluids coming out of the well. In this part of the module you will learn about the components of the choke line and the choke manifold.

THE CHOKE LINE

The choke line (see figure 1) is a high pressure line that is either flexible or hard pipe. The choke line is attached to the drilling spool on the BOP.

Figure 1
Choke Line

The following components make up the choke line:

- ❏ hydraulically controlled relief valve
- ❏ manual gate valve
- ❏ high pressure line

Hydraulically Controlled Relief Valve

A hydraulically controlled relief valve (HCR) is shown in figure 2. The HCR is the main gate valve on the choke line. It is opened and closed by pressurized hydraulic oil from the accumulator unit. This makes it possible to open the choke line to the choke manifold remotely. Remote operation means that people do not have to be in the cellar area during well control operations.

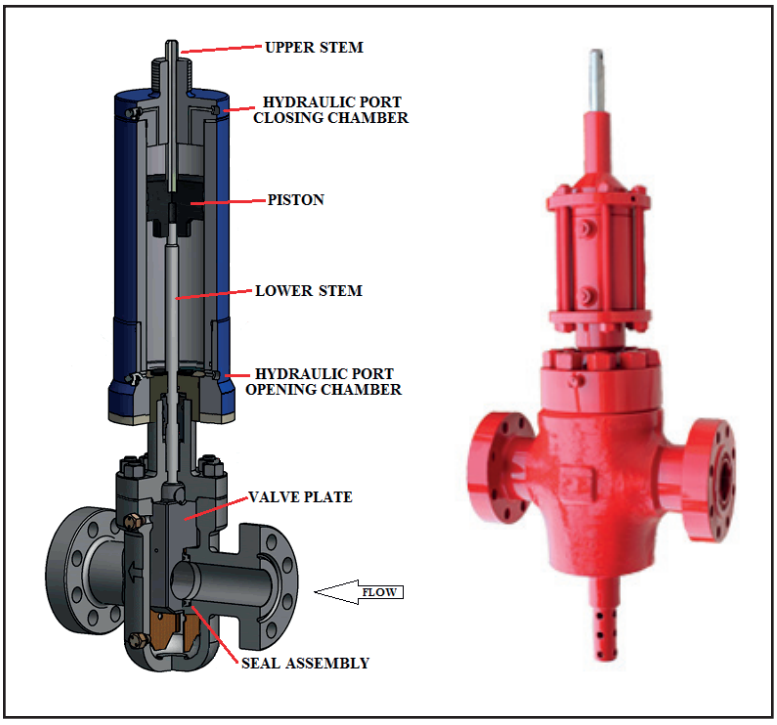

Figure 2
Hydraulically Controlled Relief Valve

The stem of the valve is attached to a piston that moves up or down to open or close the valve. To open the valve, hydraulic oil fills the opening chamber and lifts the piston. The piston lifts the valve plate, opening the gate to allow flow through the choke line.

To close the valve, oil fills the closing chamber, pushing the piston and valve plate down. This closes the gate and stops the flow through the choke line. During normal operations the HCR valve is closed.

Manual Gate Valve

A manual gate valve is used as a secondary valve in the choke line. It is normally closed, and provides another way to close off the choke line in case of maintenance. Figure 3 shows the manual gate valve.

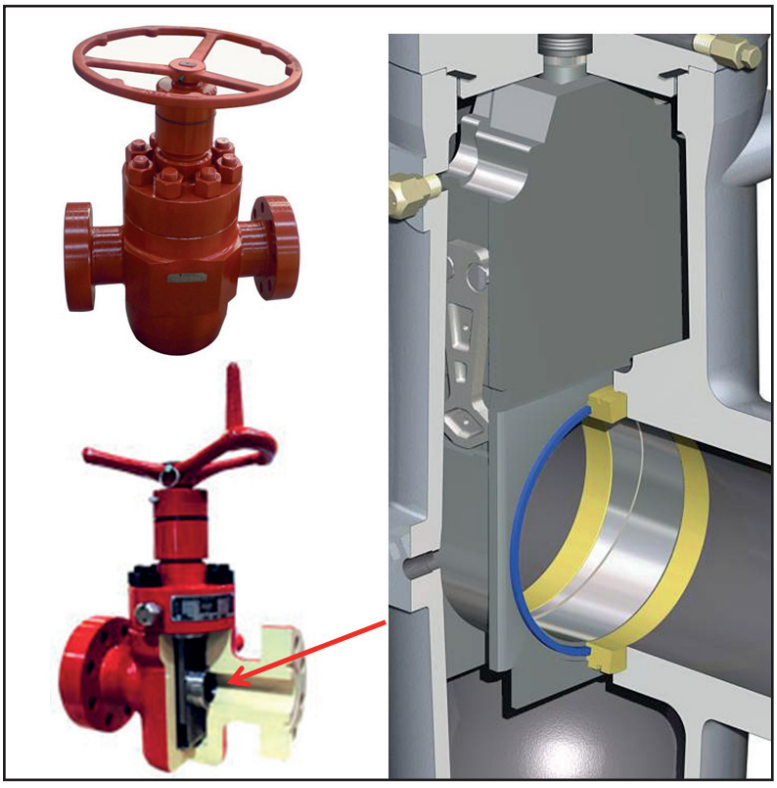

Figure 3
Manual Gate Valve

The manual gate valve opens and closes by turning the handle on top of the valve. The gate or paddle is pulled up to open the valve, by aligning the opening in the gate with the opening in the valve seat.

