GUIDELINES FOR HINGED AND BOLTED MANWAY ASSEMBLY

Assembly Instructions for the Ethanol Industry

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Authored by: Watco Compliance Services, VSP Technologies, and Salco Products, Inc.

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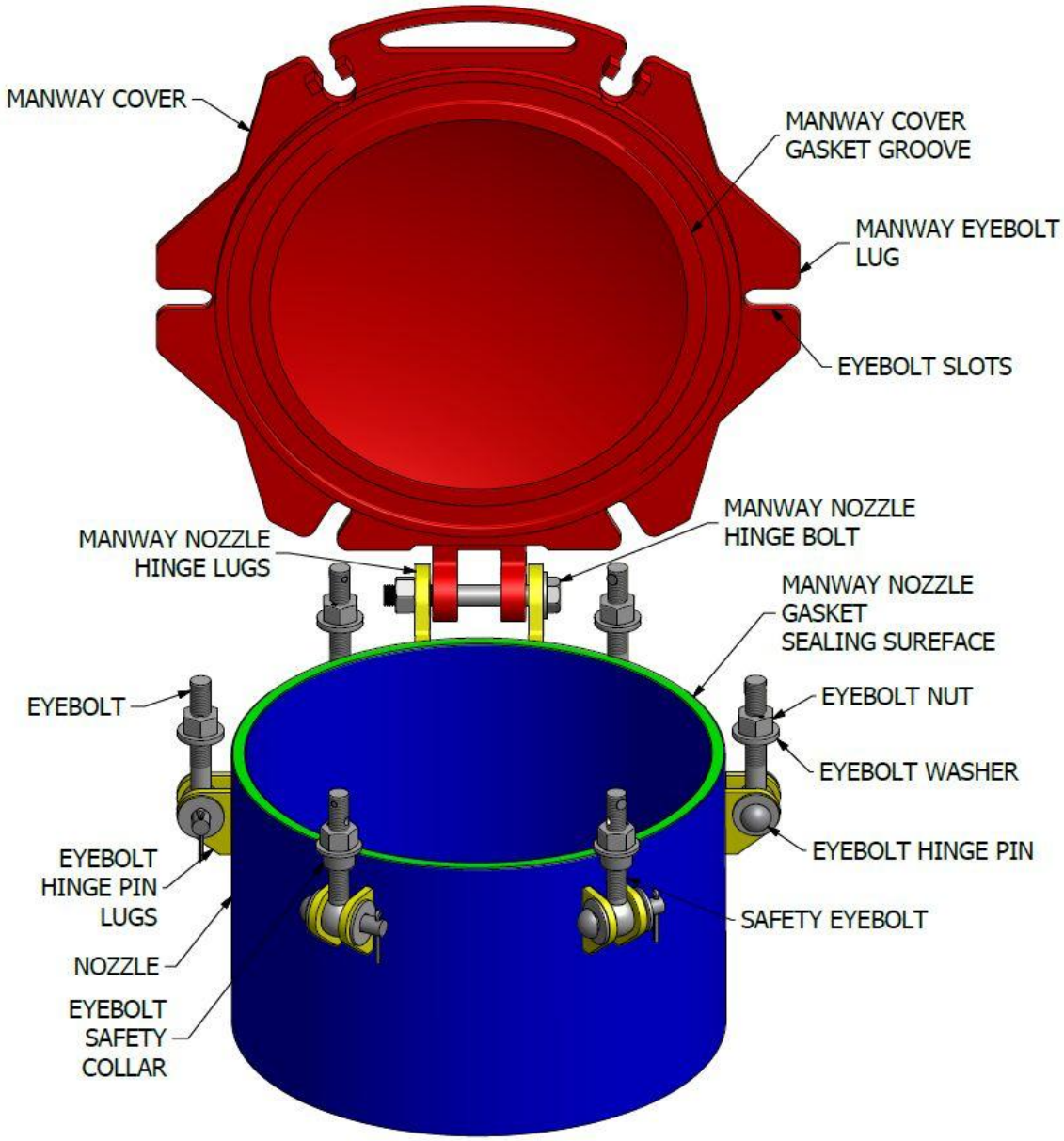
PREFACE

