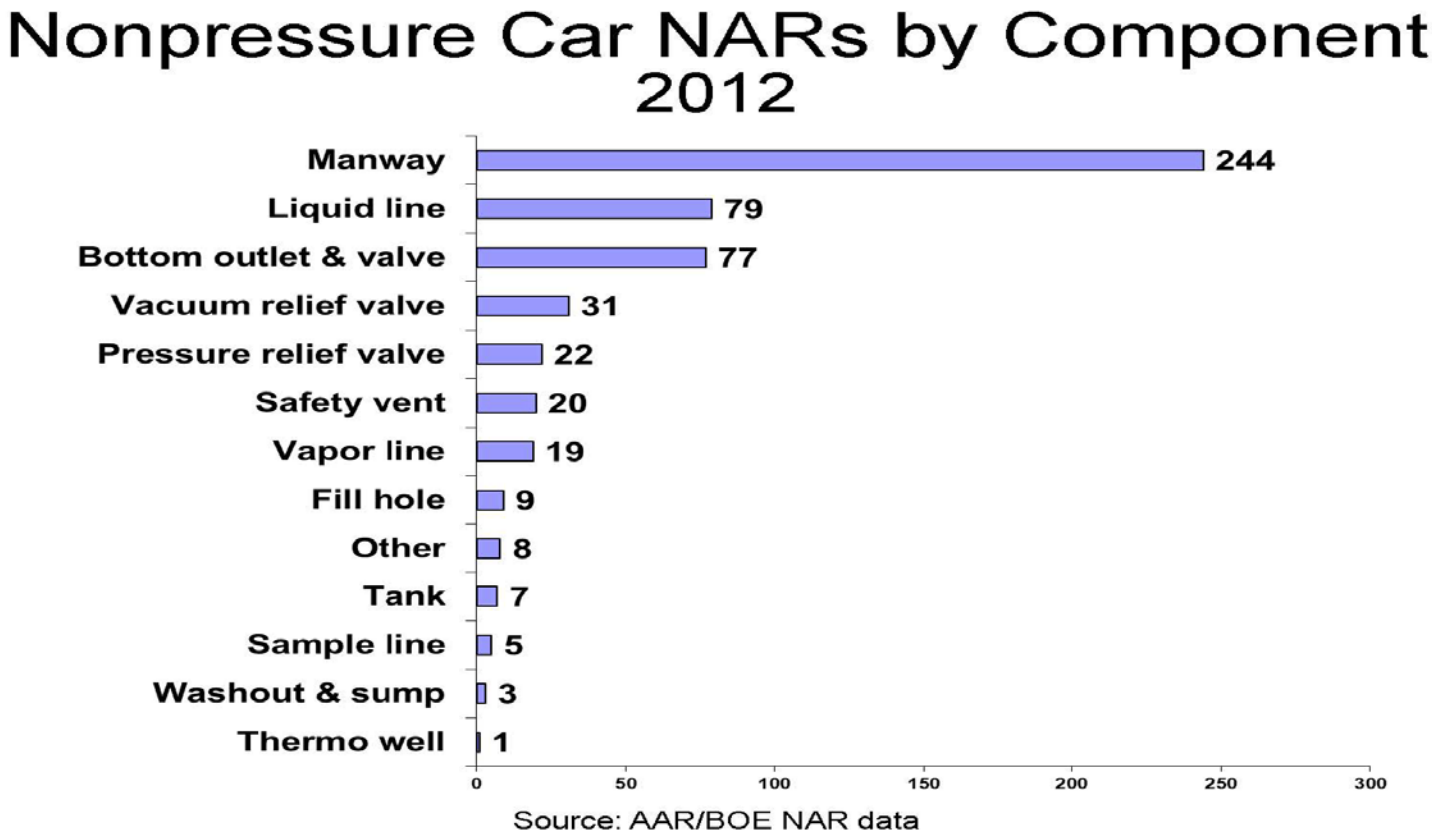
Watco Compliance Services

Securement of Hinged and Bolted Manway's and Service Equipment Inspection - Potential Leak Paths

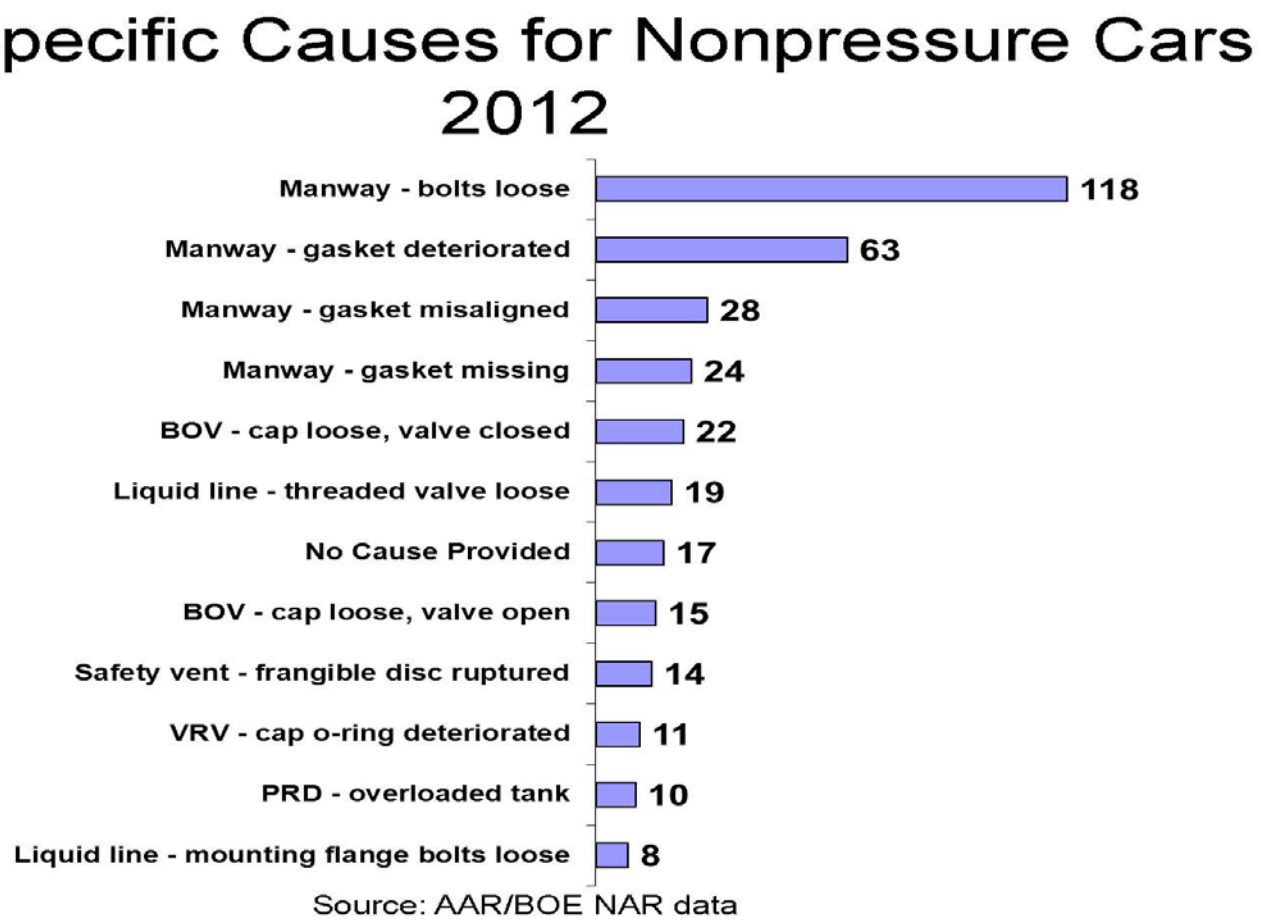
Agenda

- Review NAR “Cause” Data
- Closures, Fittings, and Valves – Inspection and Securement
- Mechanics of the Typical Hinged and Bolted Manway Design – Performance Factors
- Registered and Certified facilities
- OTMA’s