The choke line valves should be either fully open or fully closed. Running flow through them when not fully open will cause them to wash out and fail sooner.

High Pressure Line

High pressure lines connect the choke line valves to the choke manifold. These lines can be:

- ❏ coflex hose
- ❏ hard piping

Coflex Hose

Some rigs use a coflex hose to connect the choke line valves to the choke manifold. A coflex hose can contain pressures up to 3000 psi. As shown in figure 4, the hose is made of rubber layers with steel ***braiding***. The hose is covered with a flexible metal ***sheath***. The coflex hose has a flanged connection that allows it to be bolted to the high pressure valves.

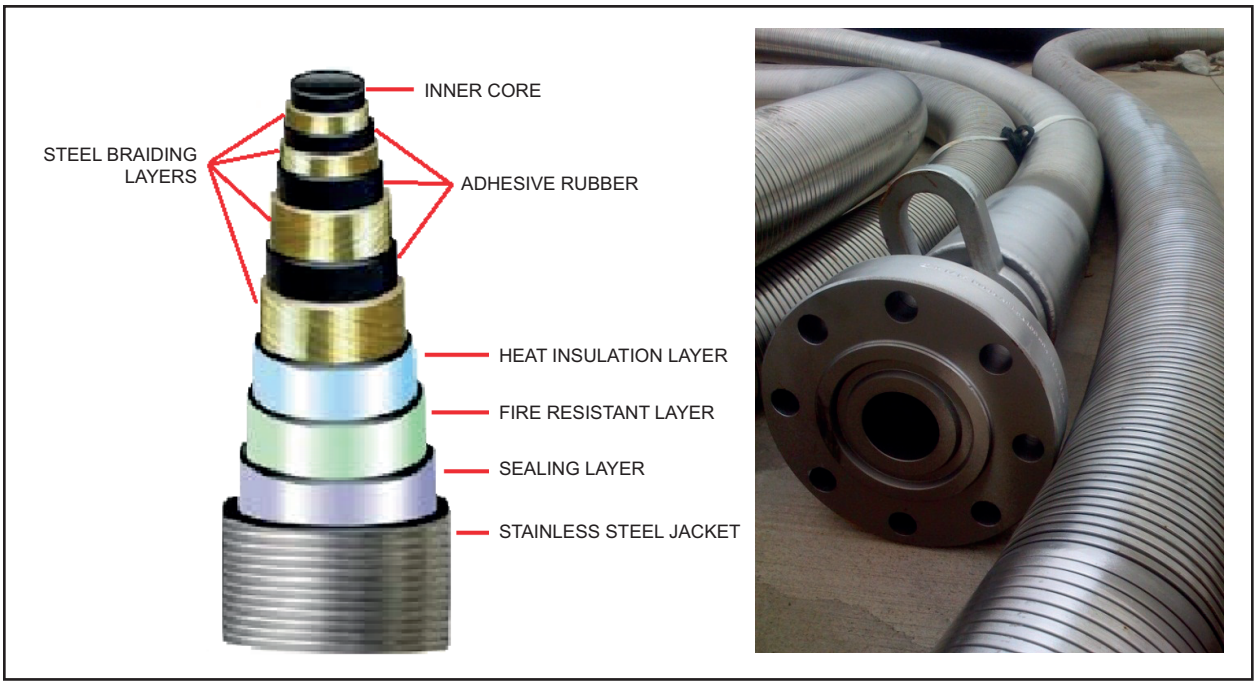

Figure 4
Coflex Hose

Hard Piping

A ring gasket is used when connecting a flanged connection as in figure 6. The ring gaskets are made of softer steel to create a metal to metal seal that prevents leaks. The seal ring must be dry and free of oil, grease or dirt when installed. The number on the side of the ring gasket identifies the size.

Hard piping, shown in figure 1, is more common than the coflex hose. Hard piping is connected with directional blocks, as in figure 5, to go around corners or change direction.

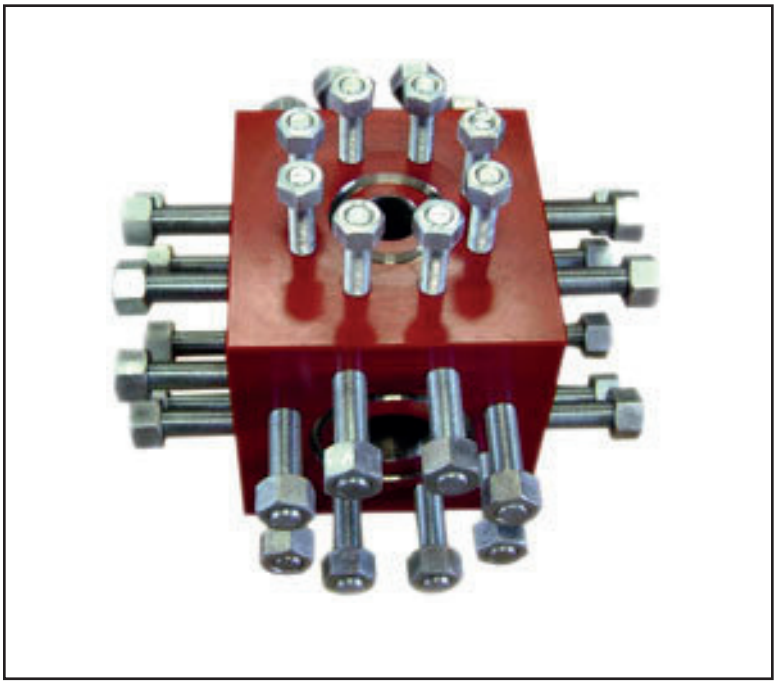

Figure 5
Choke Line Directional Block

Figure 6
Ring Gasket

CHOKE MANIFOLD

During a kick, the weight of the drilling fluid must be increased to prevent more formation fluid from entering the well. The driller can pump heavier drilling fluid downhole while the BOP is closed. As heavier drilling fluid is pumped downhole, the returns flow through the choke manifold.