This guideline document is in response to an increased need for an engineering standard for the inspection, maintenance, and securement of a hinged and bolted manway to ensure leak-free performance. Eliminating leaks around a hinged and bolted manway protects against the risks to life, property, and the environment in intrastate, interstate, and foreign commerce. By following this document, an operator can achieve a consistent, high-level, process of assembling a hinged and bolted manway.

This document is a result of a grant issued by the Federal Railroad Administration to the Renewable Fuels Association to provide an educational tool for field personnel. The Renewable Fuels Association greatly appreciates and recognizes the following contributors: Watco Compliance Services, VSP Technologies, and Salco Products, Inc.

HINGED AND BOLTED MANWAY
NOMENCLATURE



GUIDELINES FOR HINGED AND BOLTED MANWAY ASSEMBLY

Assembly Instructions for the Ethanol Industry

INTRODUCTION

Of the more than 1.5 million tank car shipments that contain a hazardous material each year, the ethanol industry accounts for more than 330,000 tank car shipments. Although nearly all of these shipments originate and arrive at their destination in a safe condition, Non-Accident Releases (NAR's) of ethanol and ethanol related products occur. For example, during the period from 2007 through 2012, there were more than 730 NAR's related to tank cars transporting ethanol and ethanol related products. Of these, more than 150 were associated with a hinged and bolted manway.

The key to eliminating NAR's around a hinged and bolted manway requires a high-level process of assembly to ensure leak-free performance over a broad range of temperatures and pressures. Common elements to consider when assembling a hinged and bolted manway include:

- Gasket-contact surface finish without unacceptable imperfections,
- Suitable gasket,
- Maintaining sufficient contact pressure on the manway cover, manway nozzle, and gasket surfaces (*i.e.*, gasket stress),
- Condition of the eyebolt,
- Maintaining sufficient contact pressure must consider the maximum and minimum temperature range and the internal pressure the joint may experience in service,
- Bolt stretch, or relaxation, or gasket relaxation, or flow may result because of changes in temperature and pressure, and
- Mechanical failure of an eyebolt may result from corrosion, fatigue, galling (*i.e.*, a cold welding process that results in an atomic bond between the male and female threads from close contact), self-loosening, stress corrosion cracking, and wear.

This guideline document is in response to an increased need for the development of an engineering recommended standard for the inspection, maintenance, and securement of a hinged and bolted manway to ensure leak-free performance. Included within this document are recommendations for pre—and post—inspection for the detection and evaluation of imperfections, proper selection of eyebolts, installation of gaskets, lubrication of working surfaces, fastener tightening sequence, and target torque value.

This document will aid load out operators at ethanol shipping locations in achieving a consistent, high-level, process of assembling a bolted and hinged manway and ensuring leak-free performance over a broad range of temperatures and pressures. Load out

operators are responsible for assembly of the tank car manway and securement of ethanol prior to release. To achieve this high-level of performance, assembly personnel require classroom and hands-on training, joined with a practical demonstration the training material was understood and can be applied in everyday situations. This document recommends qualification testing of joint assembly personnel.

When an operator discovers an unacceptable condition on the tank car, the plant may not offer the car into transportation until the condition is corrected. The operator may correct certain conditions, such as replacing a worn or torn hinged and bolted manway cover gasket. Other conditions, such as repairs to the manway nozzle, lugs, eyebolts, safety eyebolts, and the hinged and bolted manway cover will require repair by a properly certified tank car facility. This document describes how to handle most unacceptable conditions.

