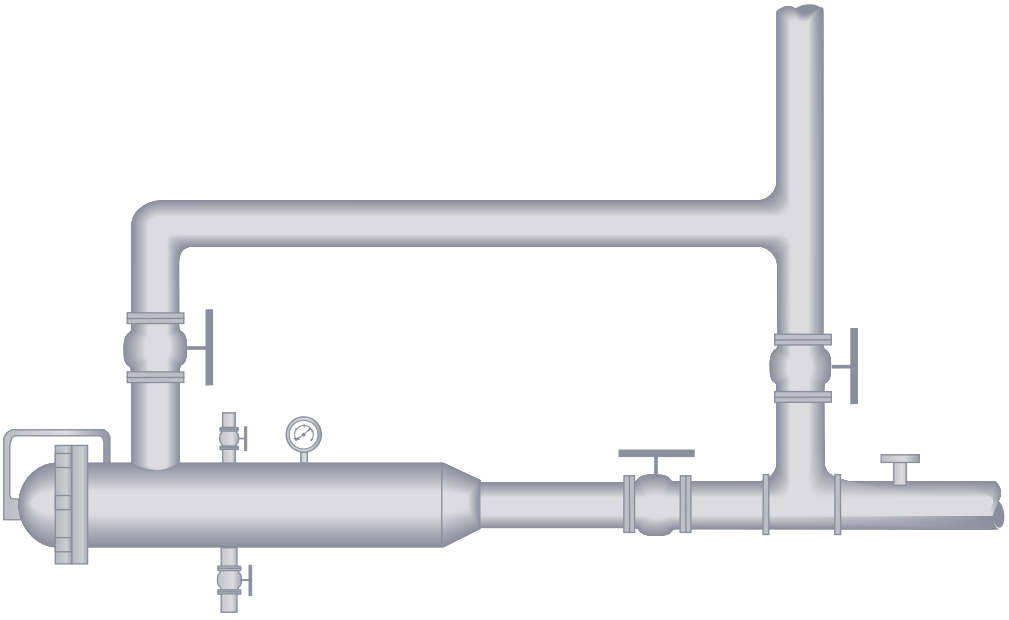
Training Module

# Pig Gathering System Pipelines



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- Training Module and Self-Check
- Knowledge Check and Answer Key
- Blank Answer Sheet
- Performance Check

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# Contents

# Contents (continued)

## Training Objectives

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

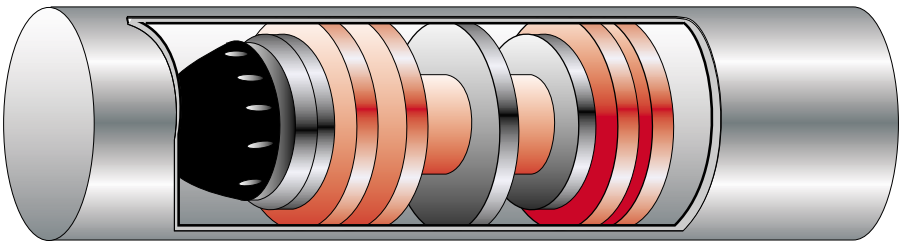
- Describe the purpose and importance of pigging operations for gathering system maintenance
- Describe reasons for pigging gathering systems
- Describe causes of internal corrosion
- Describe different types of pigs and their uses
- Describe pig launching and receiving equipment
- Describe pig launching and receiving practices
- Describe methods used to clean a pig
- Describe methods used to locate and free stuck pigs
- Describe inspection pigs
- Launch and receive pigs



# 1 Introduction

The produced fluids from many oil and gas fields contain a mixture of hydrocarbon liquids and gases, wax (paraffin), water, and sediment. As these fluids flow through the flow lines, wax is deposited on the inner walls of the flow lines and hinders fluid flow. In addition, wax, water, and sediment may create environments where internal line corrosion can occur. To reduce the buildup of wax, water, and sediment in a flow line and to reduce the effects of corrosion, companies regularly carry out pigging and batch treating.

**Figure 1—** Pig in a Line



In **pigging**, a cleaning tool, called a pig or scraper, is inserted into a flow line to scrape wax deposits and to remove water or sediment from the inner surfaces of the line.