The driller can regulate the shut-in pressure of the well by controlling the choke manifold. The heavier drilling fluid displaces the kick fluids and lighter drilling fluid in the well. The shut-in pressure decreases as the heavy drilling fluid fills the hole and suppresses the formation pressure. When the well is stabilized, drilling can resume.

The choke manifold (see figure 7) is a group of high pressure valves that control and maintain the shut-in pressure on the well. The manifold directs mud flow from the well to the mud cleaning equipment, gas/mud separating equipment, or to a flare pit.

The size and complexity of the choke manifold is determined by the size of the BOP and expected pressures while drilling the well.

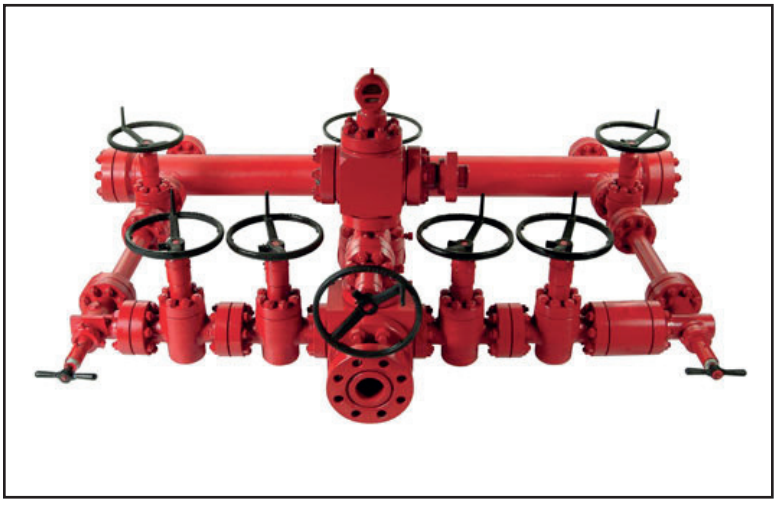

Figure 7
Choke Manifold

The choke manifold includes:

- ❏ gate valves
- ❏ choke valves
- ❏ remote operated choke valves
- ❏ flare lines

Gate Valves

Gate valves are not designed to adjust flow. They are meant to be fully open or closed. If a gate valve is used to adjust flow, the gate or seat will be damaged and will not hold pressure when closed.

The gate valves in the choke manifold work the same way as the gate valves in the choke line. There are more gate valves on the choke manifold, as they direct the flow path from the well.

The gate valves are arranged so that the flow from the well can be directed through the choke manifold while still isolating one or more valves from pressure. This allows for repairs to be made or a change out of a valve in an emergency operation.

Choke Valves

A choke is a special type of valve that controls flow. The choke is adjustable to regulate the annular pressure and flow.

A choke adjusts the size of the opening to allow passage for more or less flow of gas, mud or oil. On the choke shown in figure 8, the opening adjusts by pushing the paddle further into the opening of the seat. This reduces the area for fluid to pass. The restriction in flow creates more pressure on the well side of the choke.

