

Low Emission Packing Owner's Manual

Garlock Compression Packing



CONTENTS

1. Garlock Low Emission Packing Installation	
1.1 Valve Condition Assessment.....	2
1.2 1303-FEP Spool Stock.....	3
1.3 1303-FEP Die-formed ring set.....	5
1.4 212-ULE	7
1.5 9000EVSP with 1303-FEP end rings	9
1.6 9001 QS with 1303-FEP end rings.....	11
1.7 Cycle and Adjustment Procedure.....	12
2. Packing Performance Considerations	13
3. Troubleshooting	14
4. Common Causes for Packing Failure	17
5. LDAR	18
6. LOW E Packing Warranty	19
7. Packing Installer Program	20
8. Gland Bolt Torque Calculation Method	Appendix A (21)
9. Valve Stem Packing S.A.F.E Tags	Appendix B (21)

SECTION 1

Garlock Low Emission Packing

1 GARLOCK LOW EMISSION PACKING INSTALLATION

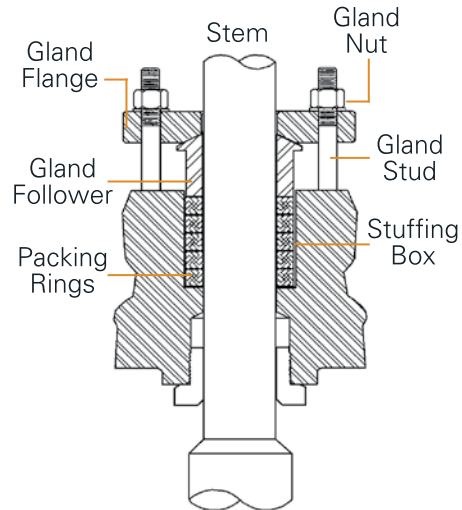
These guidelines and instructions are applicable to our valve stem packing products when best sealing is desired for fugitive emission control. Refer to our General Valve Packing Instructions (available on our website) to find installation instructions for steam or other applications requiring different performance considerations.

CAUTION: Follow all plant safety procedures to ensure valve is out of service and can be handled safely before moving forward with installation. Review below instructions carefully before proceeding with packing replacement.

1.1 VALVE CONDITION ASSESSMENT

Packing is designed to conform under axial load and generate radial load on stem and inside of the stuffing box. A smooth surface will create the best seal with the packing and allow it to consolidate and fill any void properly when loaded by the gland follower. Therefore, it is necessary to assess conditions of all the parts of the valve involved and fix or replace what is necessary. Here are important features to verify:

- » Inspect Stuffing box and stem: Both should be clean and be free of burrs, pitting, scoring or corrosion on surface. The box bottom should be flat. If box bottom is beveled, we recommend the use of a system compatible braided packing ring to be installed at the bottom of the stuffing box (before the bushing if one is necessary). Unless the bushing is already designed to accommodate the bottom beveled angle of the box.
- » The valve stem surface should be smooth and not present scratches, pits or scores. Any found shall not exceed 0.002" (.051 mm) depth and/or depth-to-width ration greater than 1.00.
- » Stem surface finish recommended: 16 - 32 µinch (0.40 - 0.81 µm) AARH
- » Stuffing box inner surface should be smooth and not present scratches, pits or voids found to be deeper than 0.006" (.152 mm). For best FE sealing, a bore finish: 63 µinch (1.60 µm) AARH or less is recommended. (Bore finish shall not exceed 125 µinch (3.20 µm) AARH)
- » Valve stem warpage/runout must be checked over of the entire length of the stem and shall not exceed 0.001 in/in
- » Inspect gland follower and packing bushing or spacer (if applicable). The surface in contact with packing should be flat. The inside diameter (ID) to stem clearance should not exceed .060" (1.52 mm). The outside diameter (OD) to stuffing box bore should not exceed .030" (.76 mm).

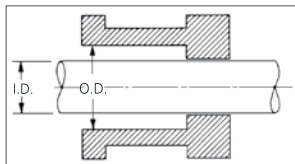
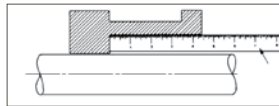
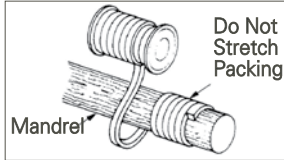
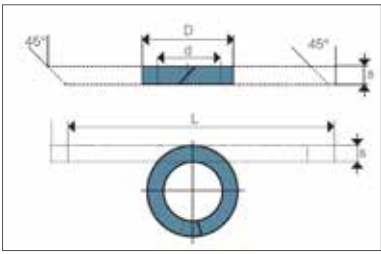


- » Inspect gland flange. It should be straight.
- » Inspect fasteners. These need to be in new or near new condition to ensure that torque load is transferred properly to gland follower and packing set. Gland bolts and nuts shall run freely on the threads. Before fastening and tightening, an anti-seize lubricant needs to be applied on gland nuts and bolts. Use of hardened flat washers is highly recommended to prevent wear and damage to fasteners and gland flange. The lubricant shall not contain any potential volatile organic compounds (VOC).

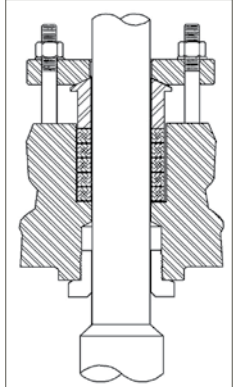
Garlock Low Emission Packing

1.2 1303-FEP BRAIDED SPOOL STOCK PACKING INSTALLATION

Packing is available on a spool and needs to be cut into lengths to form rings:

1. Raise the valve to the full open position. Remove all of the old packing from the stuffing box and dispose properly.
2. Inspect stuffing box for wear and cleanliness. Replace worn parts and clean as required to meet stuffing box condition requirements (see in above section 1.1- valve condition assessment).
3. Determine packing size by measuring stem diameter (inner dimension) and stuffing box bore diameter (outer dimension). Subtract inner dimension from outer dimension and divide by two for the cross sectional size of packing.
 
4. Measure the stuffing box depth. The packing shall be a 5-ring set. As a reference, packing needs to be compressed 30% minimum during install. Use a bushing* to fill stuffing box if depth is greater than height of uncompressed packing set. A bushing should also be used if the gland follower is short and gland flange could bottom out leaving no room for future adjustment. Garlock 1998 EZ Bushing, or a split metallic or machined carbon bushing can be used.
 
5. Cut packing into individual rings by using a mandrel with the same diameter as the stem, or a packing cutter. It is recommended to do a bevel or skive cut if this can be done with care on a mandrel.
 
6. Install one ring at a time seating each ring firmly. Insert first ring of packing into the stuffing box, noting the location of the ring seam. Push this ring down till it contacts the bottom of the stuffing box. Install the second ring of packing, offsetting the seam of this ring by 90 degrees clockwise from that of the previous ring. Push this ring down until it contacts the ring below it. Do not lubricate the packing rings.
 

