High Quality Packing Systems

Figure 1: Valtek Mark One Control Valve

Introduction

This brochure provides information for selecting and specifying packing systems and bellows for control valve applications. Packings are classified as either **environmental** or **non-environmental**. This document is broken into two sections. The first section is dedicated to enviromental packing options, the second part is dedicated to standard packing options. Environmental packings are the most effective and reliable and are used in linear or rotary applications requiring leakage levels to be less than 500 parts per million (ppm). These packings generally have more restrictive application envelopes than non-environmental packings. Most of the fluids and gases in environmental packing applications are volatile and contain hazardous air pollutants. When released from a valve, they can have the following negative consequences:

1. Personnel working near the leak are subject to dangerous conditions.
2. Valuable process fluid is wasted, increasing operating costs.
3. Hazardous chemicals escaping may cause harm to the environment.
4. Current and future government regulations may be violated, subjecting the plant operator to added costs (monitoring, maintenance and paperwork), fines and restrictions.

The first part of this brochure details the environmental packing alternatives and specifications and the latter part of this document details the non-environmental packing alternatives and specifications. The Guardian II Metal Bellows Seal is briefly presented and referenced in the environmental packing alternatives.

Valve Designs to Enhance Packing Performance

For years, Flowserve has recognized a fine stem finish on the bonnet bore and the valve stem or shaft improves sealability, packing life, and reduces packing friction. Flowserve also recognized to maintain a high degree of sealability and prolonged packing life, the stem or shaft must be centered in the packing bore. In all Valtek Mark One control valve designs, the packing follower doubles as a guide for the valve stem or shaft, keeping the packing from uneven wear or compression. Corrosion resistant, external live-loading is optional on all packing sets and standard on two packing sets. Large-diameter stems and shafts additionally contribute to good sealing by minimizing bending and deflection from process pressure drops.

All linear globe valves also feature deep bonnet bores to allow for a lower packing set that acts primarily as a wiper set to protect the upper sealing set from foreign particle damage and erosion. These deep bores also allow for long distances between the upper and lower guides to prevent stem radial deflections in the packing area. These valves also incorporate metal anti-extrusion rings between the packing and the guides to prevent packing extrusion.

All Valtek packing systems are free of asbestos and other substances that may be harmful to maintenance personnel.

High Quality Packing Systems

Figure 2: Mark One with a high-quality packing system - no leakage

Figure 3: Ineffective packing systems allow process leakage

Valtek Control Valve Environmental Packing System Alternatives

Flowserve offers six environmental packing system alternatives to meet the requirements of 500 ppm applications: SafeGuard™, SureGuard™, SureGuard XT, Double Graphite, Garlock 9001 Quickset®, and Chesterton 5800®. Table I lists these packing systems and provides information to assist the user in optimizing the selection based on temperature, pressure, options required and relative sealing performance, friction and expected service life. Although each of these packing systems may withstand higher temperatures and pressures, the reliability and life expectancy of the packing will decrease. Flowserve engineering should be contacted before any packing system is specified outside of its temperature and pressure limitations or if the chemical compatibility of the packing with the process is questioned.

Linear and Rotary Packing System Differences

All of the figures shown in this bulletin show a representative Mark One linear bonnet. However, with few exceptions, rotary products such as Valdisk, ShearStream and MaxFlo accept all standard and optional packing configurations shown. Temperature and pressure guidelines are valid for linear or rotary valves.

Rotary valves typically do not utilize guide liners on the upper guide and the lower guide is replaced by a thrust washer which serves as a packing support and shaft guide. Most rotary packing boxes are not deep enough to accept twin, firesafe, V-ring packing arrangements. The number of V-rings used may also vary because of shallower packing bores.