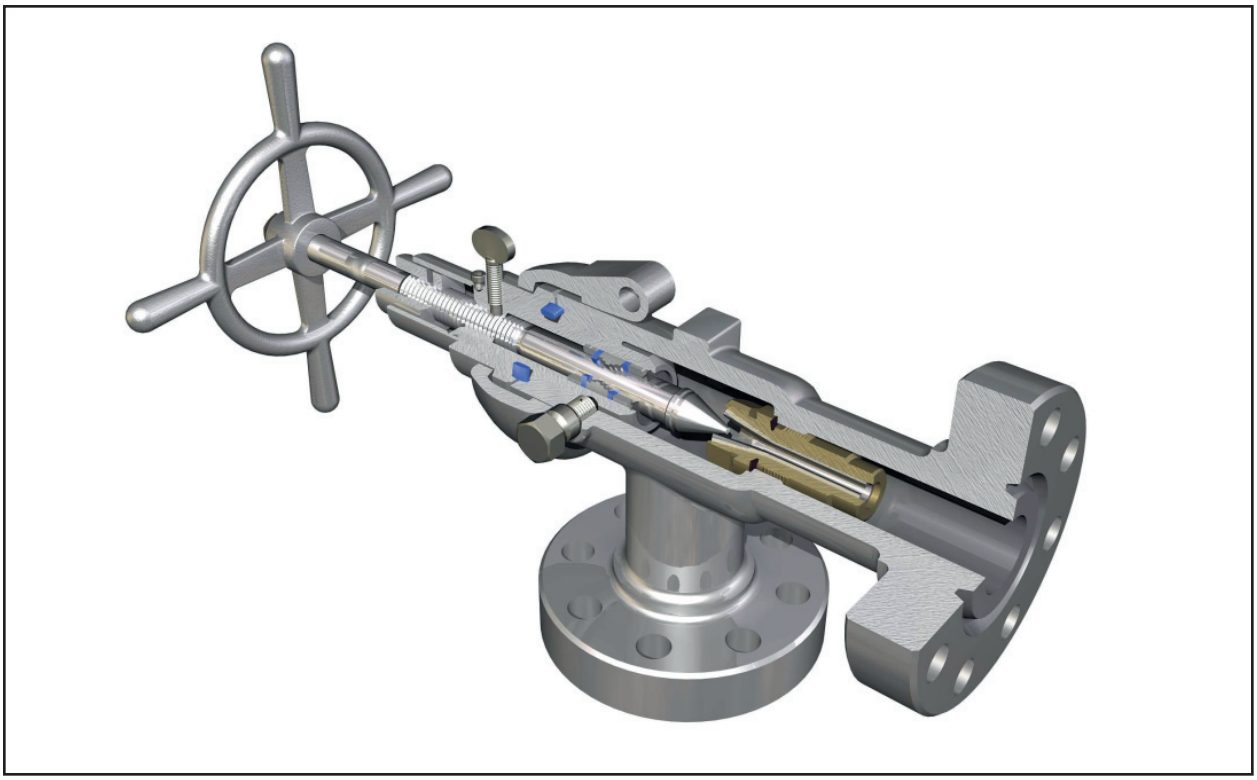

Figure 8
Choke Valve

Remote Operated Choke Valves

Remote operated choke valves (see figure 9) perform the same function as a manual choke. They are the primary choke used during well control operation. The difference is that the choke opening and closing is controlled from the rig floor control panel.

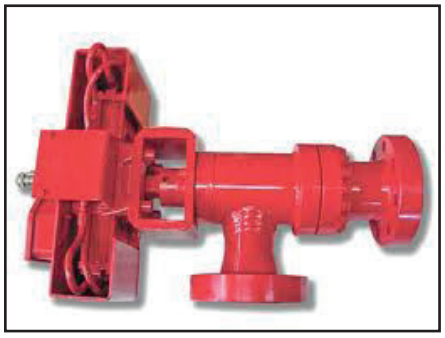

Figure 9
Remote Operated Choke Valve

The choke manifold contains more than one choke. If one choke washes or gets plugged, the other choke is used during repairs to the damaged or plugged choke.

Mud flow out of the choke manifold can be directed to the mud-gas separator (poor boy degasser), the flare pit, or the trip tank.

Returning mud is usually directed to the poor boy degasser, where gas and mud are separated. The mud then returns to the mud tanks to be treated further and pumped back down the well.

The flare pit is used to burn off the exiting gas.

If the mud returns are not sent to the degasser, they are sent to the trip tank. The trip tank can be monitored to measure the size of the kick.

Figure 10 shows a diagram of a Saudi Aramco choke manifold. The drilling fluid returns from the well through the choke line into the choke manifold. The mud then flows through the opened choke and gate valves.

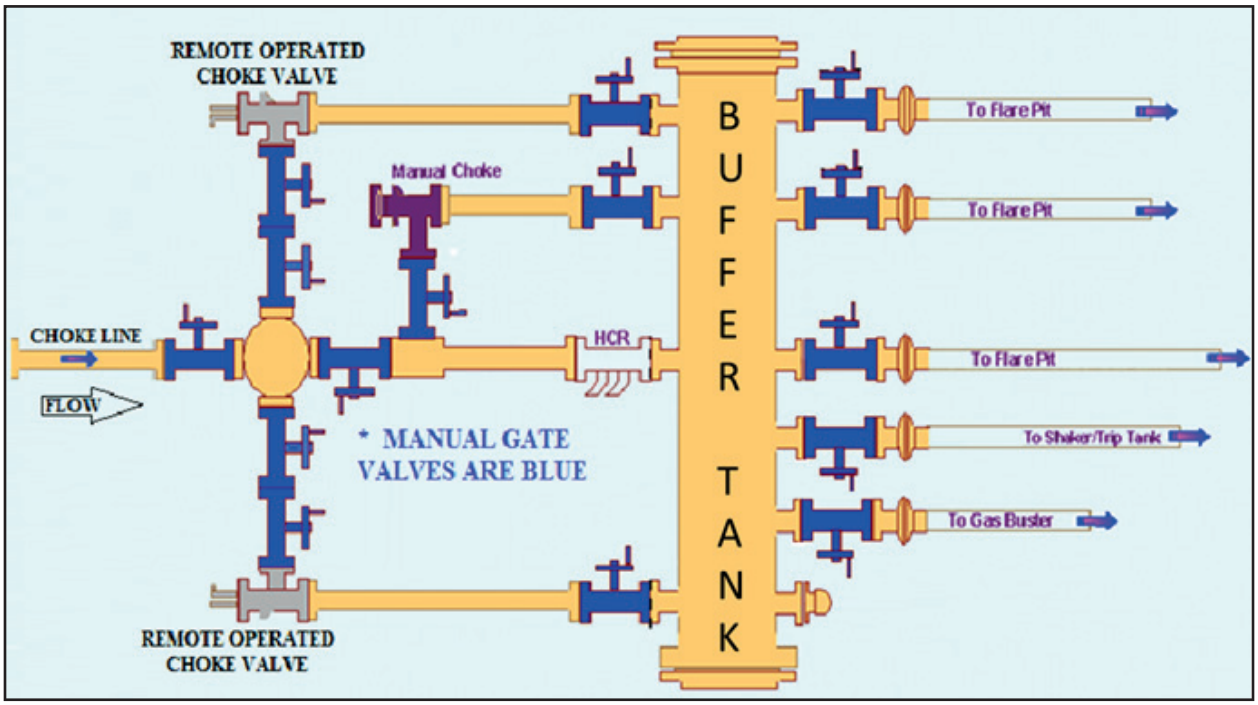

Figure 10
Saudi Aramco Choke Diagram

Only one choke is used at a time. The gate valves before and after that choke must be open to direct the flow through the manifold. The mud is directed to the flare pit, degasser, or trip tank. This requires one of the valves on the lines leaving the choke manifold to be opened.