MANWAY ASSEMBLY INSTRUCTIONS

BASIC BOLTED FLANGE DESIGN CONCEPT

The purpose of the eyebolt is to provide a clamping force between the hinged manway cover, the gasket, and the manway nozzle. The clamping force must be sufficient to keep the cover and nozzle together and to prevent the joint from leaking during normal transportation conditions and temperature extremes (*i.e.*, vibration, shocks, and thermal cycles). As an illustration, consider the eyebolt similar to a stiff spring, which responds elastically when tightened (*i.e.*, stretching like a rubber band). **See Figure 1**. Over tightening an eyebolt may cause the fastener to yield (*i.e.*, stretch beyond its capability to snap back to its original design); thereby, releasing stored energy and reducing the clamping force which may cause the cover to move and cause a leak. Likewise, under tightening an eyebolt will not result in sufficient clamping force, which may cause the cover to move and cause a leak.

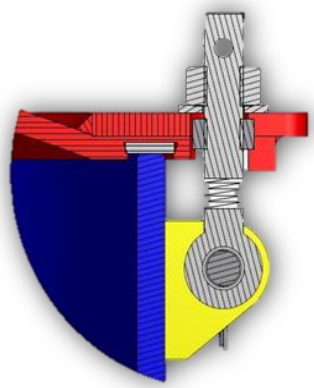


Figure 1: Representation of an eyebolt as a stiff spring.

Like the eyebolt, the manway cover, manway gasket, hinge pins, and hinge pin lugs are similar to a stiff spring, and must respond elastically when tightening the eyebolt. Together, the elastic deformation of the cover, gasket, eyebolt, and lugs, must provide sufficient clamping force on an assembled manway to ensure leak-free performance.

FUNCTION-SPECIFIC TRAINING OF ASSEMBLY PERSONNEL

Each employer should develop a systematic training program for hinged and bolted manway assembly personnel, such as, load out operators. The program should include classroom training, on-the-job-training, and a practical demonstration that personnel understood the training and can apply it in everyday situations. Assembly personnel who successfully passed the classroom, hands-on-training, and the demonstration tests are considered qualified to assemble a bolted manway assembly. The Department of Transportation requires documentation of this function specific training requirement. See 49 CFR 172.704 (d).

EXAMINATION OF CONTACT SURFACES

Eyebolts

Prior to loading, clean and examine each eyebolt, including the safety eyebolt(s) located on the manway cover opposite the manway cover hinge. **See Figure 2.** The safety eyebolts must not rotate downward until an operator lifts the cover by about 3/8-inch to 1-inch. Use a wire brush if necessary to remove debris from the eyebolt threads for a close inspection. The eyebolt and safety eyebolt threads, particularly the threads within one-inch of the manway cover, must be free of corrosion, show no signs of fatigue (*i.e.*, cracks), galling, or wear. Minor galling may appear as thread wear; whereas, major galling may prevent turning the nut about the eyebolt. If necessary, replace eyebolts with those specified on the manufacturer's approved drawing ("approved" means, approved by the Association of American Railroads).

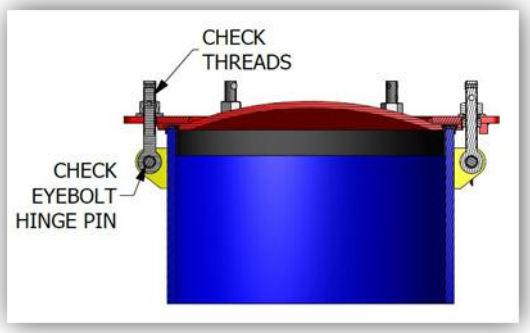


Figure 2: Check threads and hinge pin.