Bevel / Skive cut

7. Apply compression to the lower rings in the set when possible. If the gland follower will reach down to contact the second ring, then use it to apply compression by tightening down on the gland bolts to the minimum recommended torque (see below equation 1.2.1). If the gland follower does not contact the second packing ring, then insert a proper size bushing in the stuffing box and again, apply compression by tightening down on the gland bolts to the minimum recommended torque. Remove the bushing after this compression step.
 

Compress packing by applying appropriate gland load using a torque wrench
8. Follow step 6 to install 2 more rings carefully offsetting the seam as indicated. Use gland follower to apply pressure as instructed in 7). Verify that gland follower is equally centered around the stem during tightening process or it will result in side loading the packing and/or possible contact with the stem.
9. Install final ring and apply the minimum recommended torque to packing set with gland nuts using a torque wrench**. Alternately tighten the nuts until the desired torque is reached.
10. Check to make sure there is a minimum of 0.125" (3.2 mm) gland follower penetration into the stuffing box and that there is sufficient gland follower length remaining for future adjustment.
11. Perform a cycle and adjust procedure (see Section 1.6). Gland nut torque should be re-checked and re-adjusted if necessary within 2 weeks after putting the valve into service.
12. Attach a tag to the valve for recording:
 - a. Final gland nut torque – manufacturers recommended load
 - b. Date of the completed installation
 - c. Date of the follow-up gland nut torque check and measured or re-torque load if applicable.

* If help is required for appropriate bushing sizing please consult Garlock representative.

**If a torque wrench is not readily available, a work around compromise would be to apply 30% compression.

Garlock Low Emission Packing

EQUATION 1.2.1 FOR MINIMUM RECOMMENDED TORQUE - GLAND LOAD*

$$\text{Torque} = 111.3 (D^2 - d^2) (\emptyset) / B$$

Where:

T = Torque on each bolt (FT-LBS)

D = Bore diameter (inches)

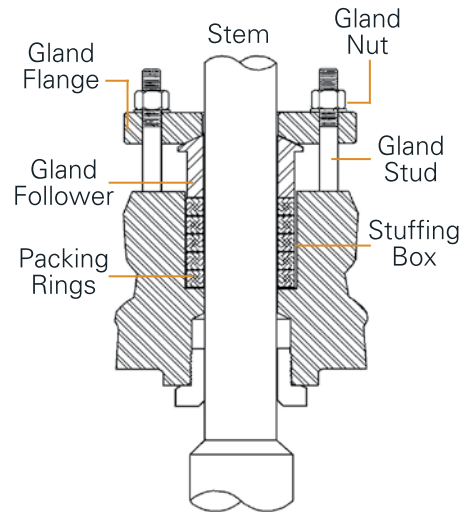
d = Stem Diameter (inches)

\emptyset = Gland bolt diameter (inches)

B = Number of gland bolts

*The torque calculated by this equation will yield a gland load of 8500 psi.

A detailed explanation of the torque calculation can be found in Appendix A.

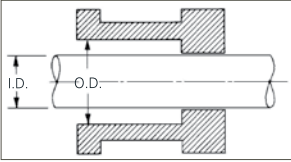
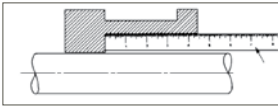


WARNING:

These are general instructions intended for qualified valve stem packing installer. If in doubt, installer should get assistance from qualified installer familiar and trained for this kind of installation or can contact a Garlock representative. Product style should be used according to specifications. User assumes the responsibility of choosing and using a specific product into particular service conditions.

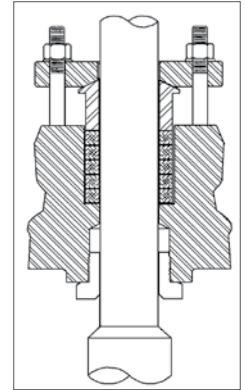
Garlock Low Emission Packing

1.3 1303-FEP DIE-FORMED PACKING SET INSTALLATION

1. Raise the valve to the full open position. Remove all of the old packing from the stuffing box and dispose properly.
2. Inspect stuffing box for wear and cleanliness. Replace worn parts and clean as required to meet stuffing box condition requirements (see in above section 1.1- valve condition assessment).
3. Verify fit of packing size by measuring stem diameter (inner dimension) and stuffing box bore diameter (outer dimension). Subtract inner dimension from outer dimension and divide by two for the cross sectional size of packing.
 
4. Measure the stuffing box depth. Die formed packing will be compressed 25% minimum during install. Use a bushing* to fill stuffing box if depth is greater than height of uncompressed packing set. A bushing should also be used if the gland follower is short and gland flange could bottom out leaving no room for future adjustment. Garlock 1998 EZ Bushing, or a split metallic or machined carbon bushing can be used.
 
5. Install one ring at a time seating each ring firmly. Insert first ring of packing into the stuffing box, noting the location of the ring seam. Push this ring down until it contacts the bottom of the stuffing box. Install the second ring of packing, offsetting the seam of this ring by 90 degrees clockwise from that of the previous ring. Push this ring down until it contacts the ring below it. Do not lubricate the packing rings.
6. Apply compression to the lower rings in the set when possible. If the gland follower will reach down to contact the second ring, then use it to apply compression by tightening down on the gland bolts to the minimum recommended torque (see below equation 1.3.1). If the gland follower does not contact the second packing ring, then insert a proper size bushing in the stuffing box and again, apply compression by tightening down on the gland bolts to the minimum recommended torque. Remove this bushing after the compression step.
7. Follow step 6) to install 2 more rings carefully offsetting the seam as indicated. Use gland follower to apply pressure as instructed in 7). Verify that the gland follower is equally centered around the stem during tightening process or it will result in side loading the packing and/or possible contact with the stem.

8. Install final ring and apply recommended load to packing set with gland nuts using a torque wrench**. Alternately tighten the nuts until the desired torque is reached.
9. Check to make sure there is a minimum of 0.125" (3.2 mm) gland follower penetration into the stuffing box and that there is sufficient gland follower remaining for future adjustment.
10. Perform a cycle and adjust procedure (see below Section 1.6). Gland nut torque should be re-checked and re-adjusted if necessary within 2 weeks after putting the valve into service.
11. Attach a tag to the valve for recording:
 - a. Final gland nut torque – manufacturers recommended load
 - b. Date of the completed installation
 - c. Date of the follow-up gland nut torque check and measured or re-torque load if applicable.

Compress packing by applying appropriate gland load using a torque wrench



* If help is required for appropriate bushing sizing please consult Garlock representative.