Flare Lines

Flare lines (see figure 11) attach to the choke manifold to direct the flow of liquid or gas away from the rig to flare.

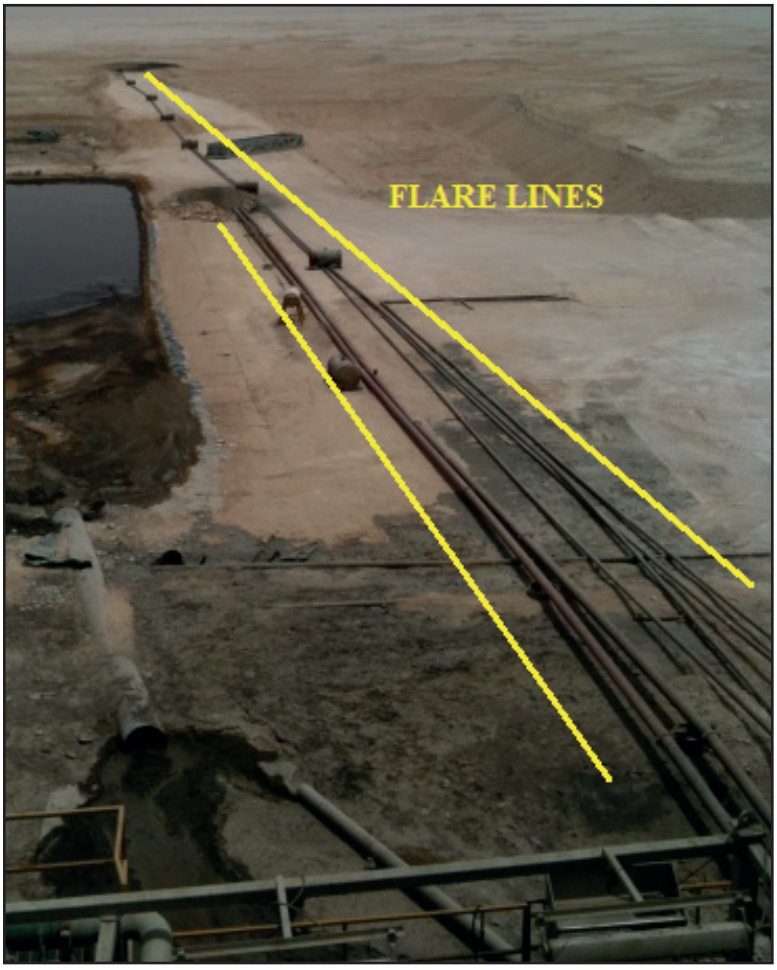

Figure 11
Flare Lines

Flare lines are made from steel piping that is flanged to the outlet side of the gate valves on the choke manifold. The connections are tight to ensure gas or liquid travels to the end of the flare line without leaks.

Figure 12 shows a Saudi Aramco diagram for flare lines. Notice there are multiple lines to the flare pit. This ensures that alternate passage for the flow is available if other lines are blocked.