Nut and Washer Engagement

Examine each of the nuts to ensure that the nuts are of the same design (*e.g.*, square or hex [*i.e.*, 4 or 6 sides]). Replace nuts that are broken, cracked, missing, or rounded. Inspect the washer for broken, cupped, cracked, or missing. The full face of the washer must seat uniformly on the manway cover. **See Figure 3.**

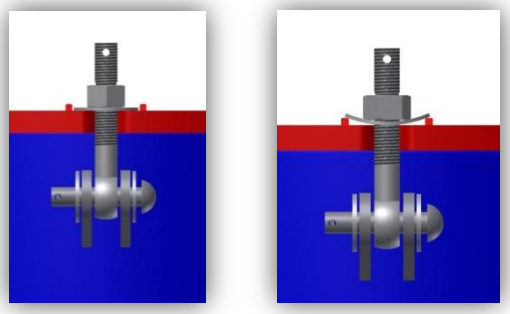


Figure 3: Correct (L) and incorrect (R) washer assembly.

Bolted Manway Cover and Nozzle

Examine the bolted manway cover for imperfections, bent and broken lugs, damaged manway gasket grooves, and detrimental residue on the gasket and sealing surfaces. Inspect the manway nozzle for imperfections. **See Figure 4**.

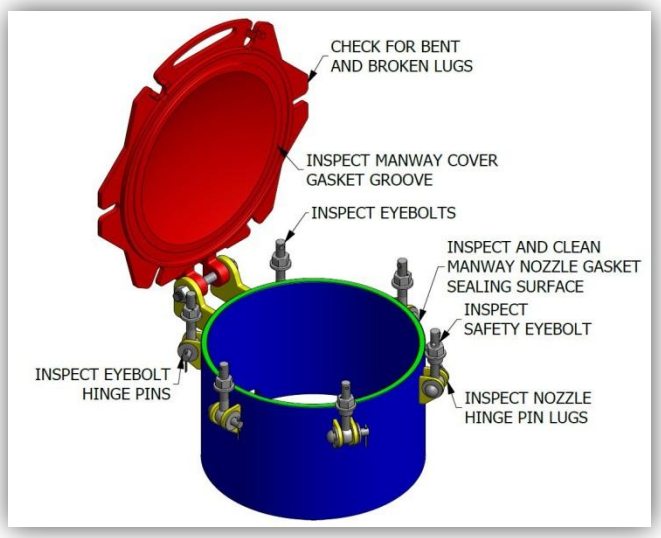


Figure 4: Inspection items of a typical manway.

Bolted Manway Cover Hinge Pin

Examine the hinge pin on the manway cover. Replace any pin bent more than 0.25-inch. A bent hinge pin may prevent proper alignment of the manway cover and the manway nozzle gasket-contact surface. **See Figure 5.** If the bend in the pin is upward, the manway cover may not seat onto the manway nozzle gasket-contact surface (*i.e.*, resulting in flange rotation). When tightening, the eyebolts may appear tight; however, the hinge pin will prevent the manway cover from contacting the gasket-contact surface; thus, providing a false sense of securement.

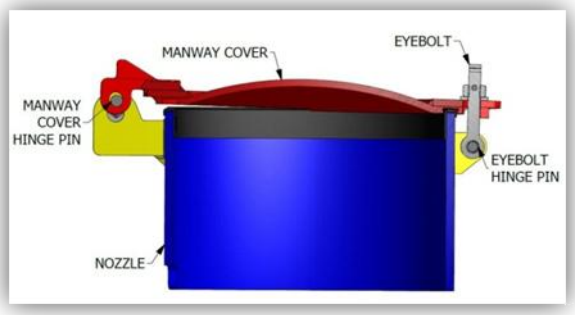


Figure 5: Inspect hinge pin.

Gasket Contact Surface

Imperfections

Clean and examine the manway nozzle gasket-contact surface (area highlighted in green). **See Figure 6.** 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 of the nozzle are detrimental. Soft gaskets (*e.g.*, rubber and expanded PTFE gaskets) will fill small imperfections when compressed between the manway cover and the tank nozzle. Hard gaskets should not be relied upon to fill these same small imperfections (*e.g.*, filled PTFE and non-asbestos fiber gaskets). A good practice is to repair imperfections deeper than 1/32-inch, and radial defects that extend across the face of the gasket-sealing surface more than 25-percent. In order to repair nozzle imperfections, repair companies must comply with the Association of American Railroads', *Manual of Standards and Recommended Practices*, Section C, Part III, Specifications for Tank Cars.