High Quality Packing Systems
Environmental Packing Options

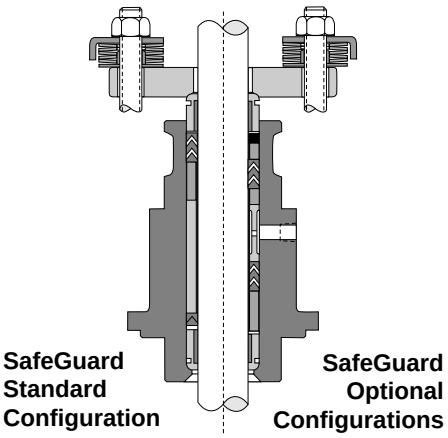


Figure 4: SafeGuard Standard and Optional Configurations

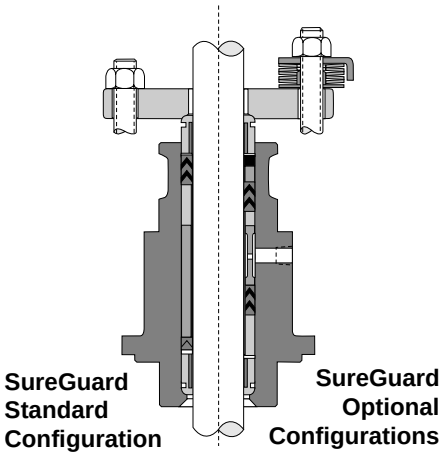


Figure 5: SureGuard Standard and Optional Configurations

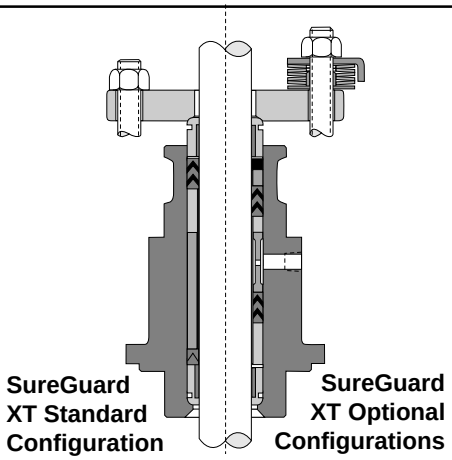


Figure 6: SureGuard XT Standard and Optional Configurations

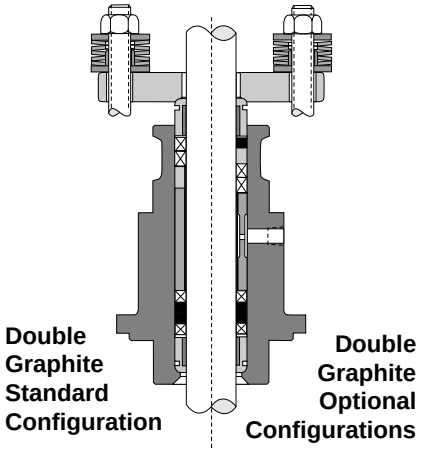


Figure 7: Double Graphite Standard and Optional Configurations

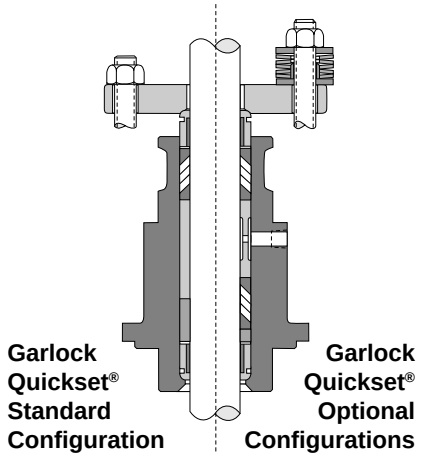


Figure 8: Garlock 9001® QuickSet Standard and Optional Configurations

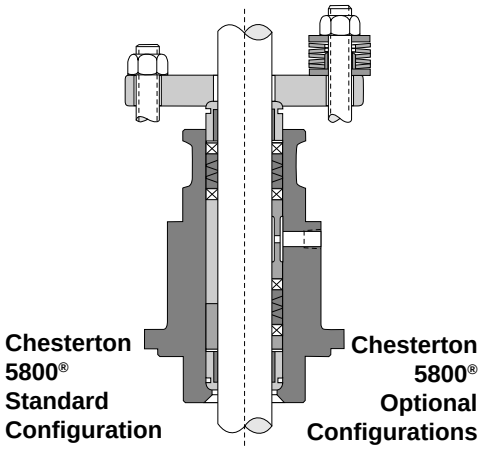


Figure 9: Chesterton 5800® Standard and Optional Configurations

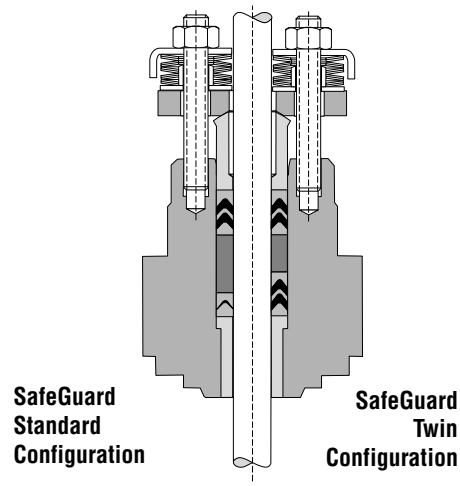


Figure 10: SafeGuard Configurations for Valtek 2000

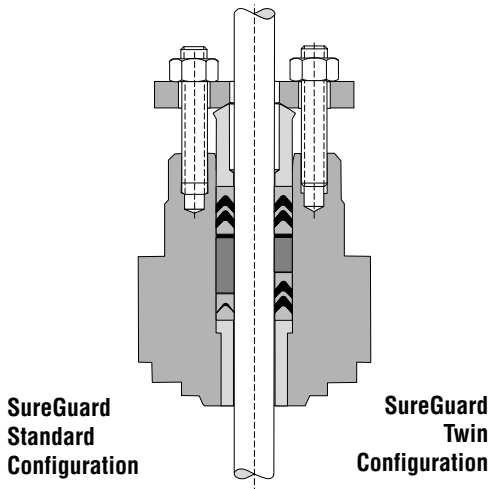


Figure 11: SureGuard Configurations for Valtek 2000

High Quality Packing Systems
Environmental Packing

Table I: Environmental Packing - Selection Guidelines

Fugitive Emission Packing for 500 ppm Service											
Fugitive Emission Packing System	**Packing Type**	**Max. Pressure (psi/bar)**		**Temperature Range (1)**				**Options Available**	**Relative Sealing Performance (2)**	**Relative Friction Level (3)**	**Relative Expected Service Life (4)**
				Standard Bonnets		**Extended Bonnets**					
				°F	**°C**	**°F**	**°C**				
SafeGuard (Always Live Loaded)	Combination of virgin and filled PTFE V-ring	See Figures 1,2		-60 to 450	-51 to 232	-150 to 650	-101 to 343	Standard Twin/Purge Std. Firesafe Twin Firesafe (5) Vacuum	0.60	0.15	0.80