**If a torque wrench is not readily available, a work around compromise would be to apply 30% compression.

Garlock Low Emission Packing

EQUATION 1.3.1 FOR MINIMUM RECOMMENDED TORQUE - GLAND LOAD*

$$\text{Torque} = 111.3 (D^2 - d^2) (\varnothing) / B$$

Where:

T = Torque on each bolt (FT-LBS)

D = Bore diameter (inches)

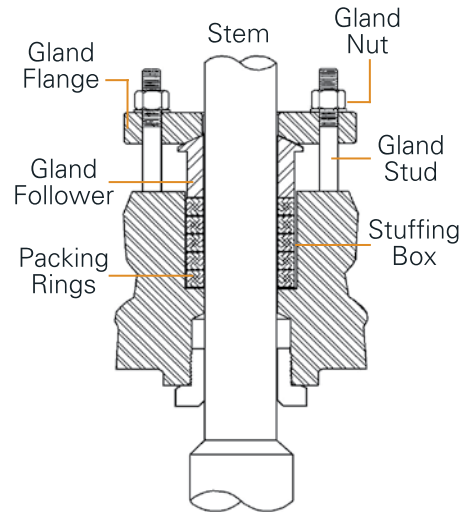
d = Stem Diameter (inches)

\varnothing = Gland bolt diameter (inches)

B = Number of gland bolts

*The torque calculated by this equation will yield a gland load of 8500 psi.

A detailed explanation of the torque calculation can be found in Appendix A.



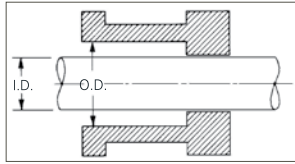
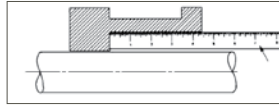
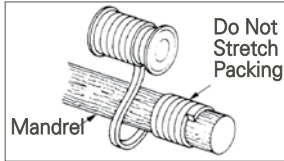
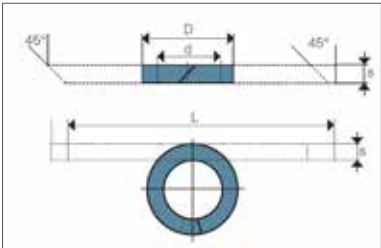
WARNING:

These are general instructions intended for qualified valve stem packing installer. If in doubt, installer should get assistance from qualified installer familiar and trained for this kind of installation or can contact a Garlock representative. Product style should be used according to specifications. User assumes the responsibility of choosing and using a specific product into particular service conditions.

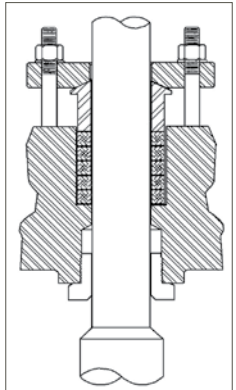
Garlock Low Emission Packing

1.4 212-ULE™ VALVE PACKING INSTALLATION

Packing is available on a spool and needs to be cut into lengths to form rings:

1. Raise the valve to the full open position. Remove all of the old packing from the stuffing box and dispose properly.
2. Inspect stuffing box for wear and cleanliness. Replace worn parts and clean as required to meet stuffing box condition requirements (see in above section 1.1- valve condition assessment).
3. Determine packing size by measuring stem diameter (inner dimension) and stuffing box bore diameter (outer dimension). Subtract inner dimension from outer dimension and divide by two for the cross sectional size of packing.
 
4. Measure the stuffing box depth. Use 5 rings for the "2-1-2" configuration as shown on box. Packing should be compressed 30% minimum during install. Use a bushing* to fill stuffing box if depth is greater than height of uncompressed packing set. A bushing should also be used if the gland follower is short and gland flange could bottom out leaving no room for future adjustment. Garlock 1998 EZ Bushing, or a split metallic or machined carbon bushing can be used.
 
5. Cut packing into individual rings by using a mandrel with the same diameter as the stem, or a packing cutter. It is recommended to do a bevel or skive cut if this can be done with care on a mandrel.
 
6. Install one ring at a time seating each ring firmly. Insert first ring of packing into the stuffing box, noting the location of the ring seam. Push this ring down until it contacts the bottom of the stuffing box. Install the second ring of packing, offsetting the seam of this ring by 90 degrees clockwise from that of the previous ring. Push this ring down until it contacts the ring below it. Do not lubricate the packing rings.
 

Bevel / Skive cut

7. Apply compression to the lower rings in the set when possible. If the gland follower will reach down to contact the second ring, then use it to apply compression by tightening down on the gland bolts to the minimum recommended torque (see below equation 1.4.1). If the gland follower does not contact the second packing ring, then insert a proper size bushing in the stuffing box and again, apply compression by tightening down on the gland bolts to the minimum recommended torque. Remove this bushing after the compression step.
 
8. Follow step 6 to install 2 more rings carefully off setting the seam as indicated. Use gland follower to apply pressure as instructed in 7). Verify that gland follower is equally centered around the stem during tightening process or it will result in side loading the packing and/or possible contact with the stem.
9. Install final ring and apply recommended load to packing set with gland nuts using a torque wrench**. Alternately tighten the nuts until the desired torque is reached.
10. Check to make sure there is a minimum of 0.125" (3.2 mm) gland follower penetration into the stuffing box and that there is sufficient gland follower remaining for future adjustment.
11. Perform a cycle and adjust procedure (see below Section 1.6). Gland nut torque should be re-checked and re-adjusted if necessary within 2 weeks after putting the valve into service.
12. Attach a tag to the valve for recording:
 - a. Final gland nut torque – manufacturers recommended load
 - b. Date of the completed installation
 - c. Date of the follow-up gland nut torque check and measured or re-torque load if applicable.

* If help is required for appropriate bushing sizing please consult Garlock representative.

**If a torque wrench is not readily available, a work around compromise would be to apply 30% compression.

Garlock Low Emission Packing

EQUATION 1.4.1 FOR MINIMUM RECOMMENDED TORQUE - GLAND LOAD*

$$\text{Torque} = 111.3 (D^2 - d^2) (\varnothing) / B$$

Where:

T = Torque on each bolt (FT-LBS)

D = Bore diameter (inches)

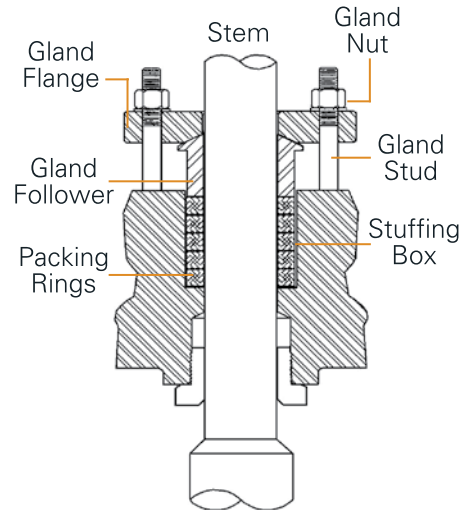
d = Stem Diameter (inches)

\varnothing = Gland bolt diameter (inches)

B = Number of gland bolts

*The torque calculated by this equation will yield a gland load of 8500 psi.

A detailed explanation of the torque calculation can be found in Appendix A.