In **batch treating**, pigs are used to apply batches of chemicals to the inner surfaces of a flow line. The chemicals limit corrosion and kill colonies of bacteria.
Additional uses of pigs in gathering system lines include the following:

- After the line is built, pigs may be used to remove construction dirt and debris, to aid in testing the new line, and to thoroughly dry the line before use.
- During the lifetime of a line, pigs may be used to inspect the line for dents, buckles, cracks, and damage, and to gauge the internal surface.

This training kit presents describes the safe and effective use of pigs to clean flow lines and control corrosion:

- the contribution of wax, water, and sediment to internal pipe corrosion and reduced fluid flow in gathering system lines
- the effect of pigging to remove wax, water, and sediment deposits from gathering system lines
- different types of pigs, pig launchers, and pig receivers
- practices and procedures for loading, launching, and receiving pigs
- batch treating to inhibit corrosion



# 2 Internal Line Corrosion and Reduced Flow Rates

Internal flow line corrosion seldom occurs unless water is present. Water in a reservoir's produced fluids can separate from the fluids and collect in the low-lying areas of a flow line. Liquids tend to pool in the dips and valleys of the line.

Pooled liquids in gas lines can lead to the following problems:

- Pooled liquids eventually restrict gas flow in the line if the flow velocity is not sufficient to sweep the liquids from the dips or valleys. Such restrictions cause pressure drops and are prime areas for hydrate plug formations.
- Pooled liquids in gas lines may travel through the line as *slugs* (known as water hammer), which are very difficult to handle when they arrive at a compressor station or gas plant. Pigging gas lines removes these pooled liquids, so

that the line's flow rate stays more consistent, allowing the gas plant to handle the liquids more efficiently.

- Pooled liquids (especially water) provide an environment where corrosion may occur. Pigging gas lines assists in corrosion control by removing the pooled liquids and allowing corrosion inhibitors to contact the pipe.

Corrosion can occur in areas where the pooled water has prevented corrosion inhibitors from reaching the metal underneath the water. Corrosion can also occur in areas where the pools of water have become breeding grounds for bacterial colonies. For example, bacteria known as *slimers* form colonies at the bottom of the line. Colonies of *sulfate-reducing bacteria* (SRB) may form underneath these slimers, creating an acidic environment that causes corrosion pitting of the pipe.

In gas gathering systems, corrosion primarily occurs as a result of electro-chemical processes. These processes begin when rust forms a *cap* or *crust* over a corrosion pit in the line. Together, the rust cap and corrosion pit become a galvanic cell. The electrical flow from this galvanic cell deepens the pit and can eventually cause the pit to enlarge and form a hole through the flow line wall.

In oil gathering systems, wax deposits build up when the wax hardens and clings along the inner surface of a flow line. Over time, the wax deposits may build up to such a degree that the flow of oil is hindered or blocked. In addition, wax may be a contributing factor in line corrosion. The wax deposits prevent corrosion inhibitors from coating the metal beneath the wax, reducing the effectiveness of the inhibitors. The deposits provide an environment in which *under-deposit corrosion* can take place or sulphate-reducing bacteria can thrive.


Cathodic control methods are used to minimize the external corrosion caused by galvanic action. Refer to the training kit *Describe and Adjust Cathodic Protection Systems* for additional information.

### Methods to Control Internal Line Corrosion and Improve Flow Rates

Several methods are used to control internal flow line corrosion and improve flow rates. These methods include injecting chemicals, pigging, and batch treating.

**Specific chemicals** are used to address problems such as bacteria, internal corrosion, scale, or wax. A unique chemical or combination of chemicals is chosen according to the characteristics of the producing system. For example:

- biocides are injected to kill bacteria
- scale inhibitors are injected to prevent the buildup of scale
- wax dispersants are injected to reduce wax formation or soften wax deposits
- corrosion inhibitors are injected or batched to adhere to the metal and protect the metal from corrosion

Special equipment is used to regularly inject chemicals into the line so that the chemical mixes with the produced fluids.

**Pigging** removes wax deposits, pooled water, and rust caps that hinder fluid flow or create environments which cause line corrosion. Pigging is described in Sections 3 to 6 of this module and in the performance checklist.

In **batch treating**, chemical inhibitor is batched between two pigs. The first pig removes produced fluids, wax, water, or sediment deposits and cleans the inside of the pipe. Chemical inhibitor, isolated from the produced fluids in the line by the two pigs, adheres to the bare metal and protects the line. Batch treating is described in Section 8 of this module.