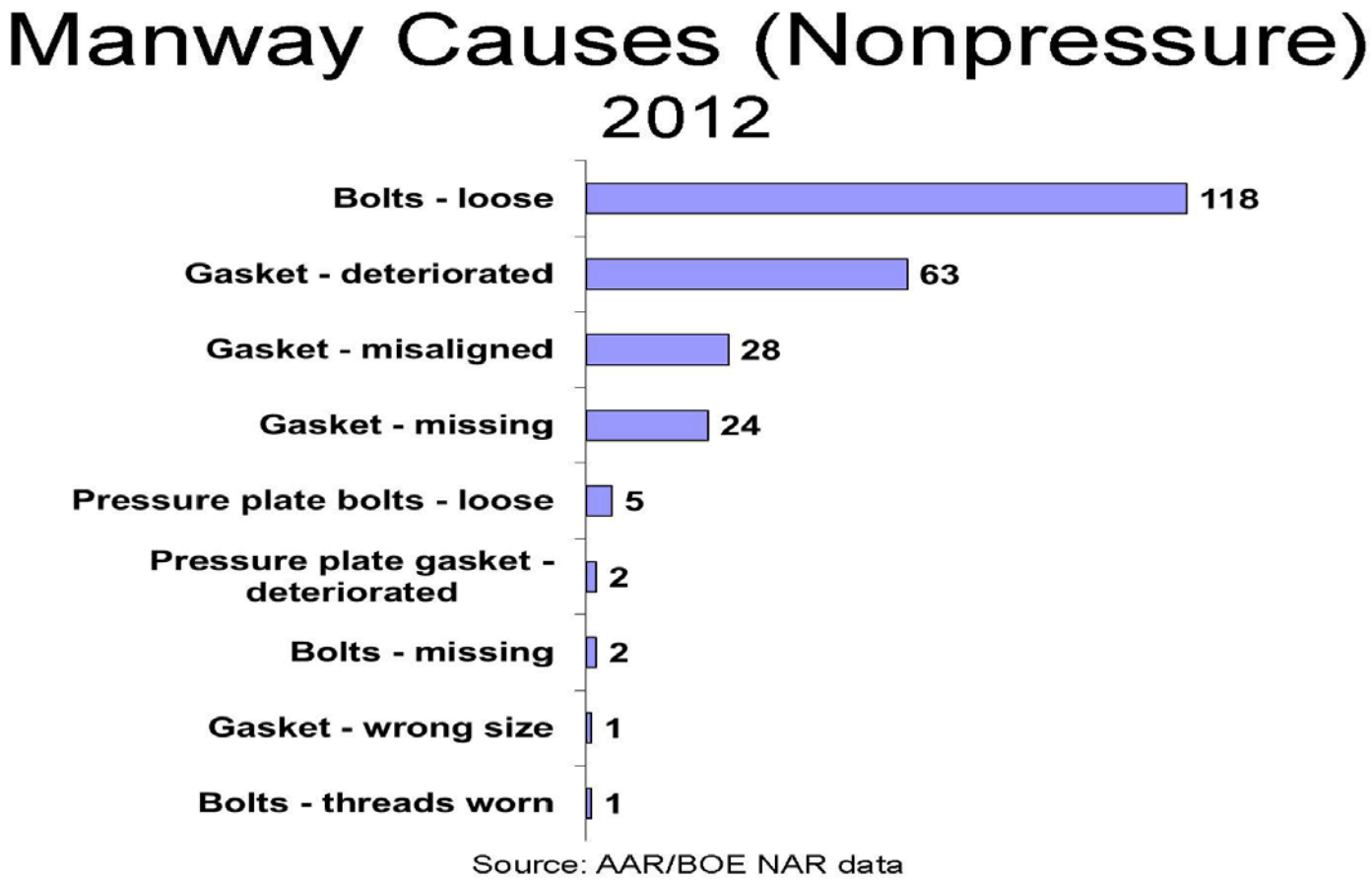
Non-Accident Release Data



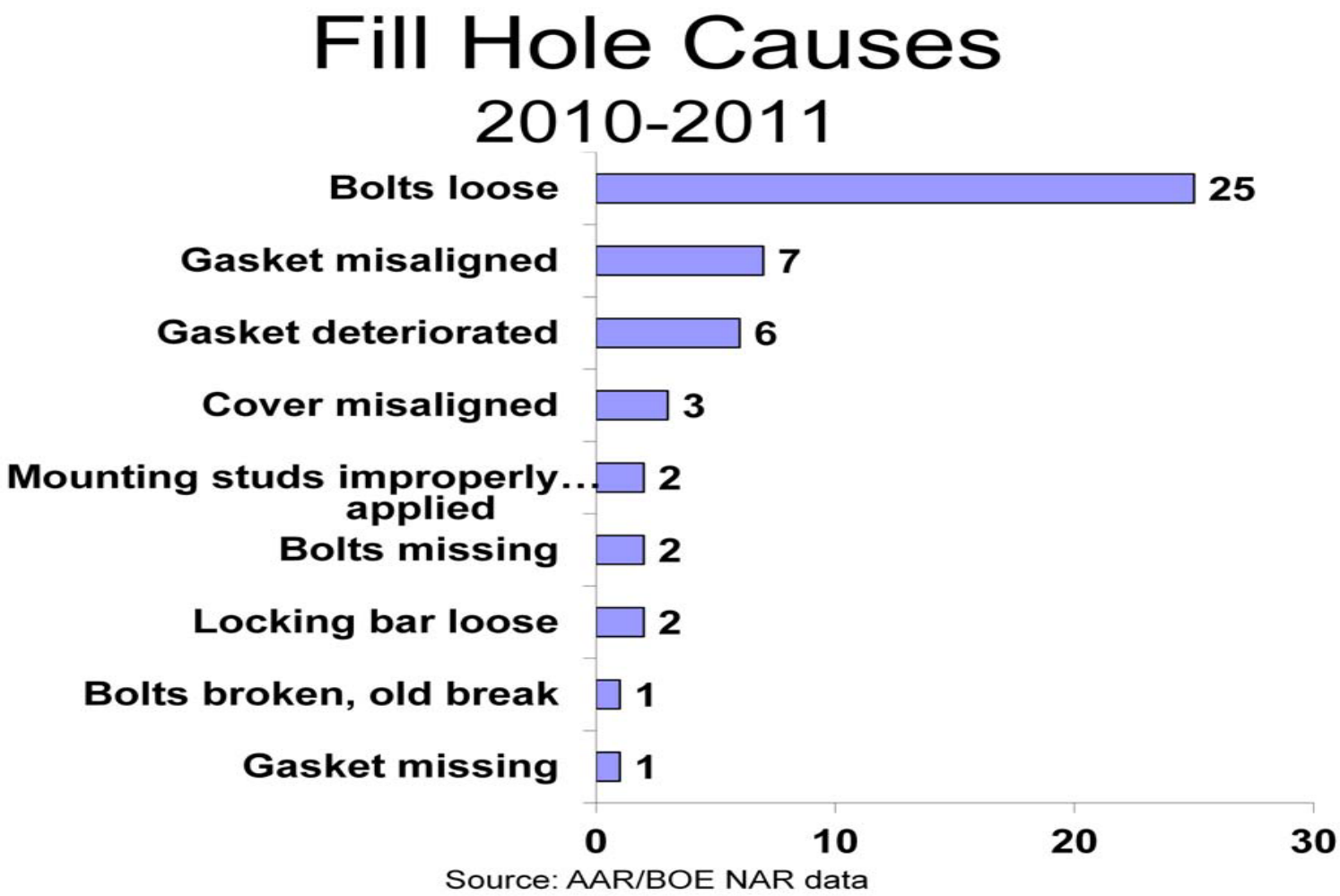
Non-Accident Release Data



Non-Accident Release Data



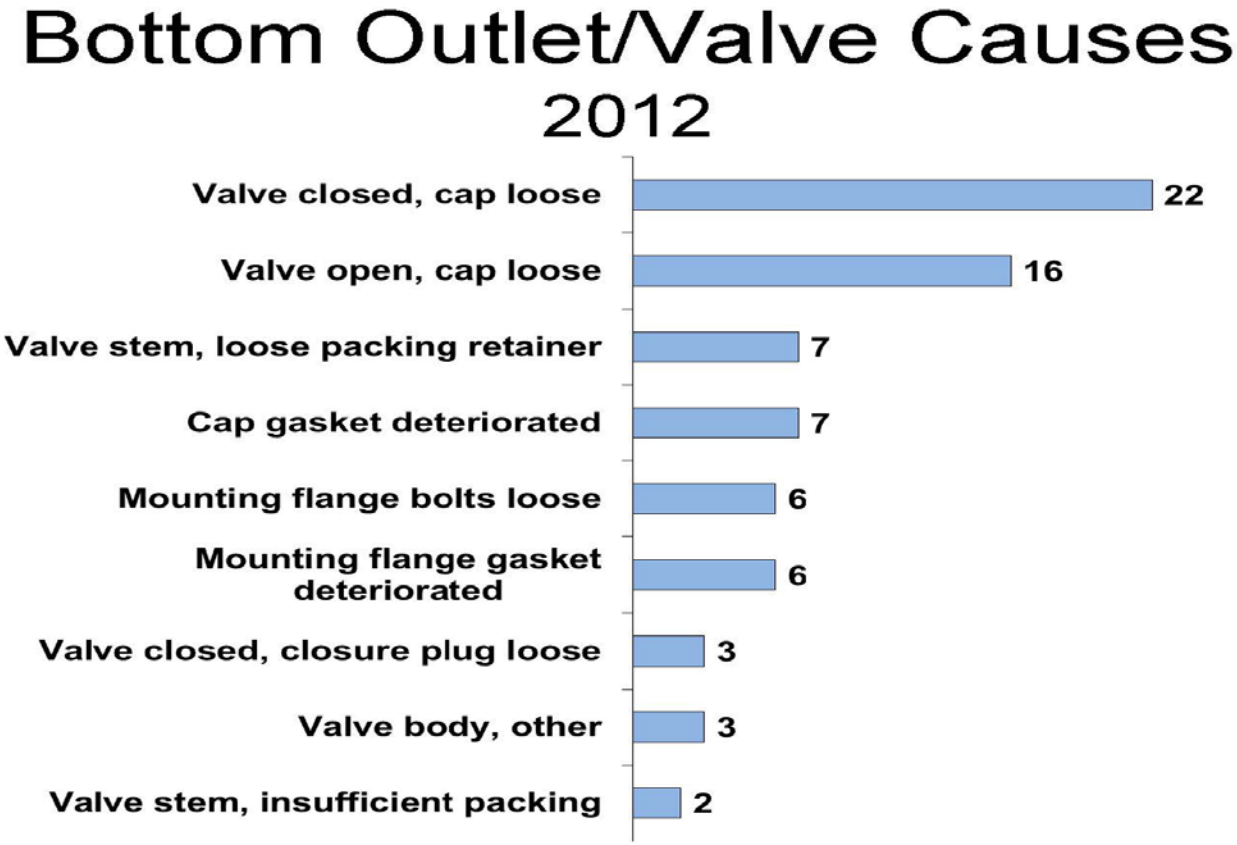
Non-Accident Release Data



Major Cause of Manway Leaks

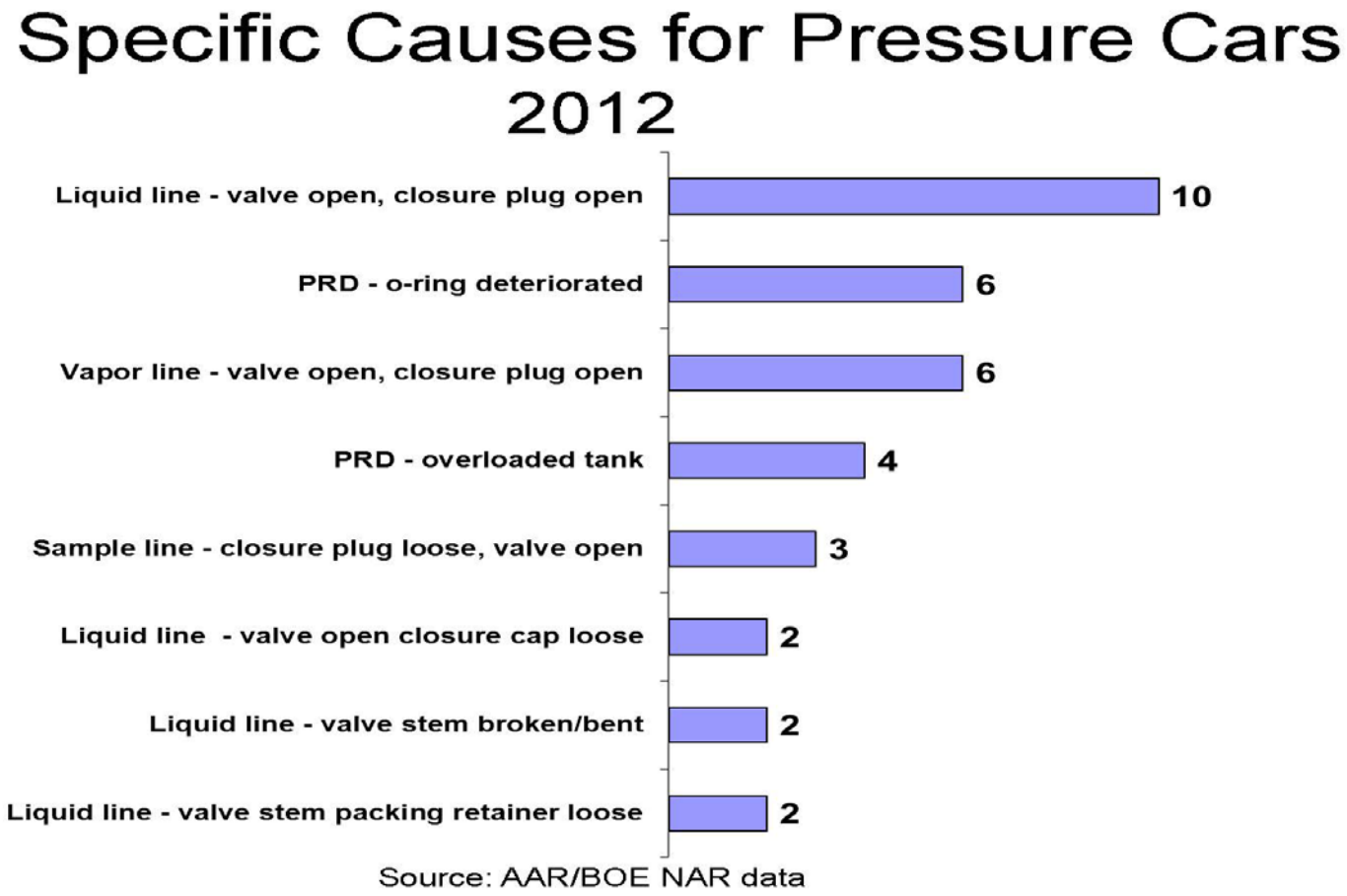
- Loose manway bolts are the leading cause of NAR's. One third of all NAR's are manway related
- Elastomer gaskets are the most widely used
- Relaxation of elastomer (rubber) gaskets can cause loose bolts.