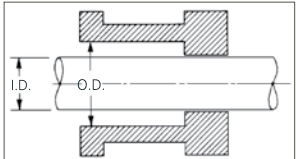
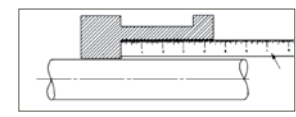


WARNING:

These are general instructions intended for qualified valve stem packing installer. If in doubt, installer should get assistance from qualified installer familiar and trained for this kind of installation or can contact a Garlock representative. Product style should be used according to specifications. User assumes the responsibility of choosing and using a specific product into particular service conditions.

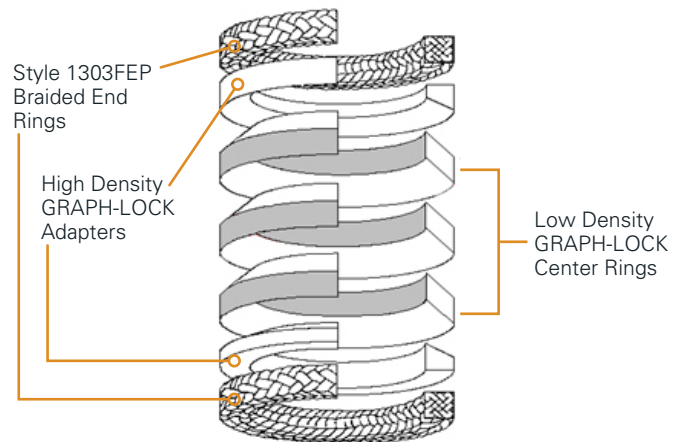
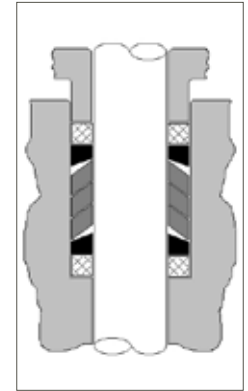
Garlock Low Emission Packing

1.5 9000 EVSP WITH 1303-FEP END RINGS INSTALLATION

1. Raise the valve to the full open position. Remove all of the old packing from the stuffing box and dispose properly.
2. Inspect stuffing box for wear and cleanliness. Replace worn parts and clean as required to meet stuffing box condition requirements (see in above section 1.1- valve condition assessment).
3. Verify fit of packing size by measuring stem diameter (inner dimension) and stuffing box bore diameter (outer dimension). Subtract inner dimension from outer dimension and divide by two for the cross sectional size of packing.
 
4. Measure the depth of the stuffing box. Packing set should be compressed 30 % minimum during install.
 
5. From the Required Box Depth Chart, determine the number of rings to be used in the set (5, 6, or 7), depending on available stuffing box depth. All the rings in the supplied set should be used whenever possible.
6. Use a bushing* to fill stuffing box if depth is greater than height of uncompressed packing set. A bushing should also be used if the gland follower is short and gland flange could bottom out leaving no room for future adjustment. To determine bushing height, subtract the required box depth from the actual box depth (Step 4).
7. Install the bushing, and then install the bottom 1303-FEP ring. Use the gland follower or an extra bushing to compress the braided ring and make sure it sits on the bottom properly. Install the GRAPH-LOCK rings, offsetting the seam of each ring by 90 degrees clockwise from that of the previous ring. Do not lubricate the rings. Push each ring down until it contacts the one below it. The flat top of the GRAPH-LOCK adapter should be approximately flush or close to the edge of the stuffing box. Do not install the top 1303-FEP ring at this time.
8. Apply compression to the lower rings with the gland follower by tightening down on the gland bolts to the minimum recommended torque (see below equation 1.5.1). This will consolidate the packing set and create enough room to enable the top 1303-FEP ring to be installed. Verify that gland follower is equally centered around the stem during tightening process or it will result in side loading the packing and/or possible contact with the stem.

9. Install the top braided ring and apply minimum recommended torque to packing set with gland nuts using a torque wrench**. Alternately tighten the nuts until the desired torque is reached.
10. Check to make sure there is a minimum of 0.125" (3.2 mm) gland follower penetration into the stuffing box and that there is sufficient gland follower remaining for future adjustment.
11. Perform a cycle and adjust procedure (see below Section 1.6). Gland nut torque should be re-checked and re-adjusted if necessary within 2 weeks after putting the valve into service.
12. Attach a tag to the valve for recording:
 - a. Final gland nut torque – manufacturers recommended load
 - b. Date of the completed installation
 - c. Date of the follow-up gland nut torque check and measured or re-torque load if applicable.

Compress packing by applying appropriate gland load using a torque wrench



* If help is required for appropriate bushing sizing please consult Garlock representative.

**If a torque wrench is not readily available, a work around compromise would be to apply 30% compression.

GRAPH-LOCK® is a registered trademark of Garlock

Garlock Low Emission Packing

EQUATION 1.5.1 FOR MINIMUM RECOMMENDED TORQUE - GLAND LOAD*

$$\text{Torque} = 111.3 (D^2 - d^2) (\text{Ø}) / B$$

Where:

T = Torque on each bolt (FT-LBS)

D = Bore diameter (inches)

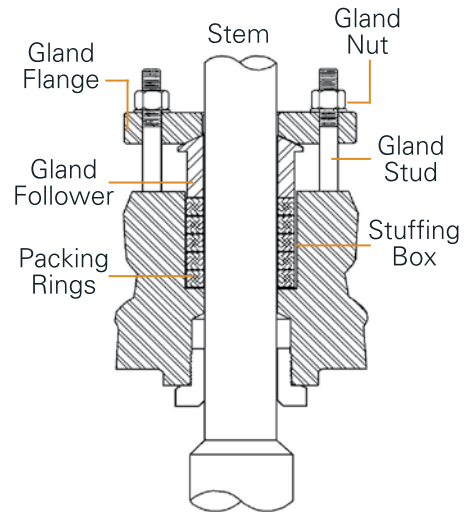
d = Stem Diameter (inches)

Ø = Gland bolt diameter (inches)

B = Number of gland bolts

*The torque calculated by this equation will yield a gland load of 8500 psi.

A detailed explanation of the torque calculation can be found in Appendix A.



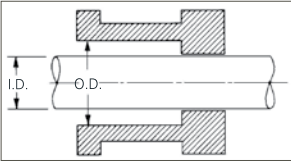
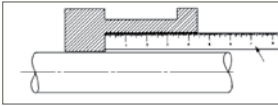
WARNING:

These are general instructions intended for qualified valve stem packing installer. If in doubt, installer should get assistance from qualified installer familiar and trained for this kind of installation or can contact a Garlock representative. Product style should be used according to specifications. User assumes the responsibility of choosing and using a specific product into particular service conditions.

Garlock Low Emission Packing

1.6 9001 QUICK-SET WITH 1303-FEP END RINGS INSTALLATION

Read the instructions entirely before beginning installation.