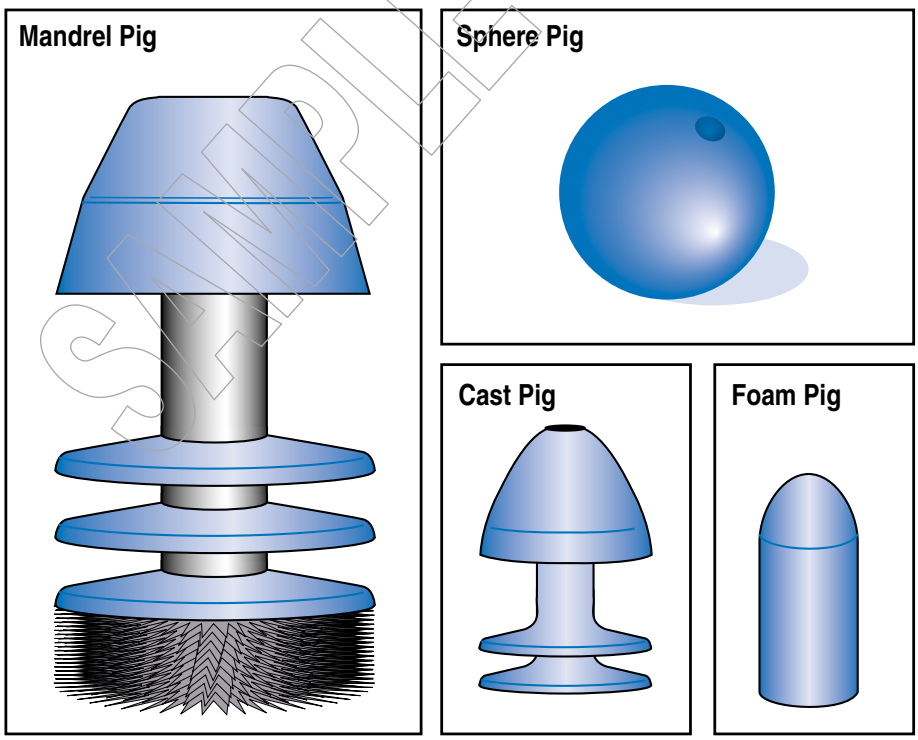
# 3 Pigs

Pigs for gathering system maintenance come in many different shapes, materials, and sizes:

- **spheres**—Most sphere pigs are made of polyurethane and are filled with a water/glycol mixture.

- **foam pigs**—Most foam pigs are made of an open cell polyurethane foam. Foam pigs may be coated with wire brush straps, silicone carbide chips, or steel studs.
- **mandrel pigs**—Discs are mounted on a central mandrel. The discs can be replaced or reconfigured, allowing for changing job requirements. Some discs have brushes to provide more scraping edges; these are called disc scraper pigs. Some disc pigs have specialty tools attached for gauging or inspection. Some disc pigs have strong magnets to remove ferrous debris.
- **solid cast pigs**—Solid cast pigs are similar to mandrel pigs, but are cast in one piece.
- **gel pigs**—Gel pigs are viscous gelled fluids used alone or in conjunction with mechanical pigs.

**Figure 2—**
Types of Pigs






## Common Uses of Pigs

The type of pig is chosen according to the specific requirements of the line. Common uses for each type of pig are:

- **spheres**—sealing: batch separation, hydrostatic line testing, line maintenance (dewatering, dewaxing, batch

treating), meter proving. Sphere pigs are particularly useful for negotiating tight 90° bends.