Non-Accident Release Data



Source: AAR/BOE NAR data

Non-Accident Release Data



Closures, Fittings, and Valves

Inspection and Securement

Definitions

- A "*closure*" is a device that closes an opening. Examples include blind flanges and pipe plugs.
- A "*fitting*" is a device the joins two or more devices or couplings.
- A "*valve*" is a device specifically designed to direct, start, stop, mix, or regulate the flow, pressure, or temperature of a process fluid.

Closures

- Closures include pipe plugs and blind flanges.
- Closures must be secure and show no visible signs of leakage when offered into transportation. See 49 CFR Part 173.31(d).
- Function specific training per 49 CFR 172.704(a)(2) Subpart H

Pipe Plug Closures

- Pipe plug closures have an NPT tapered thread.
- Compression of the mating threads during thread engagement forces a leak-free joint.
- However, continued use of the threaded plug results in thread wear and galling from compression.
- Threaded pipe plug closures must show no signs of corrosion, galling, or wear.

Pipe Plug Closures

- Prior to inserting the plug into an outlet, apply PTFE tape, or a thread lubricant to the threads.
- PTFE tape reduces thread wear and prolongs the life of the pipe plug closure.
- PTFE tape is not designed to prevent leakage.
- Wrap PTFE tape in the direction of the threads and apply no more than 3-wrappings.
- DO NOT wrap outside of the threads. Loose PTFE tape may enter the piping system.

Thread Direction

Thread Right – Wrap Clockwise

Thread Left – Wrap Counterclockwise

Flange Closures

- Flange closures include:
  - Flat face
  - Raised face
  - Tongue-and-groove
- Flanges incorporate a gasket to seal the joint and three or more fasteners and nuts to secure flange-to-flange.

Flange Closures

- The gasket must be:
  - Chemically compatible with the product;
  - Thermally compatible for the lower and upper temperature range; and
  - Mechanically compatible with the flange make-up.
- **Always** consult the experts for the exact gasket specification and torque values for the fasteners.

Flange Closures

- Normally, joint assembly personnel should not reuse a gasket in a bolted joint.
- When assembly personal reuse a gasket in a manway cover, examine the contact face of the gasket.
- Clean as necessary to observe imperfections. Replace gaskets that have indications of abrasion, cuts, tears, or other damage that may affect the fluid sealing capability.

Flange Closures

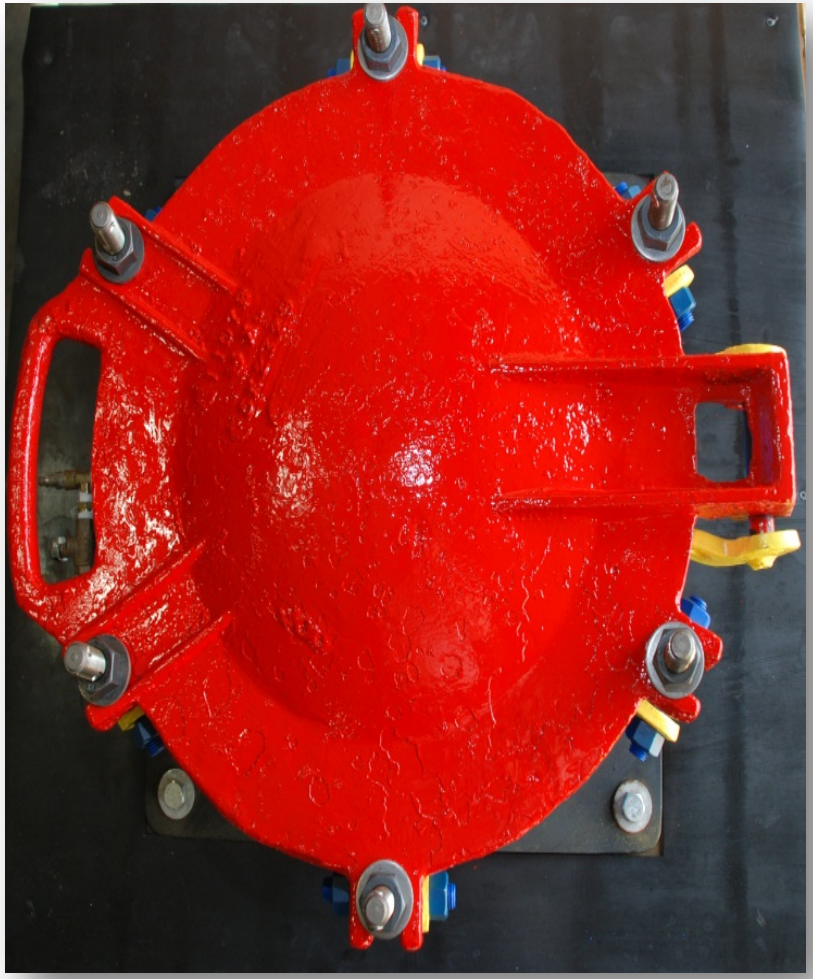
- Clean and examine the gasket-contact surface.
- The surface must not have large imperfections that could result in a leak path.
- Dents, gouges, pits, and scratches, and specifically radial defects, those that run from the inside diameter to the outside diameter are detrimental.

Manway Closures

- Manway closures consist of a hinged and bolted manway lid and a nozzle equipped with a seating surface.
  - Red represents an energized cover.
  - Blue represents a manway nozzle.
  - Yellow represents manway hinge-pin lugs.

Manway Closures

- Manway covers have 6 to 8 eyebolts.
- The eyebolts slide into the manway cover lugs.
- Washers below the nuts on the eyebolts spread the load evenly across the lug.



Manway Closures

- The top of the manway nozzle provides a gasket sealing surface.
  - Green represents the gasket sealing surface.
- The gasket sealing surface must not have any nicks or cuts that may interfere with the ability of the gasket to perform its sealing function.
  - Transverse cuts and cuts deeper than 1/32-inch may be detrimental.

Manway Closures

- The manway cover gasket sealing surface is behind the installed gasket.
- When replacing a gasket, inspect the gasket sealing surface for damage.
- The gasket sealing surface must not have any nicks or cuts that may interfere with the ability of the gasket to perform its sealing function.
  - Transverse cuts and cuts deeper than 1/32-inch may be detrimental.

Manway Cover Gasket

- Inspect the manway cover gasket.
- The gasket must not have any damage, such as cuts, tears, or degraded areas, that would prevent a proper seal.
- Replace gaskets as necessary. (Note: MSRP C-III, Appendix D, Section 6.0 provides instructions for hinged and bolted manway cover maintenance as well as gasket sizes for most covers in use today.)

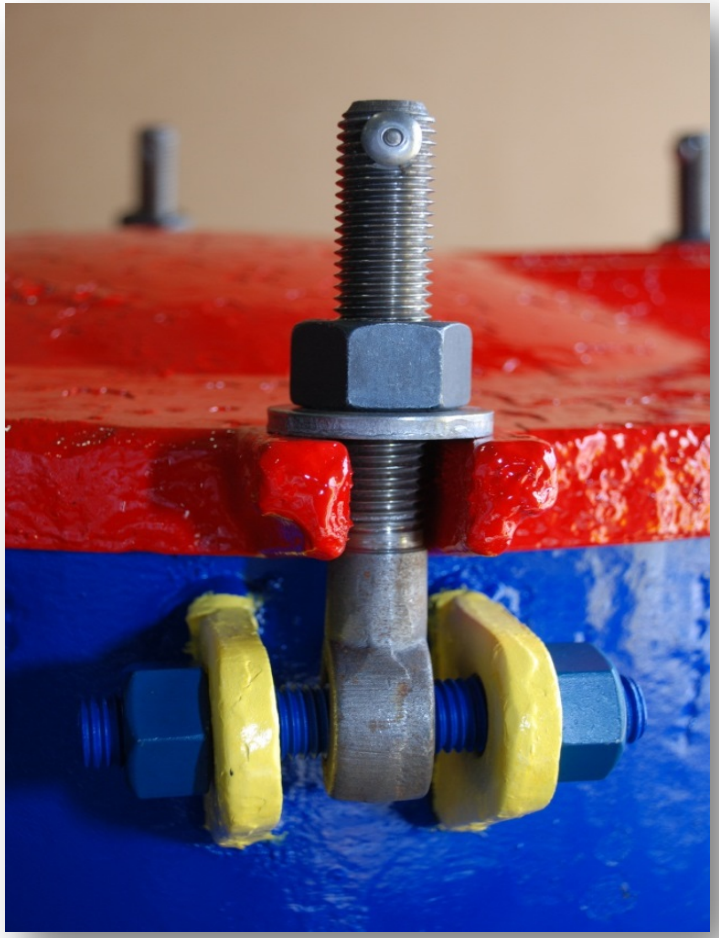
Damaged Manway Gasket

Damaged Manway Gasket

Damaged Manway Gasket

Eyebolts

- Eyebolts provide the force necessary to create sufficient gasket stress to seal a joint.
- Inspect the eyebolts for damage, wear, and galling.
- The eyebolt should be perpendicular to the manway cover and the washer must seat evenly on the manway cover lugs
- The use of washers is recommend, if you look at most flanges without washers you see nut embedment damage.