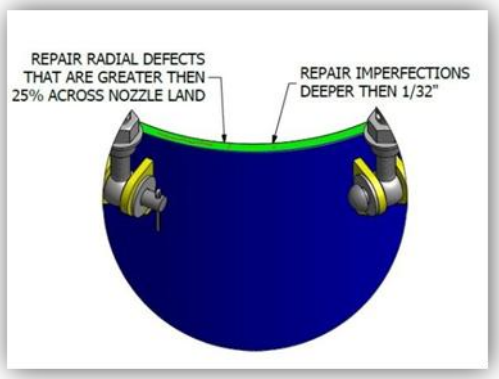


Figure 6: Inspect gasket contact sealing surface.

Flatness and Out-of-Round

The flatness of the nozzle will affect the sealing capabilities of the joint; consequently, the gasket material selected must be able to conform to the range of out-of-flat conditions. **See Figure 7**. In addition, an out-of-round nozzle will prevent the cover from seating properly on the nozzle contact-seating surface.

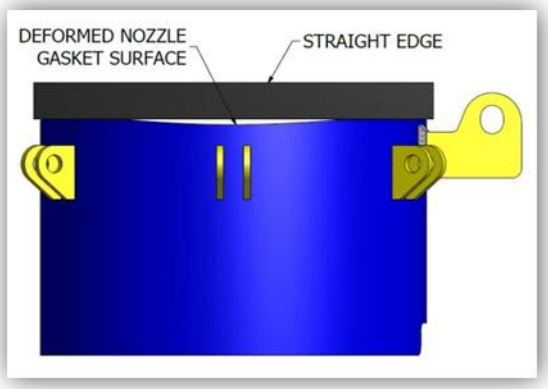


Figure 7: Inspect for out-of-round and flatness.

Cleaning, Examination, and Installation of New Gaskets

It is recommended for joint assembly personnel not to reuse a gasket in a bolted joint. When assembly personal decide to 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. **See Figure 8**.

Figure 8: Inspect gasket for defects.

When there is a need to replace a gasket, remove the gasket from the manway cover. Inspect the gasket-contact sealing surface on the cover. Repair imperfections deeper than 1/32-inch, and radial defects that extend across the face of the gasket-sealing surface more than 25-percent. Repair companies must follow the requirements in the Association of American Railroads', *Manual of Standards and Recommended Practices*, Section C, Part III, Specifications for Tank Cars.

For ethanol shipments with gasoline as a denaturant, select a gasket material from the following chart. As part of a Federal Railroad Administration field trial, the following materials have shown successful performance in service. When using a denaturant other than gasoline, choose a gasket material compatible with the denaturant.

Gasket Material Selection for Ethanol

Material Family	Material of Construction	Chemical Compatibility with Specific Denaturant	
		Gasoline	Others
Compressed Non-Asbestos	Nitrile (Buna-N) bound Aramid Fiber	Yes	Check
Elastomer	Nitrile (Buna-N)	No	No
Filled PTFE	Glass Filled PTFE	Yes	Yes
Filled PTFE	Carbon Filled PTFE	Yes	Yes
Restructured PTFE	Expanded PTFE with corrugated metal insert	Yes	Yes

Based on the manway cover style, select a gasket with the correct inside and outside diameter. Install the gasket into the manway cover. **See Figure 9.** The gasket should fit within the "*lip*" of the cover by means of an interference fit. Elastomeric gaskets typically have a tighter fit than hard gaskets, which are usually retained on the inside diameter of the cover.

Figure 9: Installation of gasket.