- **foam pigs**—sealing and cleaning: drying, wiping, dewatering, scraping (especially when coated with brushes, chips, or studs)
- **mandrel pigs**—sealing and cleaning: brushing, dewaxing, descaling, gauging, inspecting
  - when fitted as gauging pigs: determining internal diameter, locating dents and slope changes
  - when fitted as inspection pigs: detecting metal loss, including corrosion and cracks
  - when fitted as magnetic pigs: removing ferrous debris such as welding rods and mill scale after construction or before running an inspection pig
- **solid cast pigs**—sealing
- **gel pigs**—cleaning: picking up deposits and debris scraped off inner pipeline walls by mechanical pigs

## Pig Size and Fit

Pigs must be able to:

- negotiate bends, curves, and dents in the pipeline
- pass check valves and tees without buckling, tearing, or shredding
- resist rapid wear and wear evenly

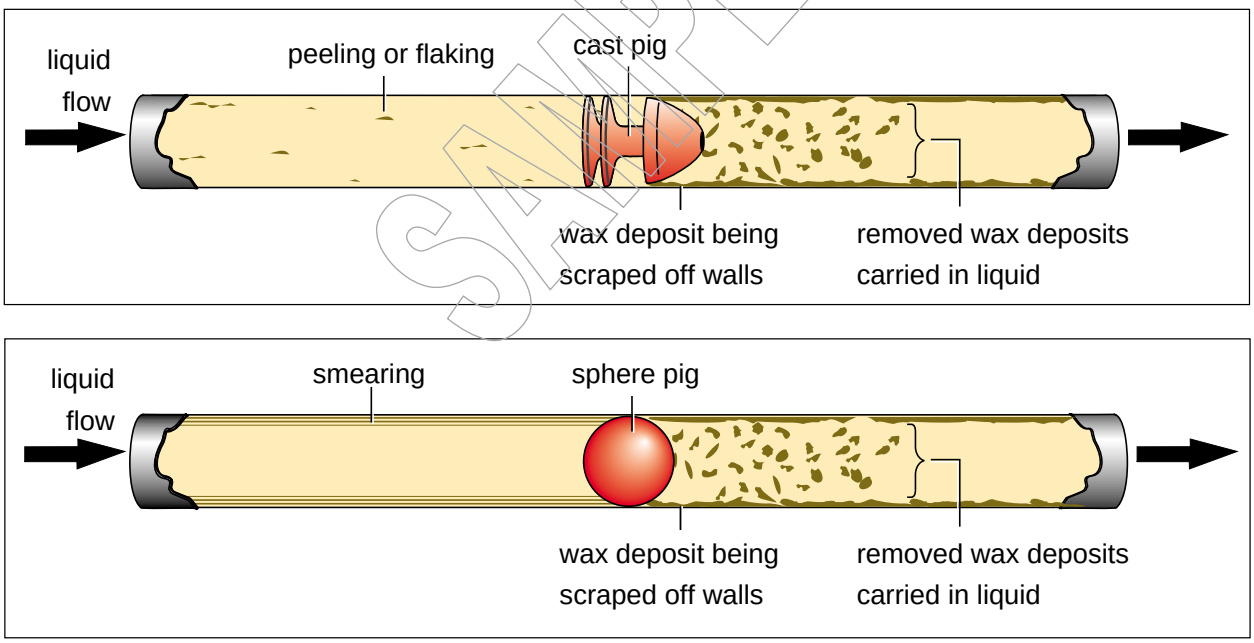
Pigs come in standard sizes to fit tightly into standard diameter mainline pipelines. Pigs must fit tightly in the line for several reasons:

- A tight fit prevents produced fluids from flowing past a pig. Product builds up pressure behind a pig: the upstream pressure (behind the pig) becomes greater than the downstream pressure (in front of the pig). This difference in line pressure across a pig (differential pressure) pushes the pig down the line.

  On disc pigs, the upstream pressure pushes the discs forward. This action forces the discs tightly against the pipe walls. For disc pigs, the greater the differential pressure, the tighter the seal.

- A tight fit permits the edges of the pig to firmly scrape along the inner surface of the flow line, scraping off wax and sediment deposits. The scraped-off deposits collect ahead of the pig, as illustrated in Figure 3. Some pigs are equipped with bypass holes. Because of the pressure differential across the pig, the holes create a jet action: fluid from behind the pig pushes through the holes, keeping the scrapings ahead of the pig.
- For batch treating, a tight fit prevents the corrosion inhibitors, which are batched between two pigs, from mixing with the normal production stream and/or with the material that is being scraped off the inner surfaces of the flow line (see Section 8—*Batch Treating*).
- A disc pig used for line gauging is typically equipped with a metal gauge plate that is approximately 90% to 95% of the internal diameter of the pipeline.