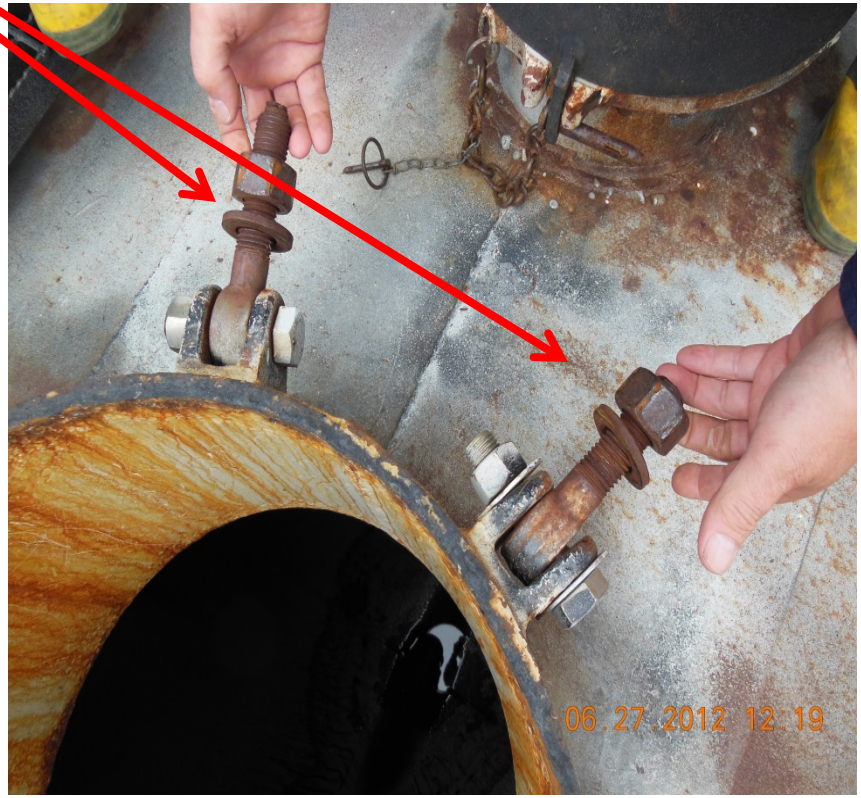


Safety Eyebolts

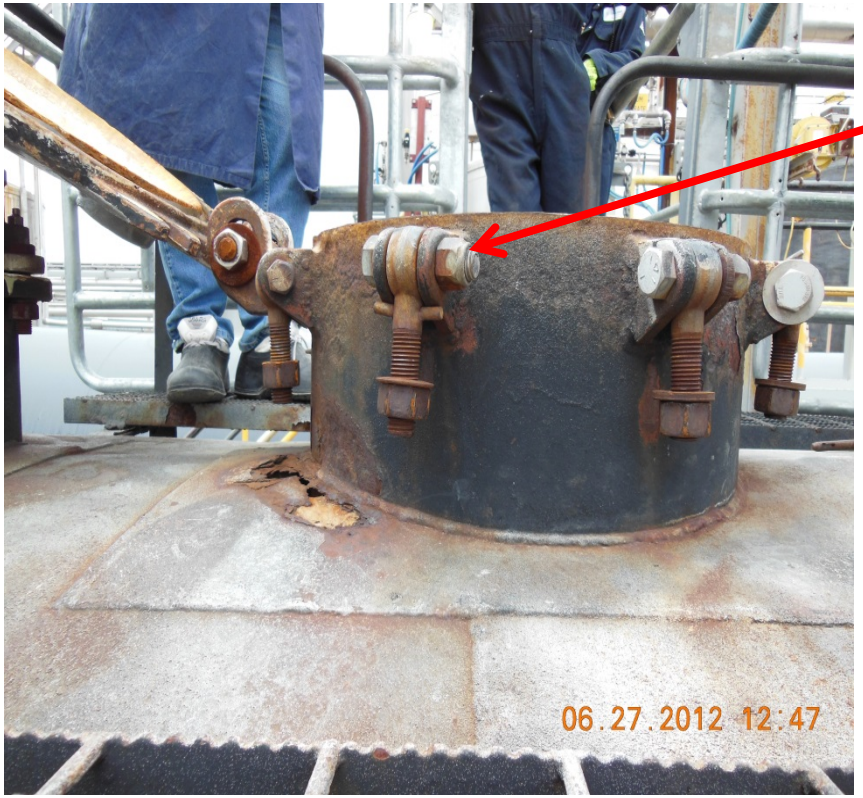
- Manway covers have one **or** two safety eyebolts opposite the manway cover hinge. See 49 CFR 179.201-6(a).
- The **safety eyebolts** make it impossible to remove the cover while the manway cover is energized.
- Always inspect and ensure that the manway safety eyebolts are in proper condition and functional.

Missing & Misapplied

Missing Safety Eyebolt(s)



Applied in Wrong Location



Missing Safety Eyebolt(s)

Damaged Safety Eyebolt

Damaged Safety Eyebolt

Safety Eyebolts

- Wedge Design properly seated.

Safety Eyebolts

- Common safety eyebolts.