MANWAY COVER ASSEMBLY

Close the Cover

After completion of the loading or off-loading operation, close the manway cover. Examine the manway cover and the manway nozzle interface to ensure alignment and constant contact of the sealing surface. The gasket should contact the tank nozzle gasket-sealing surface. **See Figure 10.**

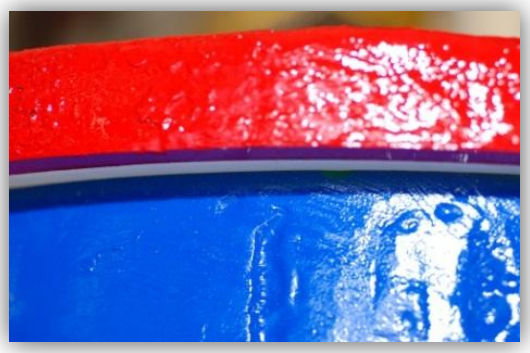


Figure 10: Inspect manway cover for alignment.

Lubrication of Fastener Working Surfaces

Proper lubrication of the eyebolts, safety eyebolt(s), and bearing surface of the nuts reduces the coefficient of friction when tightening the joint, improves consistency of the applied load from eyebolt to eyebolt, and requires less torque to achieve a given tension. The lubricant will also allow for easy disassembly of the hinged and bolted manway. Ensure the lubricant is compatible with the product. For example, a food grade lubricant for a food grade product. A common lubricant, such as molybdenum disulfide, was used in the Federal Railroad Administration field trial. **See Figure 11.**

Figure 11: Lubricate the eyebolt.

Eyebolt Numbering and Tightening Sequence

The numbering and tightening sequence of the eyebolts is a critical step in truly securing the manway. This final step ensures the manway cover is properly closed to prevent an NAR.

Operators must recognize the importance of numbering the eyebolts beginning with the safety eyebolt near the right side of the lifting handle and then following the numbered sequence in a star pattern when tightening each eyebolt on to the manway.

The numbering system is noted in **Figure 12** for a six (6) and eight (8) bolt manway cover. The figure also shows the star pattern tightening sequence for the six (6) and eight (8) bolt manway, and rotational pattern as well.

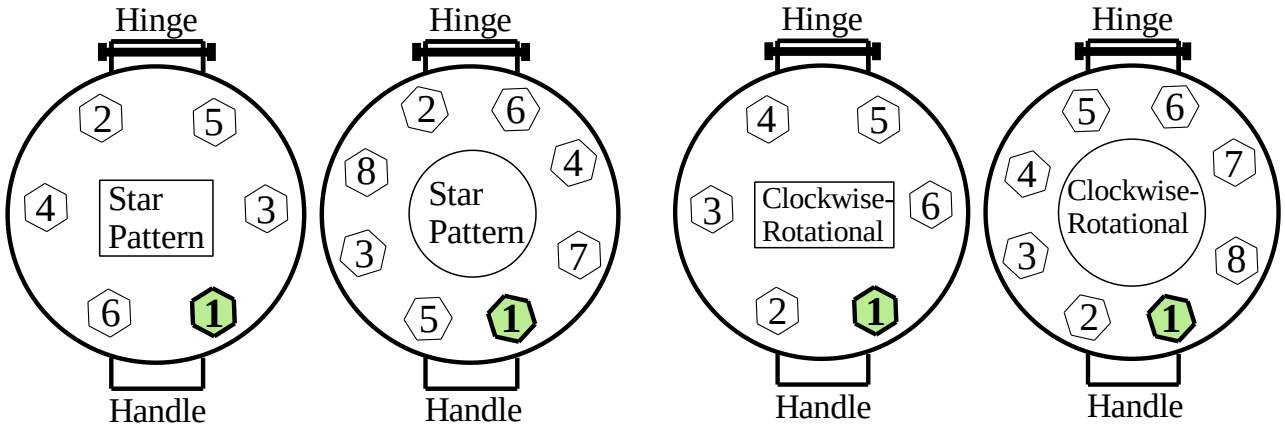
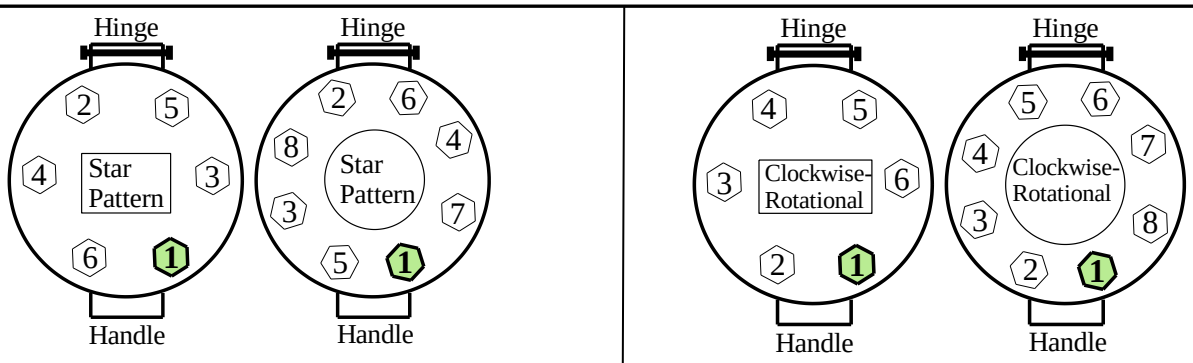