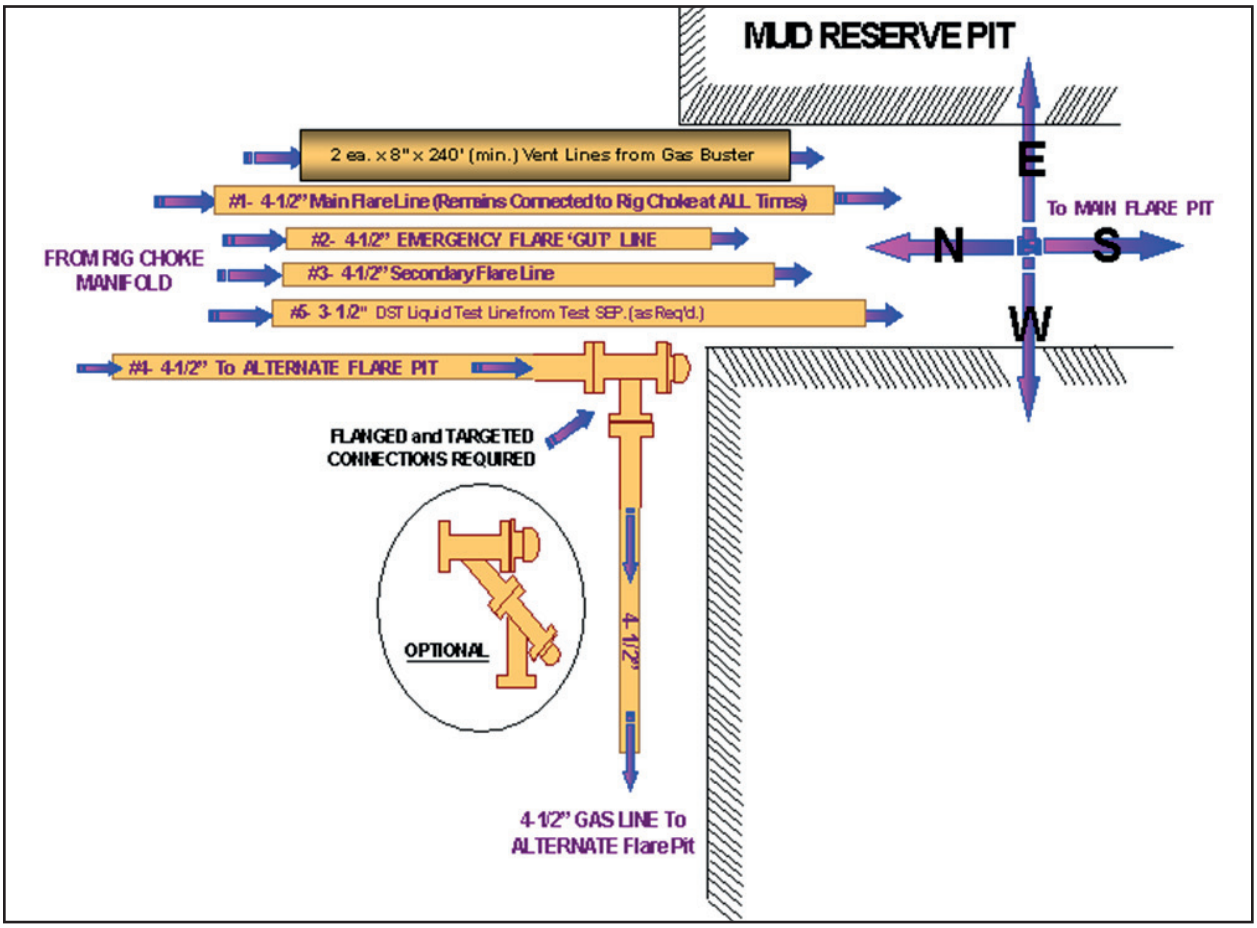

Figure 12
Saudi Aramco Flare Lines Diagram

SUMMARY

You have learned about the function of the main components of the choke line and choke manifold. You now know that the HCR valve is the primary valve used to connect the choke line to the choke manifold.

You also know that the remote choke is a variable valve, and it is the primary valve used on the choke manifold. Usually there are two remote choke valves and one manual in a choke manifold set up.

The choke adjusts the size of the opening in the valve to allow more or less fluid through the valve.

The gate valves in the choke system should be fully open to prevent any restrictions in the lines. 

EXERCISE A

Directions: *Answer the following questions or complete the statement.*

1. What is the purpose of the choke line?

_____

2. What is the name of the primary valve used on the choke line?

_____

3. What is the name of the flexible hose that is sometimes used on the choke line?

_____

4. Is the HCR valve open or closed during normal operations?

_____

5. What is the purpose of the choke manifold?

_____

6. What is the purpose of the choke valve?

_____

7. How does a choke work?

_____

8. Why should a gate valve never be used to adjust flow?

_____

PART II **OBJECTIVE 5.3.2**

Identify the Function of the Mud-Gas Separator and Flare Pits

You learned in part I of this module that the choke regulates flow from the well and directs it to the mud gas separator, flare pit, or trip tank.

In this part, you will learn about the function of the mud gas separator and flare pits.

MUD GAS SEPARATOR

The mud gas separator is responsible for removing the gas from the drilling fluid during well control operations. The main components of a mud gas separator include:

- ❏ inlets
- ❏ ***baffle*** plates
- ❏ outlets

Inlets

The mud gas separator inlets are the lines that carry the gas and mud into the degasser.

Figure 13 shows a Saudi Aramco poor boy degasser for drilling deep gas wells. The figure shows that there are two inlet lines. One line comes from the choke manifold and one comes from the flowline.

The inlet from the flowline allows gas cut mud to circulate through the poor boy while drilling, without having to close the BOP.