Safety Eyebolts

Wedge Design

“Wing” Design

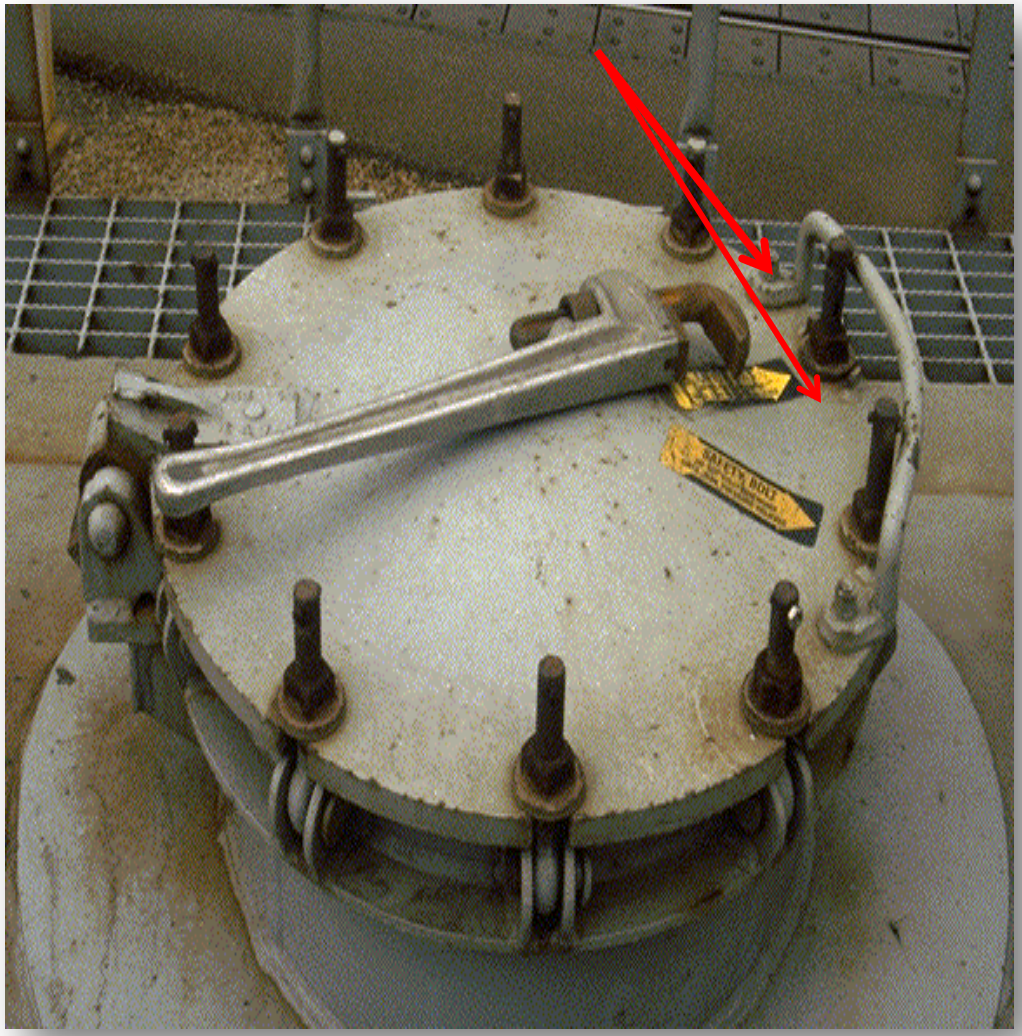
Safety Eyebolts

Collar Design

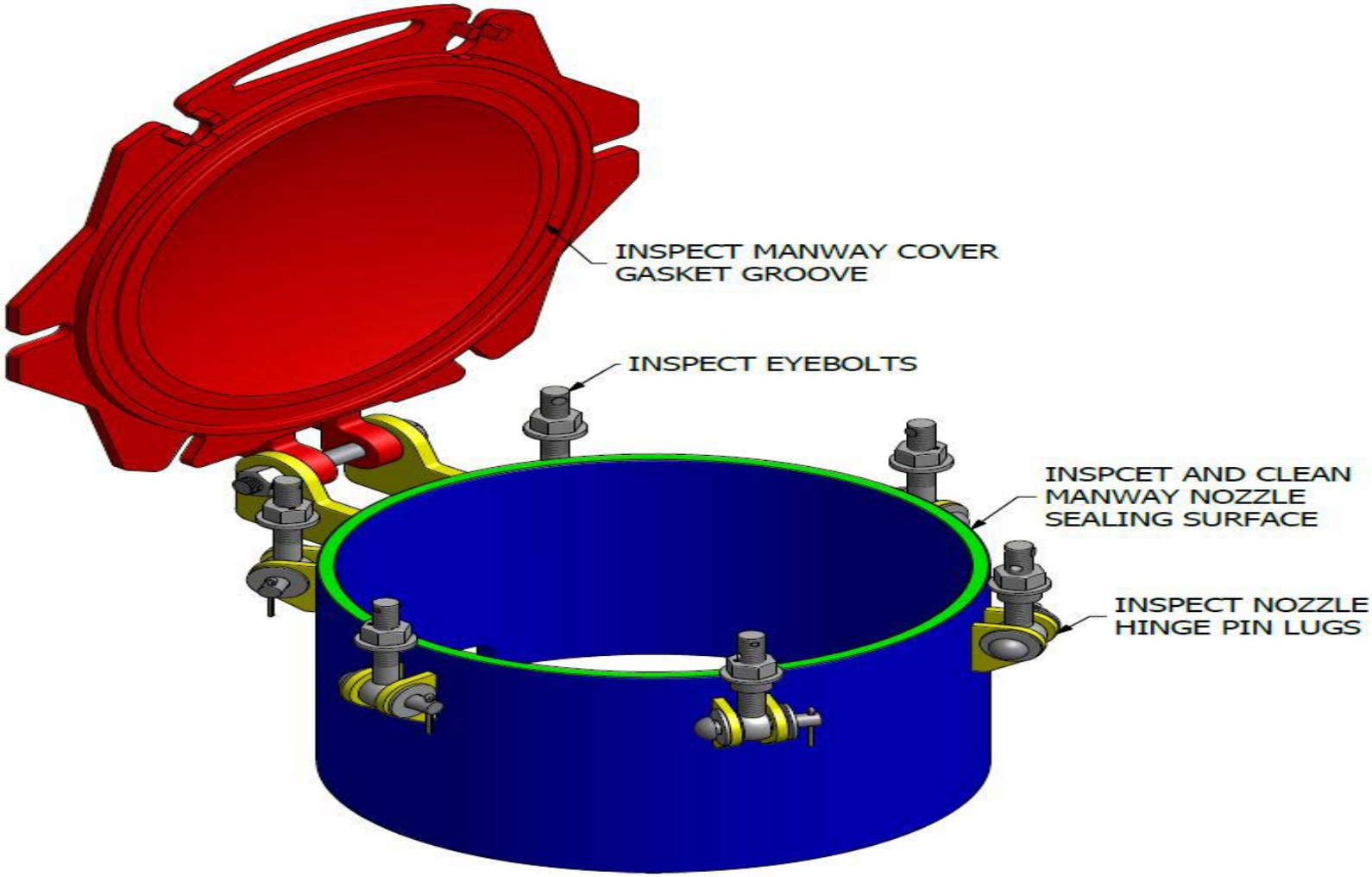
Adjustable Collar Design

Alternate Safety Eyebolt Design

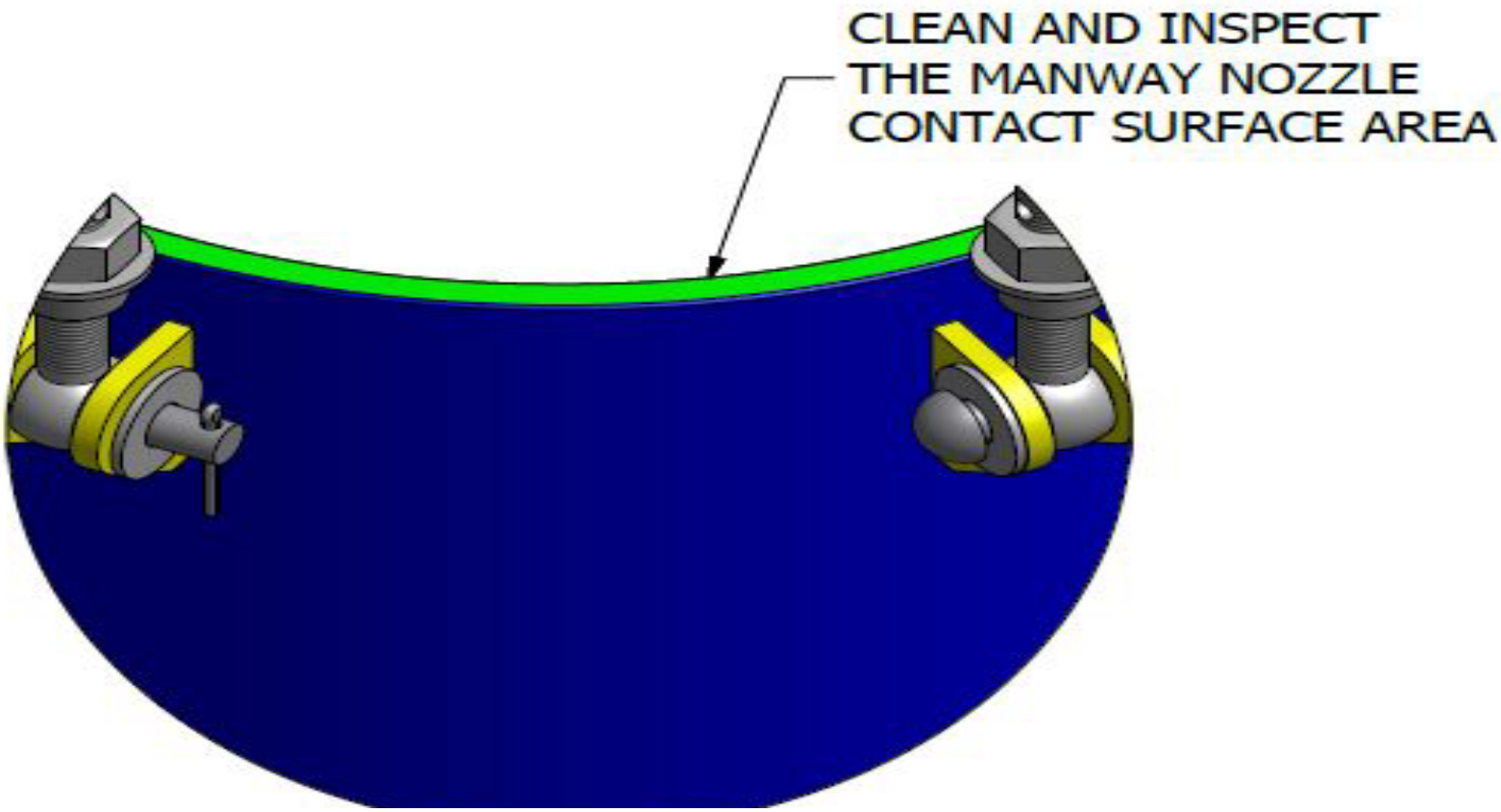
- Cover must be lifted to allow eyebolts to swing down to allow the manway cover to open.



Manway Inspection Areas



Manway Inspection Areas

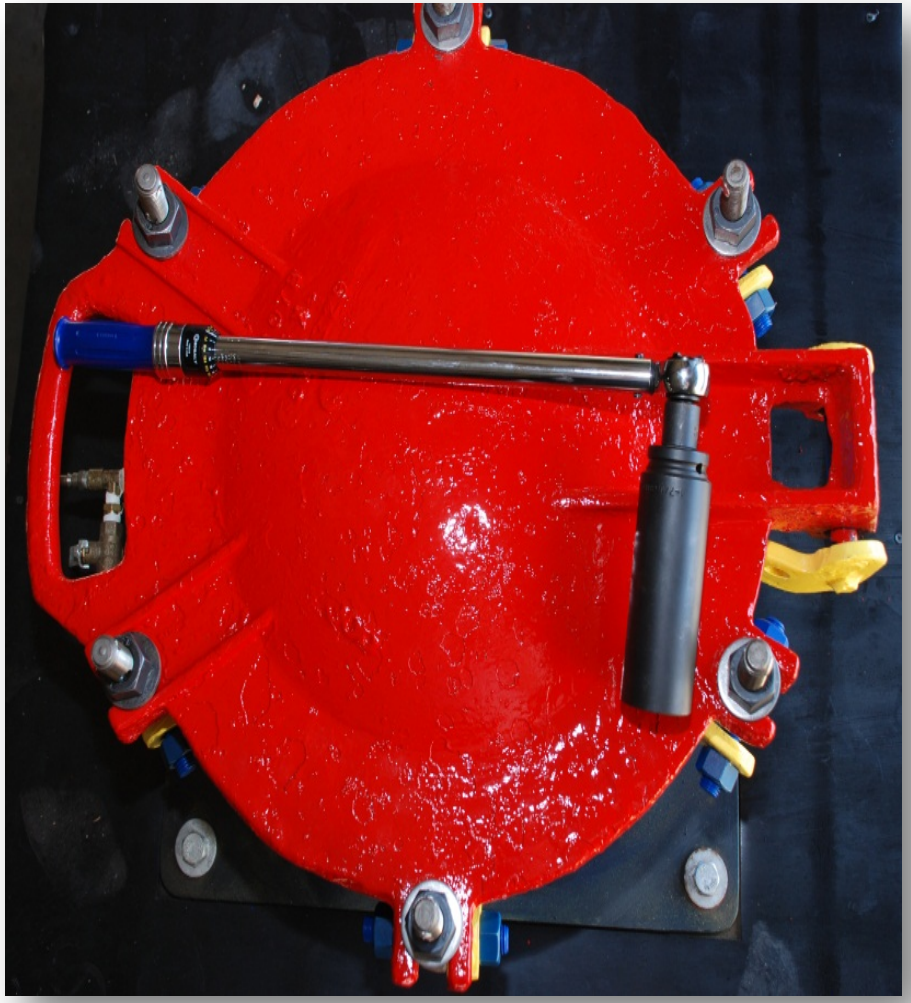


Securement

- Proper lubrication of the eyebolts and safety eyebolts is essential to ensure proper torque.
- Use a compound compatible with the product.
- Proper lubrication will also help increase the life of the eyebolts.

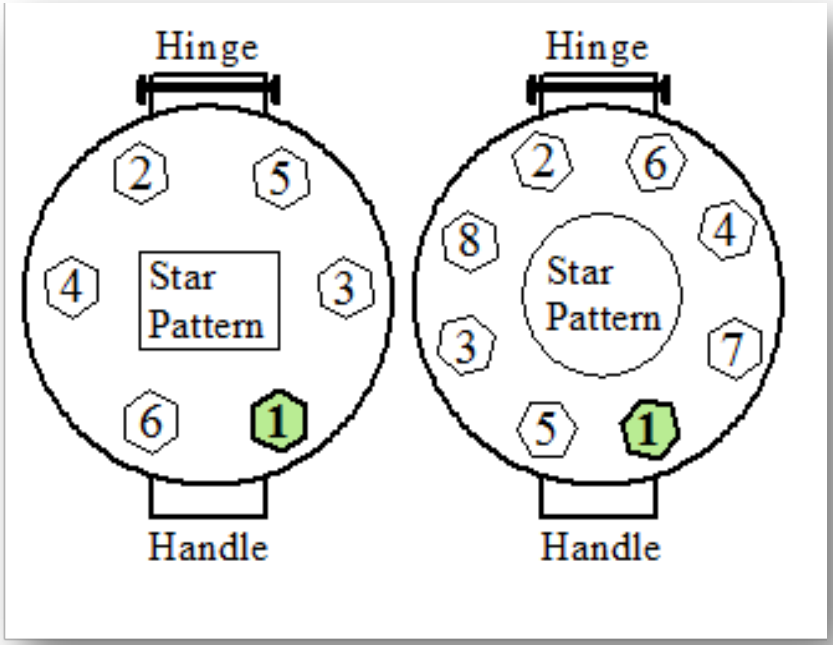
Securement

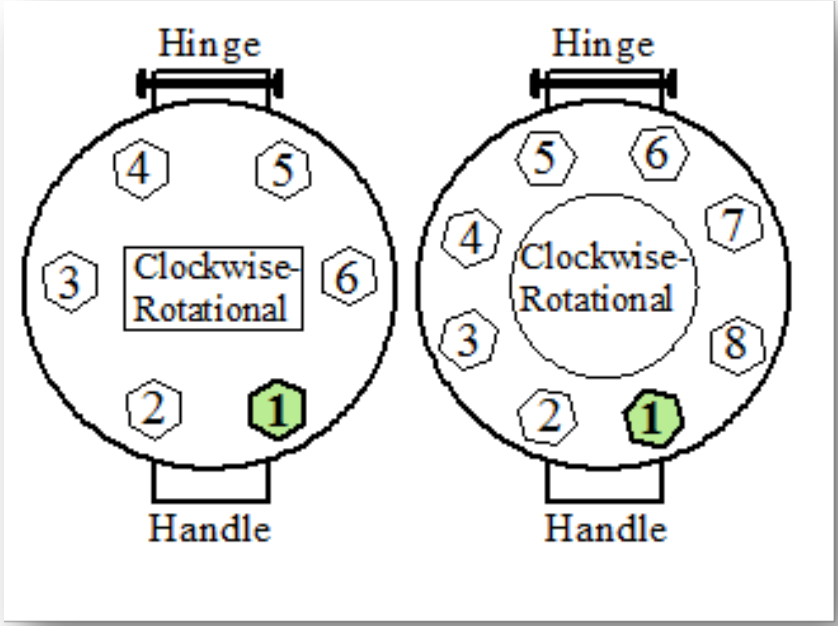
- Use a torque wrench or other means of torque control to properly tighten the safety eyebolt fasteners.
- Follow your company's recommended torque values.



Securement

- When applying torque to the fasteners, <u>always use a cross-rotational pattern</u>.
  - All passes should be star pattern, <u>except for the last pass which should be clockwise rotational</u>.





Common Valves

- Ball
- Butterfly
- Check
- Gage
- Globe
- Plug
- Pressure Relief

Materials

- Closures, fittings, and valves are manufactured from a variety of materials, including:
  - Brass
  - Bronze
  - Iron
  - Plastic
  - Steel
  - Special Alloys

Common Valves

- "*On-Off*" valves, or "*block valves,*" are used to start or stop the flow of a fluid through a process.
- Common on-off valves on tank cars include:
  - Top liquid and vapor valves
  - Top sample valves
  - Pressure relief devices
  - Bottom outlet valves