Figure 12: Common Numbering Patterns for Eyebolts

Following an optimized manway assembly procedure, as described in this Guideline, will result in a successful securement of the manway and eliminate the possibility of a Non-Accident Release of ethanol during transit.

APPENDIX A
MANWAY CLOSURE PROCEDURE
VSP CYCLETIGHT® Manway Gasket &
Hard & Elastomeric Gaskets (AAR M-1002, Appendix D, Table D3)



6-Bolt **8-Bolt** **6-Bolt** **8-Bolt**

Preferred Method -- Torque Wrench or Pneumatic Torque Wrench

	VSP CYCLETIGHT®, or Hard Gasket		Elastomeric Gasket	
Sequence	**6 Bolt**	**8 Bolt**	**6 Bolt**	**8 Bolt**
Snug Pass (Star Pattern)	**Snug**	**Snug**	**Snug**	**Snug**
1ST Pass (Star Pattern)	**75 ft-lbs**	**70 ft-lbs**	**50 ft-lbs**	**45 ft-lbs**
2ND Pass (Star Pattern)	**160 ft-lbs**	**140 ft-lbs**	**80 ft-lbs**	**70 ft-lbs**
3RD Pass (Star Pattern)	**250 ft-lbs**	**200 ft-lbs**	**115 ft-lbs**	**90 ft-lbs**
4TH Pass (Clockwise/Rotational)	**250 ft-lbs**	**200 ft-lbs**	**115 ft-lbs**	**90 ft-lbs**

Alternative Method, ½" Drive Impact Wrench @ 80 – 90 psig Air

	VSP CYCLETIGHT®, or Qualified Hard Gasket	Elastomeric Gasket
Sequence	**6 or 8 Bolts**	**DO NOT INSTALL ELASTOMERIC GASKETS WITH AN IMPACT WRENCH**
Snug Pass (Star Pattern)	**1 Second Count**	
1st Pass (Star Pattern)	**5 Second Count**	
2nd Pass (Clockwise/Rotational)	**5 Second Count**	
3rd Pass (Clockwise/Rotational)	**5 Second Count**	

- **ALWAYS** Use Approved Fastener Lubrication on Threads and Nut Bearing Surface
- **ALWAYS** Start with the **#1 Bolt**
- **DO NOT** use a **PIPE WRENCH**, this will Under Torque, Resulting in a Leak
- **DO NOT** use a **CHEATER BAR**, this will Over Torque, Bend the Manway Cover and, Result in a Leak
- Elastomeric Gaskets => Buna-N(Nitrile), EPDM PC, Neoprene, Viton®, and similar
- Qualified Hard Gasket => Means to validate that this procedure for fluid sealability based on the specific gasket