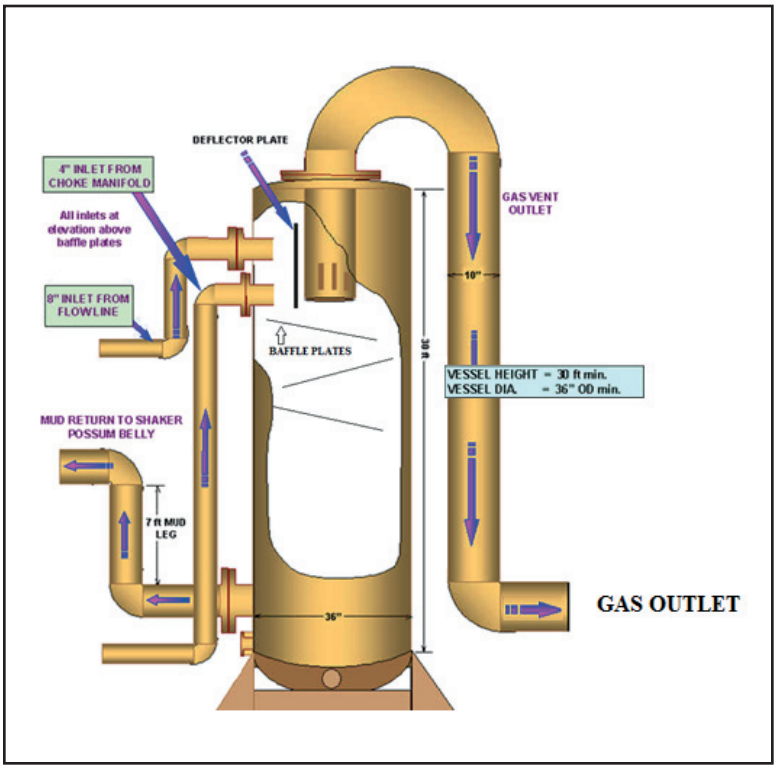

Figure 13
Saudi Aramco Poor Boy Degasser for Gas Wells

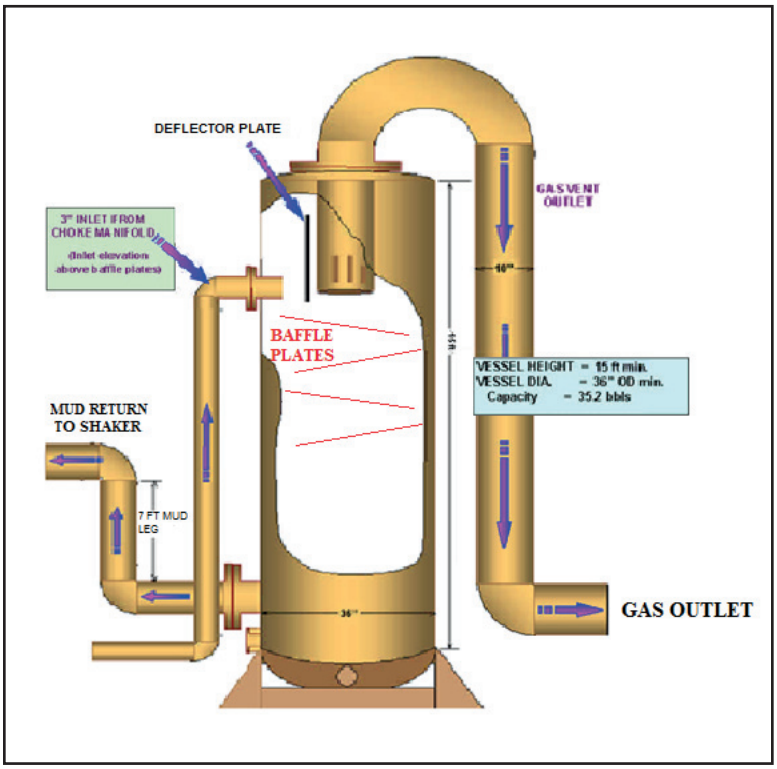

Figure 14
Saudi Aramco Poor Boy Degasser for Oil Wells

Figure 14 shows a Saudi Aramco poor boy degasser used when drilling oil wells. This setup is shorter and has only one inlet for mud from the choke manifold. The BOP must be closed to circulate through the oil well degasser.

All poor boy degassers require mud or liquid inside them to operate. The fluid level has to be higher than the outlet to the shaker. If the fluid level is not high enough, the gas flows through the mud return outlet to the shaker.

Baffle Plates

As shown in figures 13 and 14, the baffle plates are inside the poor boy. They are positioned so that when the fluid hits one, it causes the fluid to be ***agitated***. Once the mud flow is ***disturbed***, the gas starts to separate from the fluid and rises inside the body of the degasser.

The fluid flows across the baffle plates and drops down to the next plates. The impact on the baffle plates when the mud drops agitates the gas out. The fluid continues onto the next baffle plates level and drops again, releasing more gas.

Outlets

There are only two outlets on a degasser (see figures 13 and 14), one for gas and one for mud. The mud outlet is located at the bottom of the degasser and then rises up the side of the degasser to a set height. This height is important to maintain the mud level in the degasser. It creates backpressure on the poor boy degasser that prevents all the mud from exiting.

The other outlet is located at the top of the poor boy. This line is larger in diameter and transports the gas from the top of the unit to the flare pit away from the rig.

FLARE PITS

Flare pits (see figure 15) are ***shallow*** holes dug into the ground away from the rig. They contain the flames and fluids from the degasser and choke manifold flare lines. Flare pits are used during well control or flaring operations.

The primary flare pit is usually located past the drilling reserve pits about 400 feet from the rig. This pit contains any fluid that comes out of the flare lines while flaring.

A secondary pit is located away from the primary pit. This is called the alternate flare pit and is an option depending on wind direction. The alternate pit is used if flames in the primary pit would blow smoke or un-ignited gas towards the rig.