Top Fittings Arrangement

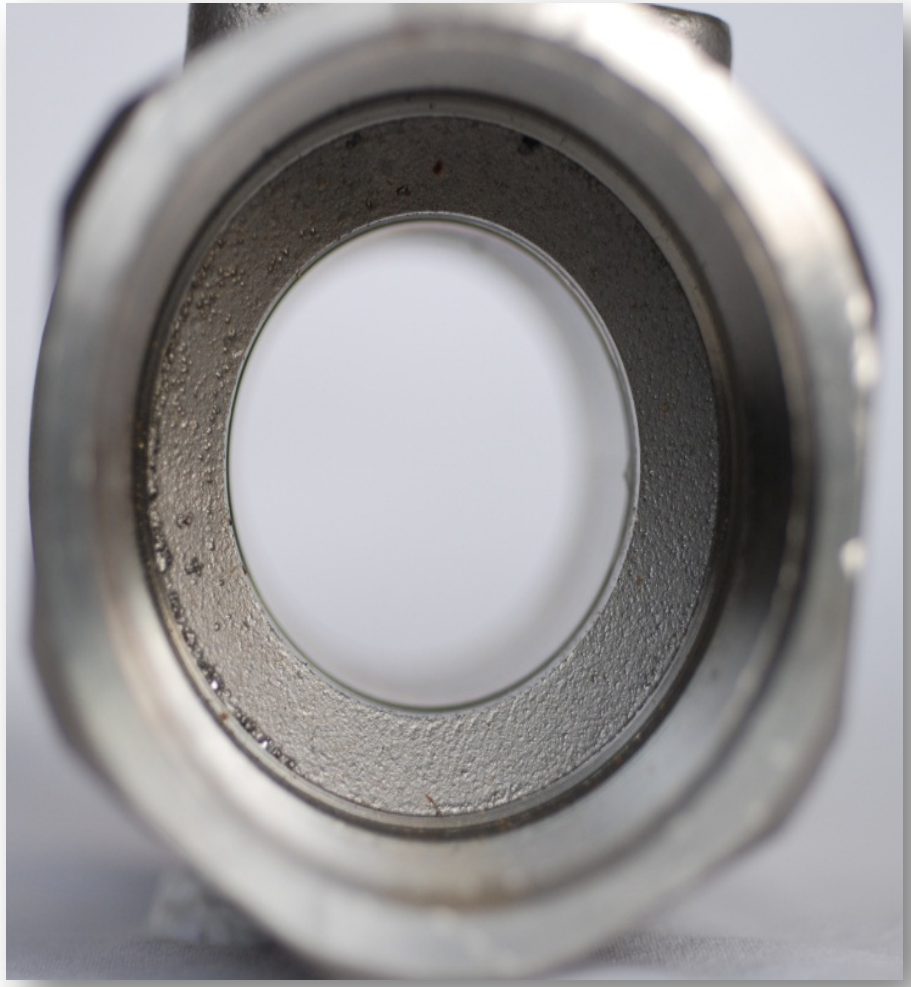
- When operating gauging devices, top operated bottom outlet valves, or any other top fittings or closures, operators should not stand directly above or place any part of their body directly above the gauging device, valve, fitting, or closure.

Common Valves

- "*Non-Return Valves*" are designed to allow the flow of fluid in a desired direction.
- This valves restrict the fluid to flow in the opposite direction (*i.e.*, prevent backflow).
- Common non-return valves include "*check valves*."

Full-Port Valves

- The large internal passageway of gate and ball valves allow the fluid to pass through the valve without significant restriction
- These valves are often called "*full-port valves*" because the internal flow is equal to the full area of the valve inlet.



Manual Valves

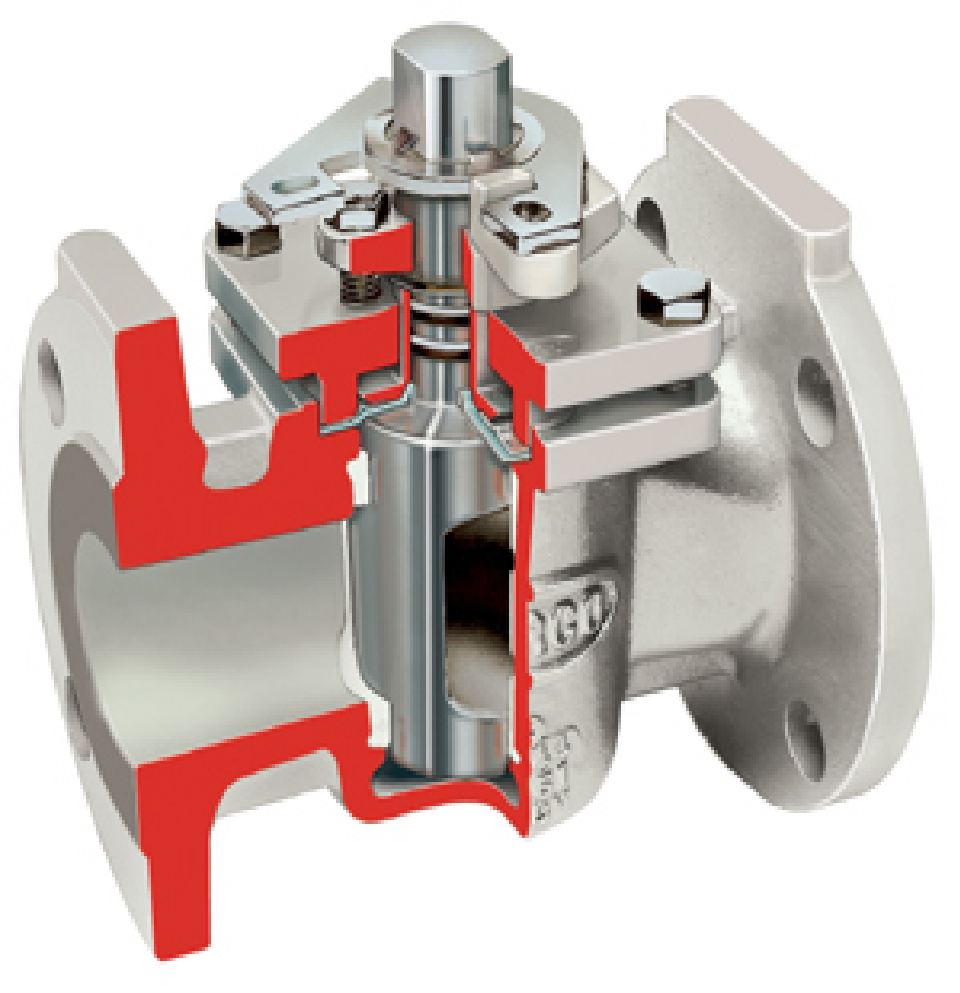
- Manual valves are designed to operate by turning a wheel or lever, with the primary purpose of starting or stopping the flow of fluid.
- Manual valves typically allow the flow of fluid to move straight through the body, with a full-port opening.
- There are four (4) types of manual valves:
  - Rotating valves
  - Stopper valves
  - Sliding valves
  - Flexible valves

Rotating Valves

- Rotating valves allow a quarter-turn rotation of the closure element.
- Rotating valves have a flow path straight through the body without any right-angle turns.
- The most common rotating valves include:
  - Ball
  - Butterfly
  - Plug

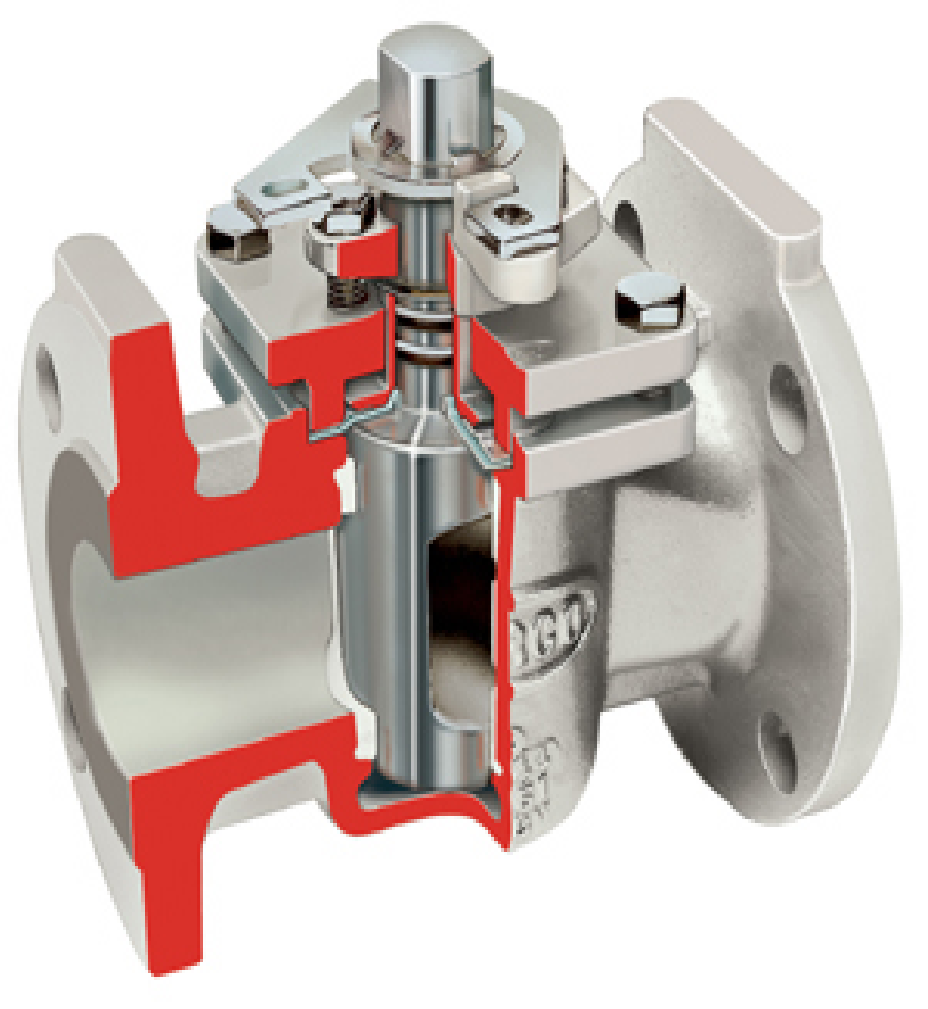
Plug Valve

- "*Plug valves*" are quarter turn manual valves that use a cylindrical or tapered plug to start or stop the flow of fluid through the valve body.
- Plug valves typically applied to low pressure and low temperature services.
- The design provides the ability to apply a lining to the inside of the body. Common lining materials include a polymeric material such as PTFE.



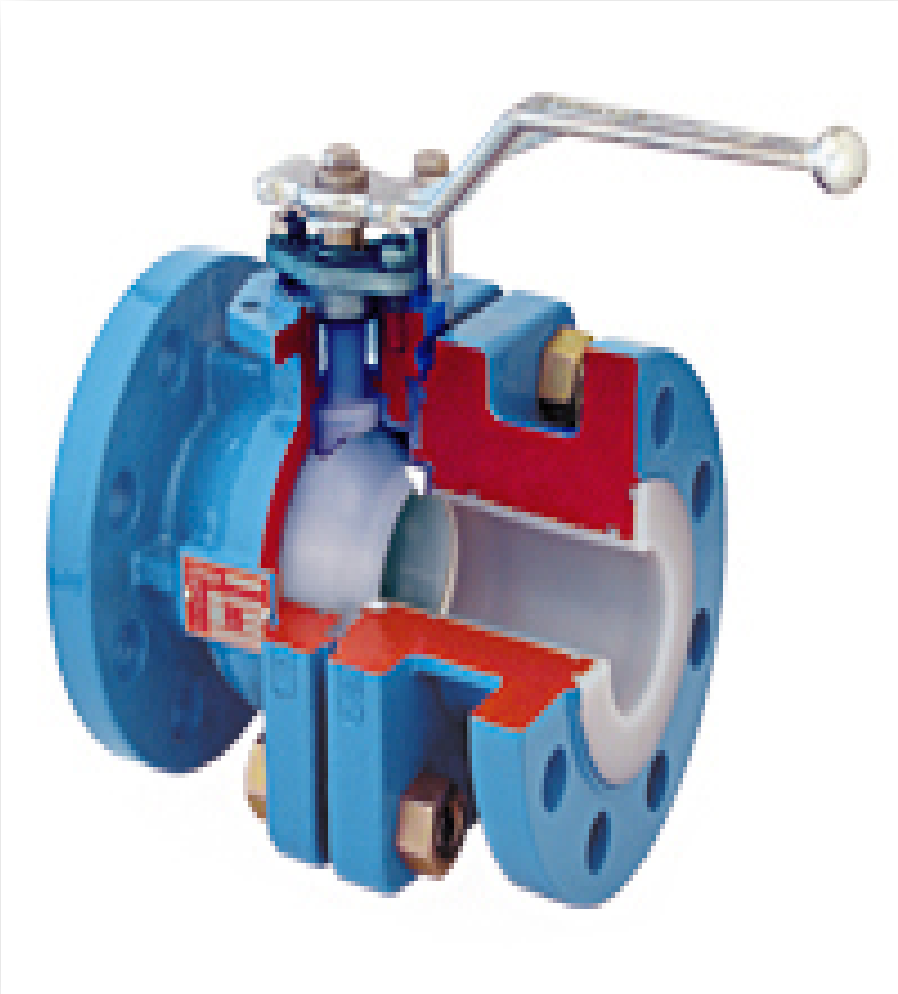
Plug Valve

- The plug and sleeve closure element is accessible through an access in the body which is sealed by a bonnet cap.
- A cylindrical sleeve and a series of O-rings between the lug and the body provides the sealing capabilities.
- The cylindrical shape of the plug must provide a solid seal between the body and wall to prevent leakage.