**Figure 3**—Pig Effectiveness






Both ball pigs and disc pigs are commonly used for dewaxing. Disc pigs are more effective than ball pigs for dewaxing for the following reasons:

- The trailing edges of the disc pig are designed to peel the wax off the walls of the pipe, whereas the ball pig tends to pack the wax and deposits onto the walls of the pipe.

- The ball pig tends to elongate as it encounters heavy or hard deposits and may not remove these deposits.
- Disc scraper pigs (with stainless steel wire brushes attached to the back disc) scrape the pipe clean and disturb corrosion cells.

# 4 Pig Launchers and Receivers

To send a pig, a pig is inserted into the *pig launcher*. Pig launchers are located at the upstream end of the flow line, usually at the wellsite, satellite, or battery. Each section of flow line which has a pig launcher at the upstream end must also have a *pig receiver* at the downstream end to catch pigs after they have traveled through the flow line. Pig receivers are commonly called pig traps.

The basic types of pig launchers for gathering system maintenance are pigging valves, pig injector tees, and barrel-shaped pig launchers. Common pig receivers are pigging valves, wire mesh basket receivers, and barrel-shaped pig receivers. Pigging valves, pig injector tees, and basket receivers are commonly used for smaller gas and liquid hydrocarbon lines (two- to six-inch diameter). Barrel-type pig launchers and receivers are used for gas and liquid lines, from two-inches diameter and up.



To allow passage of the pig, the downstream isolation valve on launchers and the upstream isolation valve on receivers must be full opening (full port). Butterfly valves and needle valves cannot be used at these locations.

## 4.1 Pigging Valves

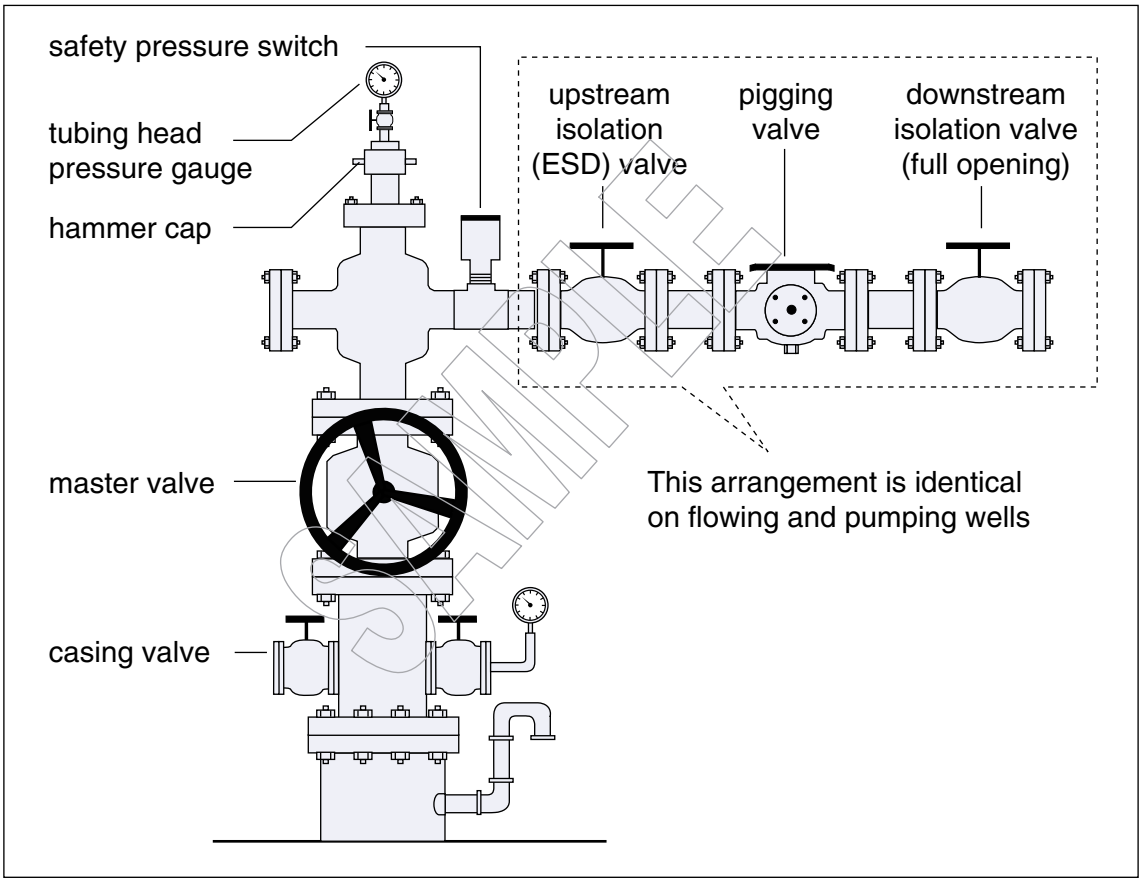
Pigging valves (commonly known as Barber valves) are used to launch and receive small, sphere- or bullet-shaped pigs. Pigging valves are commonly used to launch pigs from gas or liquid hydrocarbon wells and to receive the pigs at a satellite, battery, or gas plant. Pigging valves are designed to reduce time and labor associated with launching pigs: when using a pigging valve to launch a pig, the well normally does not need to be shutdown.