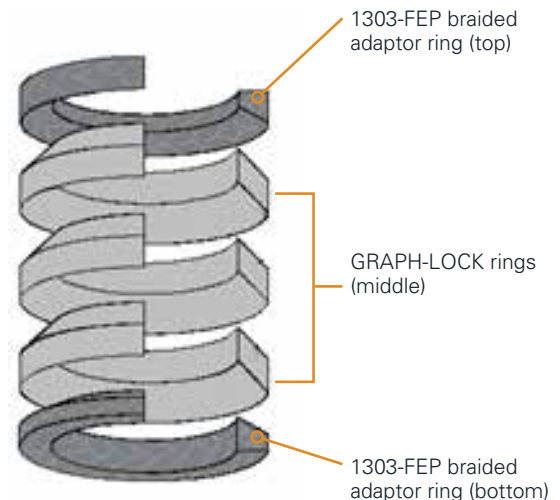
1. Raise the valve to the full open position. Remove all of the old packing from the stuffing box and dispose properly.
2. Inspect stuffing box for wear and cleanliness. Replace worn parts and clean as required to meet stuffing box condition requirements (see section 1.1- valve condition assessment).
3. Verify fit of packing size by measuring stem diameter (inner dimension) and stuffing box bore diameter (outer dimension). Subtract inner dimension from outer dimension and divide by two to compare with the cross sectional size of packing.
 
4. Measure the depth of the stuffing box. Packing set should be compressed 30 % minimum during install.
 
5. All the rings in the supplied set should be used.
6. Use a bushing* to fill stuffing box if depth is greater than height of uncompressed packing set. A bushing should also be used if the gland follower is short and gland flange could bottom out leaving no room for future adjustment. To determine bushing height, subtract the Required Box Depth from the actual box depth (Step 4).

*If help is required for appropriate bushing sizing please consult Garlock representative.

7. Install the bushing, and then install the bottom 1303-FEP adaptor ring. Make sure the braided ring sits flat and properly on the bottom. Do not heavily compress the ring. Install the GRAPH-LOCK rings, offsetting the seam of each ring by 90 degrees clockwise from that of the previous ring. Do not lubricate the rings. Push each ring down until it contacts the one below it. Install the last (second) 1303-FEP adaptor ring. The flat top of this last ring should be approximately flush or close to the edge of the stuffing box.
8. Apply compression to the lower rings with the gland follower by tightening down on the gland nuts to the Minimum Recommended Torque (see below equation) using a torque wrench**. Alternately tighten the nuts until the desired torque is reached. This will consolidate the packing set. Verify that gland follower is equally centered around the stem during tightening process or it will result in side loading the packing and/or possible contact with the stem.

**If a torque wrench is not readily available, a work around compromise would be to apply 30% compression minimum.

9. Check to make sure there is a minimum of 0.125" (3.2 mm) gland follower penetration into the stuffing box and that there is sufficient gland follower remaining for future adjustment.
10. Perform a cycle and adjust procedure (see below Section 1.3). Gland nut torque should be re-checked and re-adjusted if necessary within 2 weeks after putting the valve into service.
11. Attach a tag to the valve for recording:
 - a. Final gland nut torque – manufacturers recommended load
 - b. Date of the completed installation
 - c. Date of the follow-up gland nut torque check and measured or re-torque load if applicable.



Garlock Low Emission Packing

EQUATION 1.6.1 FOR MINIMUM RECOMMENDED TORQUE - GLAND LOAD*

$$\text{Torque} = 111.3 (D^2 - d^2) (\varnothing) / B$$

Where:

T = Torque on each bolt (FT-LBS)

D = Bore diameter (inches)

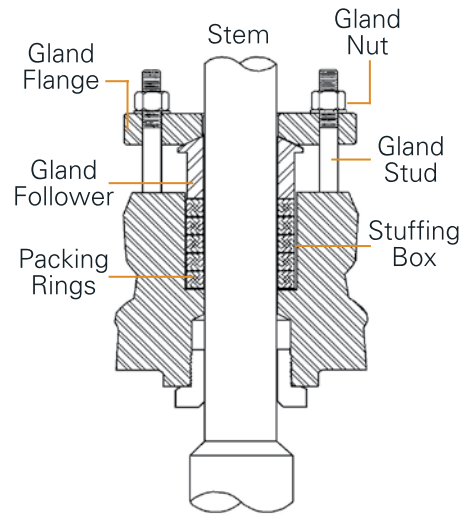
d = Stem Diameter (inches)

\varnothing = Gland bolt diameter (inches)

B = Number of gland bolts

*The torque calculated by this equation will yield a gland load of 8500 psi.

A detailed explanation of the torque calculation can be found in Appendix A.



1.7 CYCLE AND ADJUSTMENT PROCEDURE

To ensure an even compressive load throughout set:

The cycle and adjust procedure will reduce the likelihood of gland load loss over time. The use of the Cycle and Adjust Procedure can help to ensure an even load distribution throughout the depth of a packing set. This procedure uses the frictional contact between the packing and the valve stem to cause consolidation of the packing set and reduce the likelihood of gland load loss. This helps to ensure the long term stability of sealing stress over time. Optimal radial stress will be reached when gland load remains stable.

1. Install and compress packing set per guidelines and instructions (above).
2. Raise the valve stem to full open (up) position.
3. Check torque on gland stud nuts to establish a reference torque (this will be the torque applied that was calculated by using the recommended torque calculation formula gland load).
4. Actuate the stem through 3 full cycles.
5. Check the stud nut torque. If there has been any torque loss, alternately retighten the nuts to the reference value established above (step 3) or until the desired torque is reached.
6. Repeat steps 4 and 5 until no significant torque loss occurs after actuation.

NOTE: Depending on packing style, valve design, installation and operating conditions, some additional packing consolidation could occur over time. Gland nut torque should be re-checked and re-adjusted if necessary within 2 weeks of installation and putting the valve into service.

WARNING:

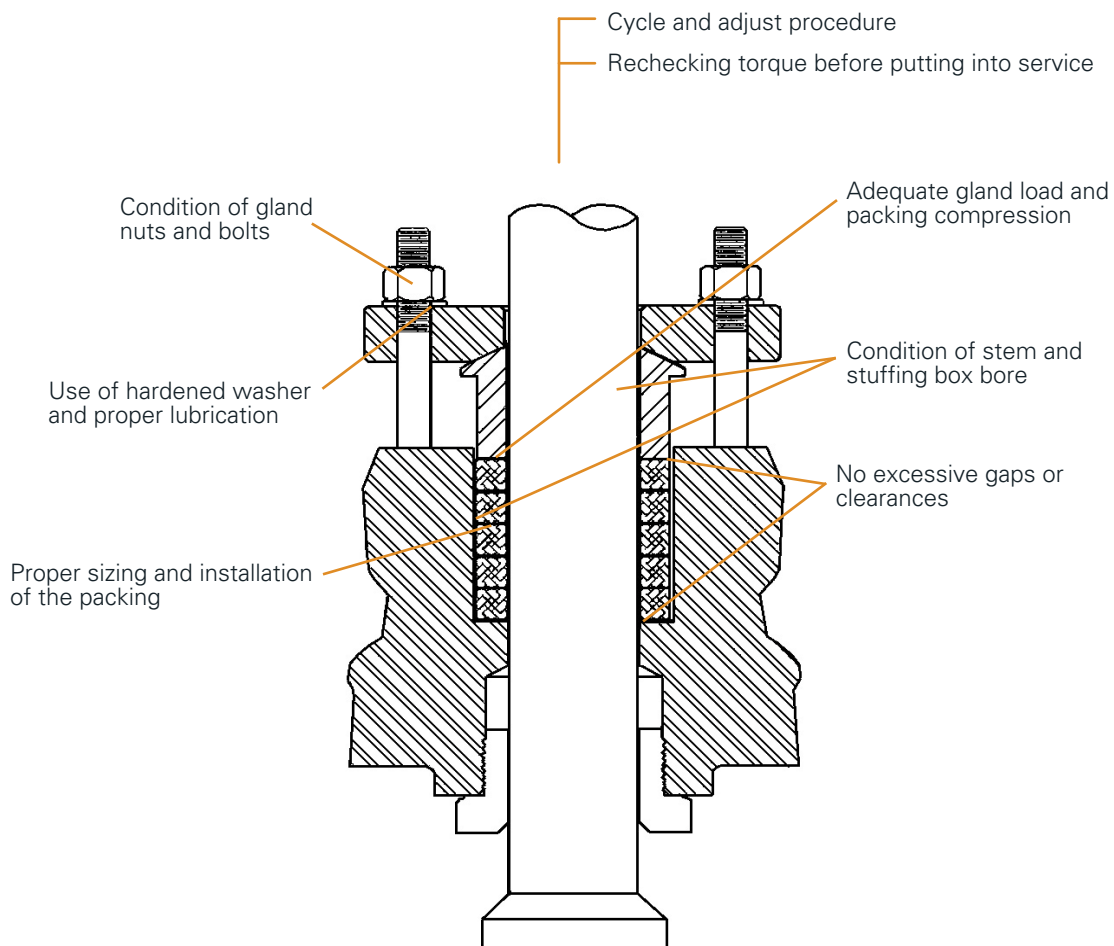
These are general instructions intended for qualified valve stem packing installer. If in doubt, installer should get assistance from qualified installer familiar and trained for this kind of installation or can contact a Garlock representative. Product style should be used according to specifications. User assumes the responsibility of choosing and using a specific product into particular service conditions.

SECTION 2

Packing Performance Considerations

Here are important factors to consider for achieving the best packing performance:

- » Valve must be inspected for any damage prior to new packing installation and prior to being put in service.
- » Packing needs to be sized to fit correctly and then installed properly.
- » Use of lubricant on gland fasteners is necessary to ensure correct load transfer and prevent wear.
- » Lubricant must not contain material that could potentially generate volatile organic compound during normal service.
- » Upon putting valve into service, the packing gland load must be checked so that it is according to manufacturer recommendations; measure gland nut torque and adjust if necessary.
- » Within (2) weeks of installation and putting into service, a facility must check that the packing gland nut torque (load on packing) is according to the manufacturer's recommendation.



SECTION 3

Troubleshooting

Troubleshooting and failure analysis requires information gathering. It requires getting familiar with the sealing materials, the process equipment, and the systems in which they are used.

WHO?

Investigation starts with seeking information from the people that work with the equipment on a regular basis. Seal installers, maintenance personnel, operators, process engineers and others can all shed light on potential causes of failure. Some key questions include:

- » How is failure defined – excessive leakage? Excessive friction load?
- » Is this application the source of chronic seal failures, or was this an unexpected event?
- » Were there any changes to the seal material, the equipment, or the overall process that preceded the failure?
- » Were there any system upsets or cleaning cycles that preceded the failure?
- » Can you describe the installation procedure?

WHAT?

Gather information about the product used. Knowing the limitations of the sealing product is the first step in the troubleshooting. The acronym “STAMPS” will help you to remember the key elements to ensure that the right packing is selected for the application:

S – SIZE:

Is the correct packing cross-section being used? Are the rings cut or formed to the correct length?

T – TEMPERATURE:

Check the system temperature against the packing manufacturer’s established temperature ratings for the product.

A – APPLICATION:

Some packing products are made specifically for valve stem sealing; others are intended for rotating equipment or to be used as static seals. Check to make sure that the packing is suitable for the equipment in which it is being used.

M – MEDIA:

Media refers to the fluid being sealed. Check with the manufacturer or with compatibility charts to be sure that the seal material is compatible with the media. If the media is toxic, explosive, or required to be contained within certain maximum allowable leakage requirements, a packing must also be selected on the basis of its ability to seal at very low levels.

P – PRESSURE:

Check the system pressure against the packing manufacturer’s established pressure ratings for the product.

S – SPEED:

This is an important element for rotating equipment but it could also be important in valves that are auto-operated or need to adjust quickly. The performance could be affected by packing to stem friction like in control valves.

WHERE?

Examine the condition of the equipment. Most packings are robust seals that can handle less than perfect equipment condition, but there are limits to the amount of degradation they can withstand. Also, performance requirement can dictate what can be tolerated or not. Low Emission requirement is a good example.

- » Valve stems should be checked for scratches, corrosion pitting, and general surface roughness. Rough surfaces can damage the sealing surface and result in excessive leakage and quick wear of the seal.
- » Excessive clearances at the top or bottom of the stuffing box can lead to extrusion of the seal material, intrusion of large solid particle into the seal area. In very severe cases excessive clearance may result in a seal blowout.



Figure1. Extrusion

- » Stem runout can “wallow out” the inside diameter of the seal. Misalignment may result in stem/stuffing box offset that causes one side of the packing set to be heavily compressed while the other side is compressed much more lightly. A side loading of a packing set can occur in large horizontally oriented valves where the packing is forced to bear the weight of the stem.
- » Check to make sure all the parts are in place. During the breakdown, repair, and reassembly of equipment it is possible to misplace parts. Equipment might be put back into service without seat rings, bushings, lantern rings, o-rings, and other parts that are essential to proper equipment operation.

Troubleshooting

FORENSIC ANALYSIS

Examination of expired packing can tell a great deal about the cause of failure and the action that may need to be taken to correct the problem.

Ideally, the whole packing set should be removed and the pieces should be arranged in the same order that they were taken out. The set can then be re-constructed outside of the stuffing box and examined for clues. If the entire set of packing cannot be retrieved, then pieces or photos of the remains may still prove helpful.

THE USUAL SUSPECTS

The lineup below gives some of the most common causes of packing failure. By looking at the failed packing, you might recognize some of the telltale signs that are left by these common modes of failure. Once they are detected, action can be taken to make sure that their threat is reduced or eliminated.