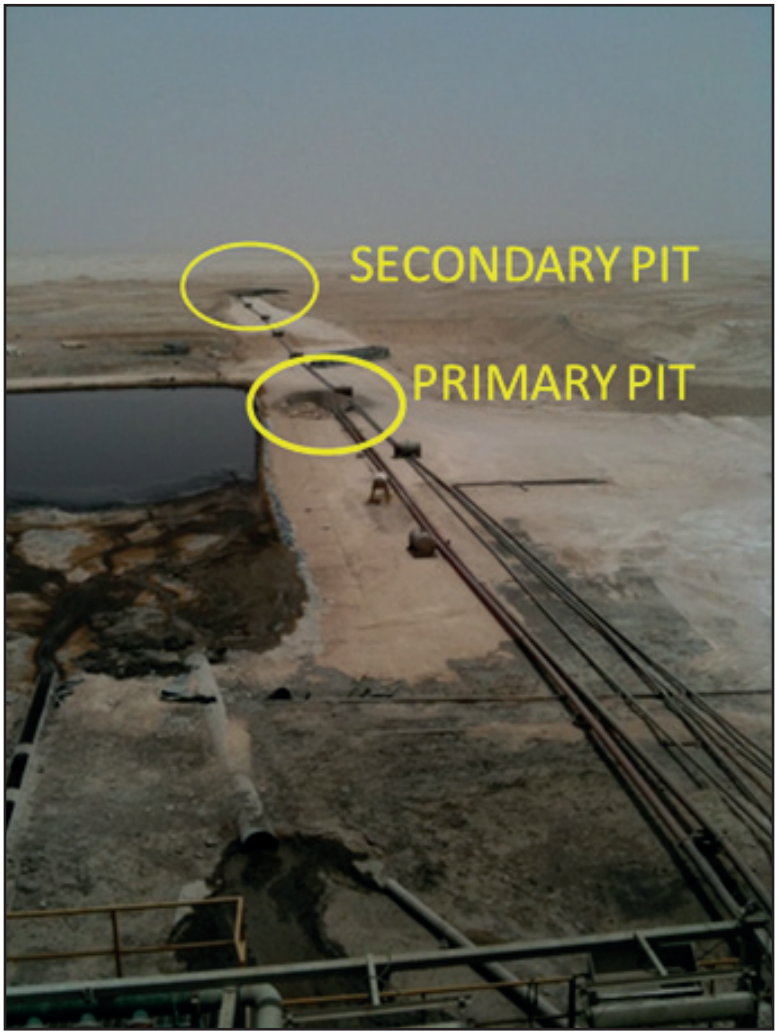

Figure 15
Flare Pit

SUMMARY

In this part of the module, you learned the basic function of the mud gas separator and the flare pits. You learned that the mud falling onto the baffle plates agitates the mud causing the gas to separate from the mud.

There is a second inlet valve on the poor boy degasser used on gas wells. This allows gas cut mud to circulate through the degasser without having to close the BOP.

You know that there are two outlets on the degasser, one for fluid and one for gas. The gas outlet pipe on the degasser is the larger diameter pipe and directs gas to the flare pit.

You also learned that the flare pit is an earthen pit that holds fluid and contains flames during well control or flaring operations. There is a secondary flare pit to allow the well to be flared in a location that keeps the gas or fumes from blowing onto the rig.

EXERCISE B

Directions: *Answer the following questions.*

1. What is the purpose of the degasser?

_____

2. What is the purpose of the degasser inlet line from the flowline?

_____

3. Why does the poor boy need to have mud in it before using it?

_____

4. What causes the agitation of the mud in the poor boy degasser?

_____

5. Where does the gas exit the poor boy degasser?

_____

6. Why are there two flare pits near a rig?

_____

Agitate
To move or stir up a liquid.

Baffle
A device that impedes the flow of a liquid or gas.

Braiding
Material that is made by crossing long pieces over and under each other.

Disturb
To change the position, arrangement, or order of something.

Shallow
Having a small distance to the bottom from the surface or highest point.

Sheath
A protective covering.

MAXIMUM: 96

OBJECTIVE 5.3.1

Directions: *For questions 1 through 8, select the correct answer. (8 points each)*

1. The choke line is attached to the _____ on the BOP.

   a. ram preventer

   b. annular preventer

   c. drilling spool

   d. lifting shackles

2. The _____ is the primary gate valve on the choke line.

   a. BOP

   b. HCR

   c. coflex

   d. HPU

3. During normal drilling operations, the valves on the choke line are _____.

   a. closed

   b. opened

   c. throttled

   d. removed

4. The high pressure choke lines connect the choke line valves to the _____.

   a. mud-gas separator

   b. choke manifold

   c. flare pit

   d. trip tank

5. The _____ on the choke manifold controls the shut-in pressure of the well.

   a. flare line

   b. choke line

   c. gate valve

   d. choke valve

6. The primary choke used during a well control operation is the _____ valve.

   a. remote operated choke

   b. manual choke

   c. hydraulically controlled relief

   d. manual gate

7. The _____ is used to burn off gas returns from the well.

   a. choke manifold
   b. flare pit
   c. poor boy
   d. trip tank

8. Returns to the _____ are monitored to measure the size of a kick.

   a. trip tank
   b. flare pit
   c. poor boy
   d. annulus

OBJECTIVE 5.3.2

Directions: *For questions 9 through 12, select the correct answer. (8 points each)*

9. Mud-gas separators used on gas wells have _____ inlet lines.

   a. five
   b. single
   c. two
   d. four

10. The _____ needs to be closed to circulate through a degasser with one inlet.

    a. choke
    b. HCR
    c. gate valve
    d. BOP

11. The fluid entering the degasser is agitated by hitting the _____.

    a. outlet lines
    b. gate valve
    c. baffle plates
    d. choke valve

12. The _____ flare pit is used if the wind blows gas fumes towards the rig.

    a. poor boy
    b. primary
    c. alternate
    d. closest

Trainee name		Badge No.		Date		Score	

MAXIMUM: 96

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   b. HCR
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   d. HPU

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   b. opened
   c. throttled
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   a. flare line
   b. choke line
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