The pigging valve is positioned directly in the flow line, and consists of a specially designed valve body.

**WARNING**

Review the installation and operation of each brand of pigging valve from site P&IDs and manufacturer manuals. Some pigging valves block off the flow when launching a pig; other types of pigging valves bypass the flow during pig launching.

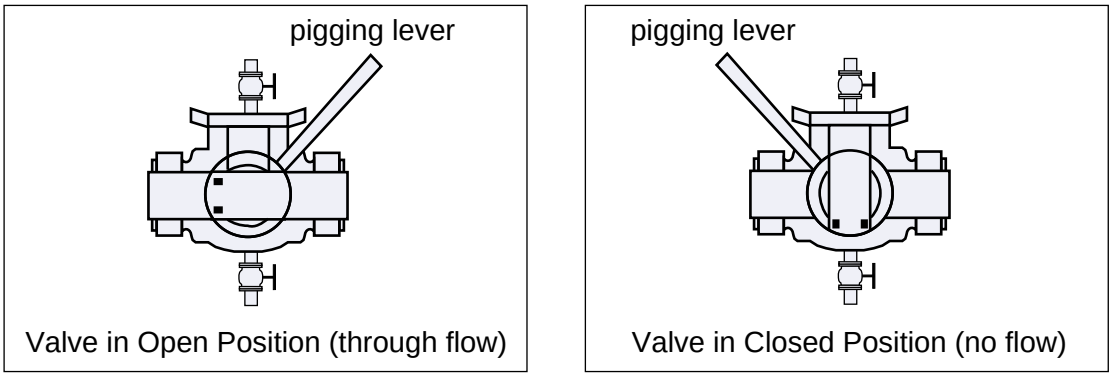
**Figure 4**—Pigging Valve on a Flowing Well






In the open position, fluid flows through the pigging valve. In the closed position, the valve's side entry cap can be opened.

**Figure 5**—Pigging Valve in Open and Closed Position




- To insert a pig, the pigging valve is closed, the side entry cap is opened, and the pig is inserted. A funnel may be used to insert the pig if the pig has swelled. To launch a pig, the side entry cap is replaced, and the pigging valve is opened.
- To receive a pig at the receiving end of the line, the pigging valve is left open. To remove the pig, the pigging valve is closed, and the side entry cap is opened.

Pigging valves that are equipped to handle sphere pigs may be retrofit (using kits from the valve manufacturer) to accommodate bullet or disc pigs.


For launching disc pigs from pigging valves, make sure you insert these pigs in the correct orientation. If the pig is inserted backwards, the pig may get stuck in the flow line.



## 4.2 Pig Injector Tees

Pig injector tees are used to launch small two-, three-, or four-inch pigs into the line near the wellhead of a gas or liquid hydrocarbon well. Pigs sent from this type of pig launcher are used to clean the lines from the wellsite to the satellite or to the central battery.

To insert a pig into the body of the pig injector tee, the cap must be removed. Most caps associated with this type of pigging tee have an O-ring seal and a drilled port(s). The port allows trapped pressure to escape when the cap breaks contact with the O-ring and the O-ring seal is broken.

Some pig injector tees may have an additional safety feature known as a pressure warning valve. The pressure warning valve prevents the cap from being removed until the seating screw is removed. There are many different types of installation; make sure you are familiar with each type of launcher in use at your site and follow the operating directions set out by the manufacturer and your company.

# End of Sample

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