Ball Valve

- "*Ball valves*" are quarter turn manual valves that use a round closure element to start or stop the flow of fluid through the valve body.
- The ball has a flow through port with rounded elastomeric seats on each side of the ball that provide uniform seating stress (*i.e.*, double seating).
- The upstream fluid pressure assist the seal by pushing the ball against the downstream seal.
- Common seats include PTFE that allows for bubble-tight sealing through a broad temperature range.



Ball Valve

- Because of the wiping rotary motion, ball valves are ideal for slurries or processes with particulates.
- However, the particulates may foul or damage the elastomeric seats causing leakage.
- Ball valves used in highly corrosive environments, such as Hydrochloric, and Sulfuric Acid, the valve body and ball are completely lined with PTFE based material.

Ball Valve

- The valve stem is usually sealed by packing rings with a packing follower and gland flange.
- Tightening the bonnet cap bolting compresses the seats.
- The joint between the bonnet and body provides an effective seal.

Angle Globe Valve

- Globe valves are linear motion on-off valves, and may be used for throttling applications.
- Most globe valves have a single plug-seat design.
- Globe valves are used in both gas and liquid service.
- The product service should be relatively clean from particulate to prevent particulates from being caught into the seat

Angle Globe Valve

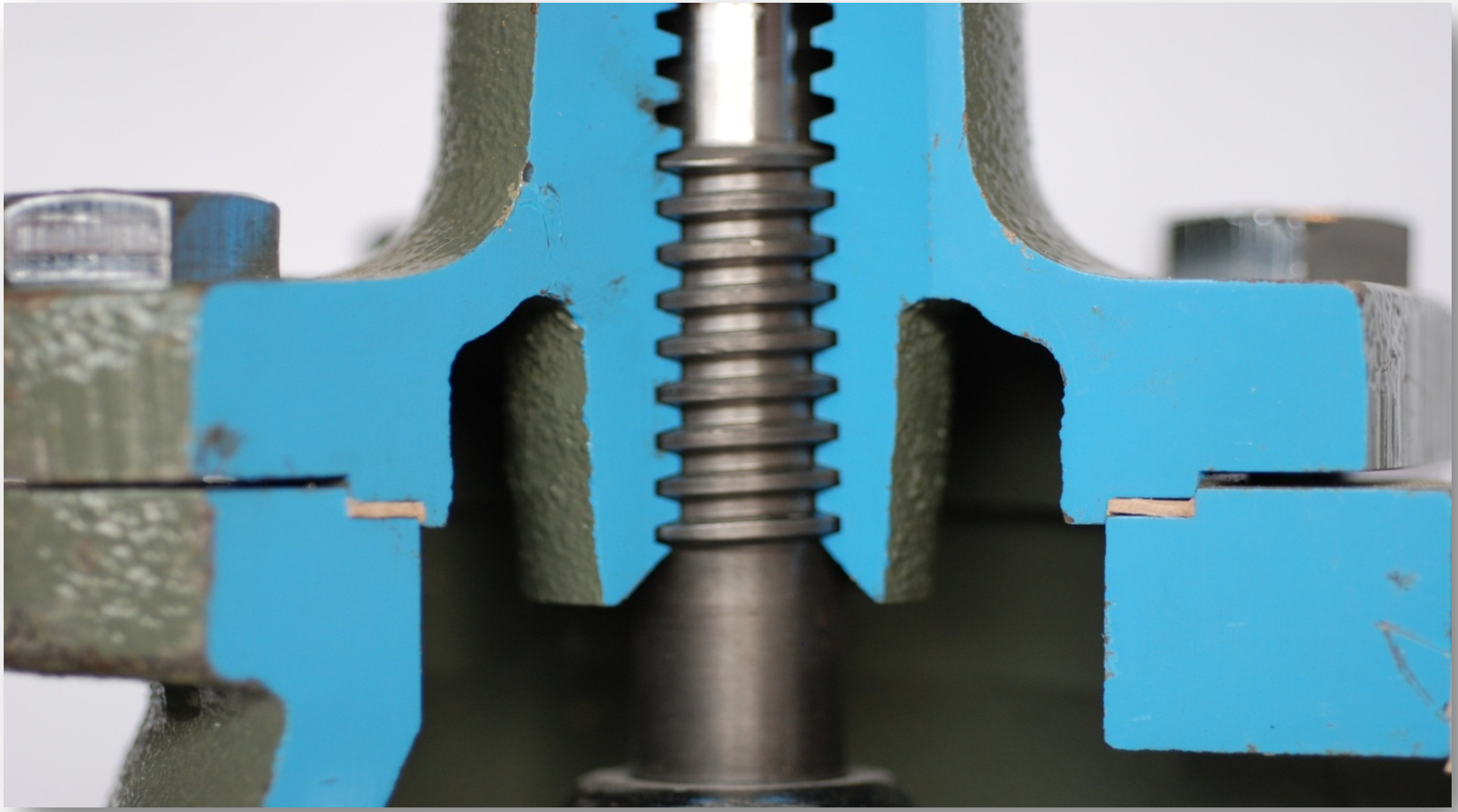
- Most globe valves feature a top entry, bonnet assembly, to allow access to the trim and plug.
- The trim consists of two key components:
  - A plug
  - A seat ring
- The portion of the plug that seats onto the seat ring is called a "*plug head*" and the portion that extends up through the top is called the "*plug stem*."

Angle Globe Valve

- Plug head and Seat Ring
- Keeping the plug head in alignment with the seat ring is important for tight shut-off.
- A damaged plug head or seat ring will result in leakage.
- Bubble tight plug heads typically incorporate a polymeric material such as PTFE.

Angle Globe Valve

- Plug Stem



Angle Globe Valve

- The "*bonnet*" is a major pressure-containing component of the valve.
- The bonnet consists of body gaskets and a packing-box (a series of packing rings), followers, and guides.

Butterfly Valves

- Butterfly valves have a very narrow face-to-face; which accommodates a low profile.
- The “wafer-body,” sometimes called “flangeless body” is common in the railroad industry.
- The inside diameter of the valve is close to the inside diameter of the pipe or bottom outlet saddle flange opening.

Butterfly Valves

- The closure element within the butterfly valve is called a “disk,” of which the outside diameter fits the inside diameter of the seat.
- The seat fits around the entire inside diameter of the body. A with a polymeric material such as PTFE.
- Concentric valve bodies may be lined with rubber or elastomer.

Butterfly Valves

- Butterfly valves contain a packing box, similar to plug and ball valves.
- The packing box contains the stem, packing rings, packing, and a follower.

Leaking Bottom Outlet Valve

Leaking Bottom Outlet Valve

Auxiliary Valve

- If equipped with an auxiliary bottom outlet valve, the auxiliary bottom outlet valve must be left open with the plug removed during the entire loading process to ensure that the primary bottom outlet valve is not leaking.

Top-Operated-Bottom-Outlet Valve

- If equipped with a Top Operated Bottom Outlet Valve (BOV), if practicable, loosen the top packing nut and operate the valve to verify proper operation.

Top-Operated-Bottom-Outlet Valve

- Depending on findings, close the valve and tighten the top packing nut or stop the operation and repair the valve before loading the car.

Top-Operated-Bottom-Outlet Valve

- If equipped with a Bottom-Operated-Bottom Outlet Valve, if practicable, operate the bottom outlet valve to verify proper operation.

Top-Operated-Bottom-Outlet Valve

- Depending on findings, close the valve and lock the handle in the closed position or stop the operation and repair the valve before loading the car.

GP Cars Equipped w/Interior Coils

- If equipped with interior heater coils, remove heater coil caps and check for leakage before connecting steam hoses.

Thermometer Well

- Thermometer wells provide non-product contact to the interior of the tank for product temperature measurement.
- Requires the use of a thermometer or a thermocouple probe.

Sample Valve

- Sampling valves allow access to the product without the use of larger flow rated valves.

Magnetic Gauging Devices

- Magnetic gauging devices provide accurate level monitoring.
- A light-weight float, incorporating a magnet, provides superior reliability and accuracy.
- A graphite rod, with stainless-steel specific gravity ball, correction nut and cap, provides measurement accuracy and corrosion resistance service.

Pressure Relief Devices

- There are two types of pressure relief devices:
  - Re-closing
  - Non-reclosing
- Re-closing pressure relief devices have a spring arrangement that is either internal or external to the tank.

Types of Safety Valves

Internal Spring

External Spring

Pressure Relief Devices

- A non-reclosing pressure relief device incorporates a Rupture disc designed to burst at a predetermined pressure.

Pressure Relief Devices

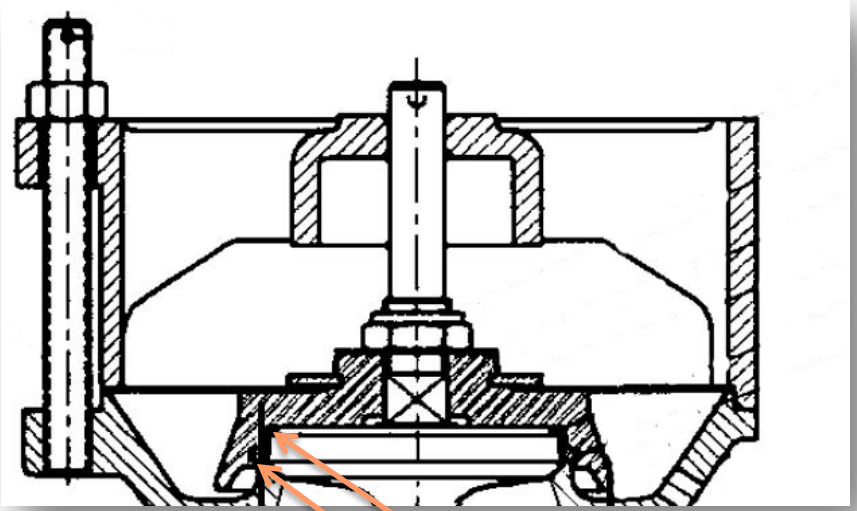
- A pressure relief device is designed to protect a pressurized system against excessive normal or subnormal pressure.
- Pressure relief devices are designed to function at a predetermined pressure.

Re-Closing Pressure Relief Device

- Re-closing pressure relied devices incorporate a:
  - Body;
  - Stem and seat;
  - Spring;
  - Top guide;
  - Adjustment nut;
  - Followers and retainers; and
  - O-rings

Pressure Relief Devices

- The predominate leakage path through a re-closing pressure relief device is around or through the O-ring that provides a bubble leak-tight seal.
- O-rings degrade overtime and may be subject to incompatible chemistries between the product and the O-ring.