PACKING LOAD

It is important to adjust packing load to manufacturer specification before putting the valve into service to ensure proper sealing of the packing. Packing consolidation can happen over time in valves that have been in storage or in transit for a while. This can result in a loss of gland load and leakage. Some valve designs could be more affected than others by these circumstances.

IMPROPER INSTALLATION

Signs of improper installation can usually be seen upon examination of the failed packing set.

- » Packing should be cut and installed as individual rings with cut ends that meet after they are twisted around the stem. It should not be installed as a continuous length that is "spiraled" into the stuffing box.
- » Packing rings that have bulges in the axial direction are indicative of rings that are either cut too short or too long. This creates gaps or overlaps at each ring generating an irregular surface for each successive packing ring and an associated uneven loading of the packing set.
- » Each ring should be installed and seated into the bottom of the stuffing box before the next ring is installed. If rings are not seated properly this can result in heavy compression of the rings at the top of the set, while the rings deeper in the box are compressed very little. In this case the packing may be very sensitive and hard to control with adjustments.
- » The gland follower should be adjusted evenly so that the packing is not compressed more on one side than the other. This will also help to prevent "cocking" of the gland follower and the possibility of metal-to-metal contact with the stem.

- » Gland bolts and nuts need to be in new or near new condition and run freely on the threads. This is necessary to ensure that nut torque load is transferred properly to gland follower and packing set. An anti-seize lubricant needs to be applied on gland nuts and bolts. Use of hardened flat washers is highly recommended to prevent wear and damage to fasteners and flange.



Figure 2: Improper installation: packing out stuffing box

ABRASIVE WEAR

Abrasive wear of packing is recognized by the loss of material on the inside diameter of the packing set. While the top, bottom, and outside diameter surfaces of the set may look new and in good condition, the inside diameter is abraded to form leak paths. Abrasive wear is usually a result of solid particles in the media working their way into the stuffing box with leakage. The use of more abrasive resistant packing end rings can help wipe the stem and keep particles out from the packing set.



Figure 3: Abraded Packing

Troubleshooting

EXCESSIVE HEAT

Heat can come from many different sources. In valve applications, the most direct source of heat is from the fluid being sealed, however some valves may be simply soaked in heat from the surrounding environment. Exposure to air at high temperature along with oxidizing media will affect the graphite in the packing.

CHEMICAL ATTACK

Strong Acids and bases may cause damage ranging from weakening of the fibers to complete disintegration of the packing material. If the packing is made from several different ingredients, a strong acid or base may selectively attack some ingredients while leaving others untouched.

Strong solvents may also attack certain synthetic fibers, or they may dissolve and wash out grease or oil lubricants. Over time this may result in a very dry packing that does not seal well even under high compressive loading.

Strong Oxidizers will attack most packing materials with the exception of PTFE. The problem of chemical attack is usually solved by changing to a more resistant seal material.

GALVANIC CORROSION

By understanding the conditions under which galvanic corrosion can occur and by using readily available compression packing products with appropriate corrosion protection, galvanic corrosion is a problem that can be eliminated from your packing gland.

The following are several examples in which corrosion inhibitors would be recommended to prevent corrosion in equipment made of less resistant alloys such as martensitic stainless steel:

- » Valves and pumps that are hydrostatically tested are often stored in a wetted condition. They should be dried after the test even with packing containing corrosion inhibitors.
- » Steam service valves that will undergo cold downtime periods because, depending upon the valve's position within the piping system, some may be exposed to water or condensate during the cold exposure period.
- » Equipment that is located in an outdoor environment in which rain water can collect in the top of the stuffing box between the gland follower and the stem.
- » Valves that are under constant moisture exposure due to their intended service conditions.



Figure 4: Galvanic corrosion

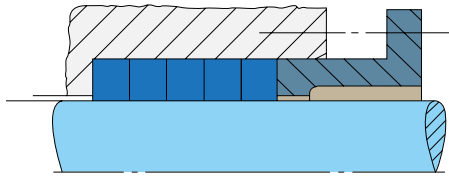
SECTION 4

Common Causes for Packing Failure

It is not always clear why a packing fails, however by carefully checking the used packing rings, the causes can often be found.

ISSUE:

One or more rings in the set are missing.

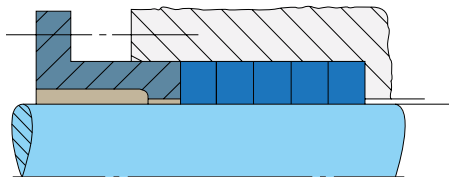


CAUSE:

The clearance between stem and housing is too large, allowing an extrusion of the packing into the system. Installing end rings or mounting bushings in the stuffing box is recommended.

ISSUE:

Parts of the packing are found between stem and gland follower.

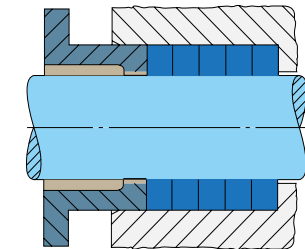


CAUSE:

The clearance between shaft and gland follower is too large. Restoring proper clearance will prevent packing extrusion and should solve the problem.

ISSUE:

The packing exhibits wear along the stem and the radial thickness of the packing is uneven.

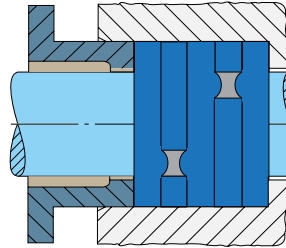


CAUSE:

The stem has excessive runout, warping or deflection compressing packing radially in one area. Valve stem needs to be repaired and or re-aligned.

ISSUE:

Rings show uneven surface that is against adjacent ring.

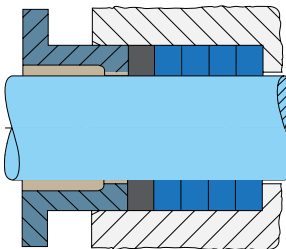


CAUSE:

One or more rings have been cut too short causing the compressed adjacent ring to fill the empty space.

ISSUE:

The bottom rings show no or little compression compared to the top ring.



CAUSE:

Not enough load was applied to the gland and /or cycle and adjust procedure was not performed correctly to distribute the compressive load throughout the packing.

SECTION 5

LDAR - Leak Detection and Repair

EMISSION CONTROL

Valve stem leakage is the largest contributor to the fugitive Emissions (FE) of any plant processing volatile organic compounds (VOC) and hazardous air pollutants (HAP).

This leakage, in most cases, can be prevented with correct maintenance and with the use of high performance compression packing.

HOW CAN THE LEAK DETECTION AND REPAIR PROGRAM HELP WITH OUR PRODUCTS?

Consent decrees issued by Justice Department, require the use of certified low emissions valve and packing.