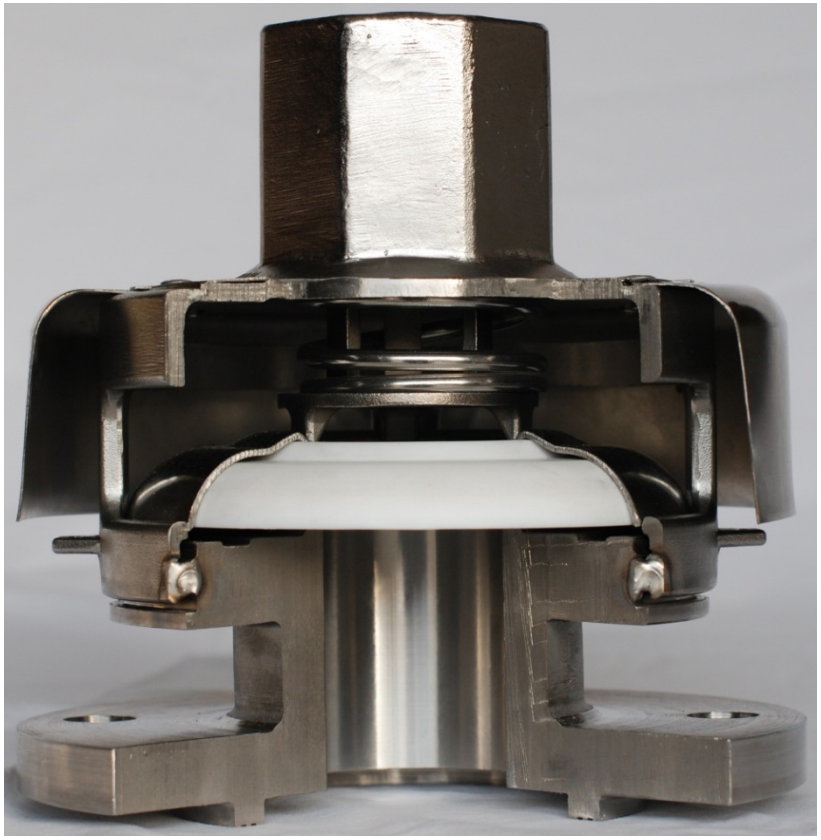


Stem O-ring

Seat O-ring

Pressure Relief Device
Girard Equipment

- Girard Equipment, Incorporated RR407 PRD.
- 165 psi start-to-discharge pressure.
- External spring arrangement.
- Teflon seat with Teflon-Silicone O-ring.
- Typical for hydrochloric acid service.



Pressure Relief Device
Kelso Technologies

- Kelso Technologies JS165H PRD.
- External constant force spring arrangement.
- Seal materials include: Buna, Chemraz7, Simriz7,EPDM, EPR, Kalrez7, Nitrile, Viton7, White Neoprene Available
- Kelso's PRD has the lowest maintenance cost because of the external spring
- Also the highest flow rate

Pressure Relief Device
Midland Manufacturing

- Midland Manufacturing A3400 Series PRD.
- Internal spring arrangement.
- Wide variety of seal materials available.

Pressure Relief Devices
Crosby

- Crosby JQ 375 combination PRD.
- External spring.
- Designed in collaboration with the Chlorine Institute, Inc.
- Breaking pin assembly at the valve inlet forms the gasket face for the mounting flange.
- Diaphragm seals on both the inlet and outlet prevents corrosion to internal parts.

Non Re-Closing Pressure Relief Device

- Historically, non-reclosing pressure relief devices are used in services where the corrosive action of the product may damage internal spring mechanisms, or products that solidified during transit.

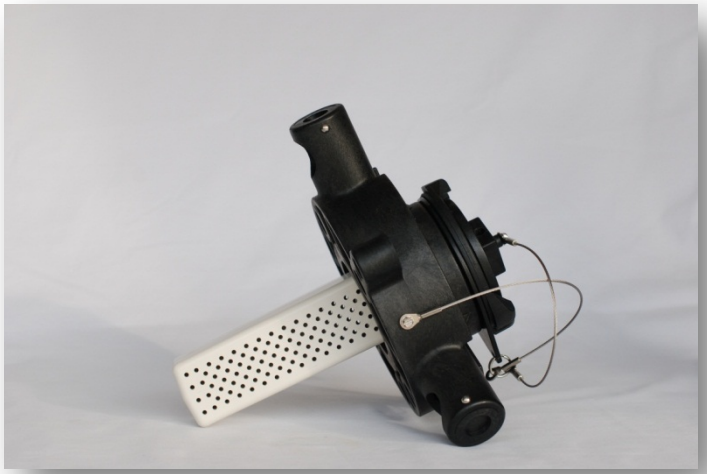
Salco Assembly Shown

Non Re-Closing Pressure Relief Device

- Midland Manufacturing non-reclosing pressure relief device.
- Incorporates a pin and hinged cover to gain access to the rupture disc.
- Common in sulfuric acid service.

Surge Baffles

- Surge baffles attenuate the hydraulic pressure surge acting upon a disc resulting from in-train forces and switch yard impacts.
- All tank cars equipped with a non-reclosing pressure relief device should have a surge baffle installed.



Non Re-Closing Pressure Relief Device

- The non-reclosing pressure relief device incorporates a sacrificial component, a rupture disc, to prevent over-pressurization.
- Rupture discs are manufactured from a variety of products, such as copper, stainless steel, Ryton, resin-impregnated graphite, and various plastics.

Rupture Disc

- Rupture discs provide instant response (within milliseconds) to an increase or decrease in system pressure, but once the disc has ruptured it will not reseal.
- Rupture discs have a set pressure rating.
  - This model has a pressure rating of 165 psig. (100# tank is set at 33% of its burst pressure (500# PSIG), 80 psig for 60# tank, (240# PSIG))

Rupture Disc

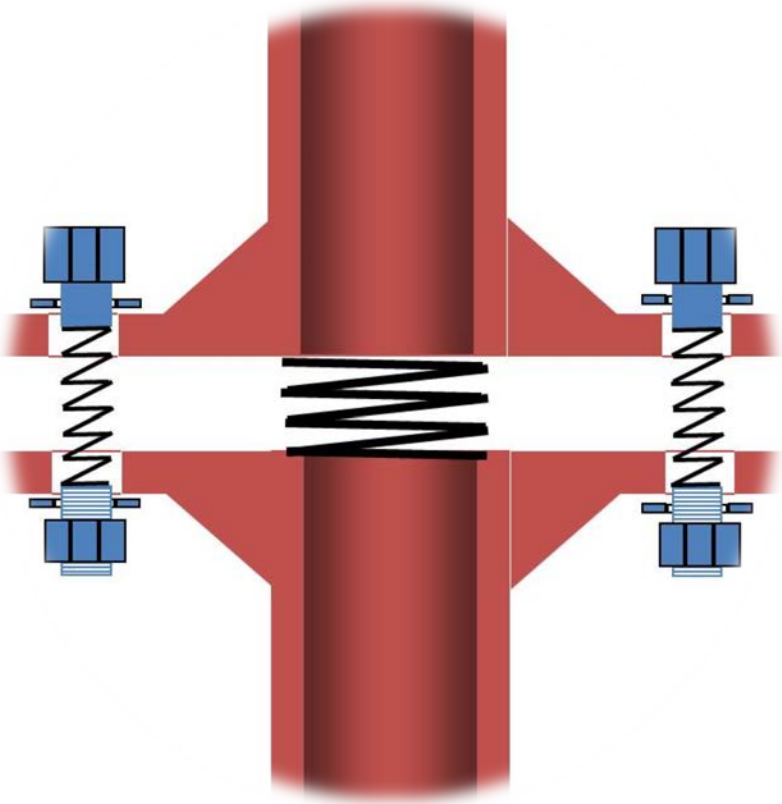
- Federal regulations require a "careful" inspection of the rupture disc in a non-reclosing pressure relief device for corrosion or damage that may alter the intended operation of the device.
- A careful inspection means to inspect "both" sides of the rupture disc. There is no need to remove the rupture disc from the non-reclosing pressure relief device on tank cars containing a residue of a Class 8 material.
- Note: See 49 CFR 173.31(d)(vi).

Rupture Disc

- Damage may appear as:
  - Cracks; or
  - Corrosion
- There is no means to determine product permeation or remaining life through a visual inspection.
- Rupture disc replacement frequency is a function of:
  - Severity of service (corrosion, operating pressure, cyclic duty, and temperature);
  - History of prior failures;
  - Cost of failure; and
  - Newer disc technology.

Threaded Fasteners

- The main function of the fastener and nut is to clamp two joint members together.
- Inspection of a threaded fastener and nut is essential to avoid joint failure.
- Fasteners deform elastically when tightened and act like stiff springs. The gasket also acts elastically when compressed.



Threaded Fasteners

- Mechanical failure of a fastener results from:
  - Mechanical failure during assembly;
  - Mechanical failure at elevated temperatures;
  - Corrosion;
  - Stress corrosion cracking; and
  - Fatigue.
- Inspect each threaded fasteners used to secure a closure, fitting, and valve to the tank.
- The threaded fastener must not have indications of damage that could result in joint failure.

Threaded Fasteners

- A properly installed fastener must have exposed threads above the nut – which represents total thread engagement.

Threaded Fasteners

- An improperly installed fastener does not have exposed threads above the nut – which represents the lack of thread engagement.

Threaded Fasteners

Corrosion Damage

Corrosion Damage

PAMPHLET 34/Shop Certification

- Training and the Use of Checklists
- Recommended Methods for the Safe Loading and Unloading of Low Pressure (General Service) and High Pressure Tank Cars – Guidelines to Use When Developing Your Companies Pre and Post Loading Inspection Program.
- Lug repair, eyebolt change-outs, and other maintenance work must be performed by an AAR registered or certified facility.

FRA's One Time Movement Approvals (OTMA's)

- TYPES OF OTMA'S
- OTMA-1 (High-Risk): Requires a formal written FRA approval to move the car. The approval will contain certain and specific conditions for the movement, including the need to perform a root cause analysis. Shipping papers should show, "Moving per 174.50: OTMA 1." Cars should be marked "Home Shop for Repair Do Not Load" or "Moving for Dismantling Do Not Load." Defective service should be tagged.

FRA's One Time Movement Approvals (OTMA's)

- OTMA-2 (Medium-Risk): Requires FRA notification and generally e-mail acknowledgement by the FRA that the car may move. The grantee must comply with the general requirements in FRA's "Hazardous Materials Guidance" document, HMG-127. Shipping papers should show, "Moving per 174.50: OTMA 2." Cars should be marked "Home Shop for Repair Do Not Load" or "Moving for Dismantling Do Not Load." Defective service should be tagged.

FRA's One Time Movement Approvals (OTMA's)

- OTMA-3 (Low-Risk): FRA provides a standing approval to move certain low-risk nonconforming items. Requires an e-mail to FRA, which must contains specific information. The grantee must comply with the general requirements in FRA's "Hazardous Materials Guidance" document, HMG-127. Shipping papers should show, "Moving per 174.50: OTMA 3." Cars should be marked "Home Shop for Repair Do Not Load" or "Moving for Dismantling Do Not Load." Defective service should be tagged.

Your Responsibility

- No person may offer a tank car into transportation unless:
  - The tank car meets the applicable specification and packaging requirements of the hazardous materials regulations.
  - A person determines that the tank car is in proper condition and safe for transportation.
- This means an inspection of the tank car, service, equipment, safety systems, and markings – including those "*not touched*" by the operator.

Questions