Enhanced LDAR used by the Environmental Protection Agency (EPA) will describe actions that plants must take to attain and go beyond regulatory compliance. Enhanced LDAR covers a number of elements such as quality control, training, monitoring, repairs and most notably, equipment upgrades. These upgrades include, requiring use of "low leak" or low emissions (LE) valve and its compression packing. More specifically:

- » New installed valves must be LE.
- » Re-pack or replace valves that leak above 250 PPMv (Chemical) with LE products.
- » Re-pack or Replace valves that leak above 500 PPMv (Refinery) with LE products.

A LE valve (including its packing) is defined as a valve for which the manufacturer has issued a written warranty that it will not emit fugitive emissions at greater than 100 PPMv in the first 5 years of service and if otherwise, will offer a replacement.

Garlock pioneered the development of LE packing in the 1980s and has continued to refine and widen its product offering through the years to meet stringent performance requirements and best suited maintenance program needs.

Our sealing solutions meet or exceed the requirements of many recognized international standards and we offer our limited performance warranty on these products. Our highly trained technical support experts will help find the most appropriate solution and supply precious advice.

GARLOCK WARRANTY

Garlock will warranty that these sets will provide leakage rates no greater than 100 ppm above background in VOC service for a period of 5 years, when installed and maintained in accordance with Garlock installation instructions and warranty conditions**.

**Warranties are generally subject to valve conditions and installation practices. For more information, please refer to our Warranty Conditions and Requirements available on our website.

SECTION 6

Low E Packing Warranty

GARLOCK STYLE #1303-FEP

100 PPM VALVE PACKING WARRANTY

This warranty applies to valves operating in refinery or chemical service when packed with five (5) rings of style #1303-FEP using the 5-ring set configuration. When installed in accordance with warranty conditions specified herein, compressed, and maintained according to Garlock instructions, conditions, and guidelines, these sets will provide leakage rates no greater than 100 ppm above background in VOC service. If rates of leakage above 100 ppm are detected pursuant to EPA Method 21 (40 CFR 61.245(b)) and the customer can demonstrate to the satisfaction of Garlock that they met all of the Warranty Condition Requirements specified herein, then for a period of five (5) years from the date of shipment of the packing sets by Garlock, Garlock will provide a replacement packing set free of charge to the customer.

Warranty Condition Requirements

1. The stem must have a relatively smooth and clean surface with no score marks or concentrated pitting areas being present.
 - » The stem finish shall be no greater than 32 (Micro Inches) AARH.
 - » There should be no noticeable stem warpage or runout.
 - » The bottom of the gland follower must be flat.
2. Stuffing boxes that contain burrs on the stem and/or box bore walls are expressly excluded from this warranty.
3. Installation, compression, and adjustment guidelines:
 - » Initial Installation - Multiple step installation, compression, and cycle/adjustment procedures must be utilized in accordance with the guidelines provided for the above product as identified by Garlock 1303-FEP Installation Instructions dated 01/16 or after.
4. System and media temperature should not exceed 755°F (400°C). Other media/exposure conditions must also be within the recommended Garlock guidelines for Garlock Style 1303-FEP.
5. Valves with a stuffing box depth greater than five (5) rings will be eligible for warranty only if a bushing system, approved by Garlock, fills the remainder of the stuffing box. Control valves recording 5,000 or more cycles between maintenance intervals or those which constantly modulate must be live-loaded, utilizing a Garlock-designed spring washer arrangement.
6. A packing set warranty will be applicable if it can be demonstrated to the reasonable satisfaction of Garlock that repeated attempts to additionally compress/adjust the set were unsuccessful to reduce leakage below 100 ppm above background.
7. This warranty shall apply only to valves packed either as the result of a completed Garlock valve survey or through the use of an authorized and/or certified Garlock valve repair / Installation Company. Style 1303-FEP packing must be provided through an authorized Garlock distributor and installed by an authorized and/or certified Garlock valve repair/installation company.
8. The warranty will only apply to products for which a copy of the Garlock Product Performance Tracker (Form PPT-1) is completed, signed, and returned by an appropriate representative of the end-user, the repair/installation company, and Garlock.

STANDARD TERMS AND CONDITIONS OF SALE

SELLER warrants that any product of its manufacturer, which upon examination is found by a SELLER's representative to be defective in either workmanship or material under normal use and service, will be, at SELLER's option, repaired or replaced free of charge including lowest transportation charges but not cost of installation or removal, or have the purchase price refunded, provided that SELLER receives written claim specifying the defect within ninety (90) days from date of distributor sale or one (1) year from date of factory shipment, whichever occurs first. In no event shall SELLER be liable for any claims, whether arising from breach of contract or warranty or claims of negligence or negligent manufacture, in excess of the purchase price. ALL OTHER WARRANTIES EXPRESSED AND IMPLIED INCLUDING ANY WARRANTIES OF MERCHANTABILITY AND FITNESS FOR PARTICULAR USE ARE HEREBY DISCLAIMED. The forgoing expresses all of SELLER's obligations and liabilities with respect to the quality of items furnished by it and it shall under no circumstances be liable for consequential, collateral or special losses or damages.

SECTION 7

Packing Installer Program

This program is available from Garlock and offers comprehensive valve packing Installation training on materials and procedures to ensure:

- » Safety
- » Reduced Emissions
- » Reduced Maintenance

Please contact your Garlock representative for more information.

Appendix A

GLAND BOLT TORQUE CALCULATION METHOD

For Low Emissions Services

1. Calculate the packing surface area (A)

$$A = \frac{(D^2 - d^2) \pi}{4}$$

Where: D = Stuffing box bore (in)
d = Stem diameter (in)

2. Calculate the force on the gland follower (F)

$$F = A \times LF$$

Where: A = Packing surface area (sq in)
LF (load factor) = 8500 psi

3. Calculate the gland bolt torque (T)

$$T = (K \times F \times \phi) / B$$

Where: T = Torque on each bolt (in-lbs)
F = Force exerted by gland (lbs)
 ϕ = Gland bolt diameter (in)
B = Number of gland bolts
K = Nut Factor of 0.2

Combining all the above into a single Equation:

$$T \text{ (in-lbs)} = \frac{[(0.2) (D^2 - d^2) (\pi) (8500)] \phi}{(4) B}$$

Simplifying and using a 1/12 conversion factor to convert from in-lbs to ft-lbs:

$$T \text{ (ft-lbs)} = \frac{111.3 (D^2 - d^2) \phi}{B}$$

Appendix B

GARLOCK VALVE STEM PACKING S.A.F.E. TAGS

Garlock will supply tags to attach to the valve for identification and to record installation information. Please contact Garlock distributors or send a request through our web site.



GARLOCK

an *EnPro* Industries family of companies

Tel: 1-877-GARLOCK / 315.597.4811

Fax: 800.543.0598 / 315.597.3216

www.garlock.com

GST

GPT

Garlock Australia

Garlock do Brasil

Garlock de Canada, LTD

Garlock China

Garlock Singapore

Garlock Germany

Garlock India Private Limited

Garlock de Mexico, S.A. De C.V.

Garlock New Zealand

Garlock Great Britain Limited

Garlock Middle East