SureGuard	Combination of Kalrez and filled PTFE V-ring	See Figures 1,2		-20 to 450	-29 to 232	-100 to 650	-73 to 343	Standard Twin/Purge Std. Firesafe Twin Firesafe (5) Live Loading Vacuum	0.45	0.15	0.95
SureGuard XT	Combination of Kalrez and Zymaxx V- ring	See Figures 1,2		-20 to 550	-29 to 288	-100 to 750	-73 to 399	Standard Twin/Purge Std. Firesafe Twin Firesafe (5) Live Loading TA Luft Certification (6) Vacuum	0.40	0.20	1.00
Double Graphite (Always live loaded)	Combination of braided and die-formed graphite square rings	2000	136	-20 to 800 (7)	-29 to 427	-20 to 1100 (7)	-29 to 593	Standard Twin/Purge TA Luft Certification (6)	1.00	1.00	0.40
Garlock Quickset	Combination of braided and die-formed graphite cup and cone rings	1000	68	-20 to 700	-29 to 371	-20 to 1000 (7)	-29 to 538	Standard Twin/Purge Live Loading Dry (8)	1.00	0.70	0.50
Chesterton 5800	Combination of braided carbon and die-formed graphite wedge rings	1500	103	-20 to 1000	-29 to 538	-20 to 1300 (7)	-29 to 704	Standard Twin/Purge Live Loading Dry (8)	1.00	0.80	0.40

1. Temperatures are valve body temperature limits for fugitive emission service (less than 500 ppm). Exceeding these limits may increase leakage and decrease service life.
2. Normalized index where 1.0 represents highest relative leakage
3. Normalized index where 1.0 represents highest relative friction
4. Normalized index where 1.0 represents longest relative packing life
5. Twin firesafe is not available in rotary valves.
6. Live loading required for TA Luft certification. Available with standard or firesafe options.
7. The temperature of graphite packing should not exceed 800° F in an oxidizing service such as air.
8. “Dry” packing is void of binders or fillers.

High Quality Packing Systems

Environmental Packing

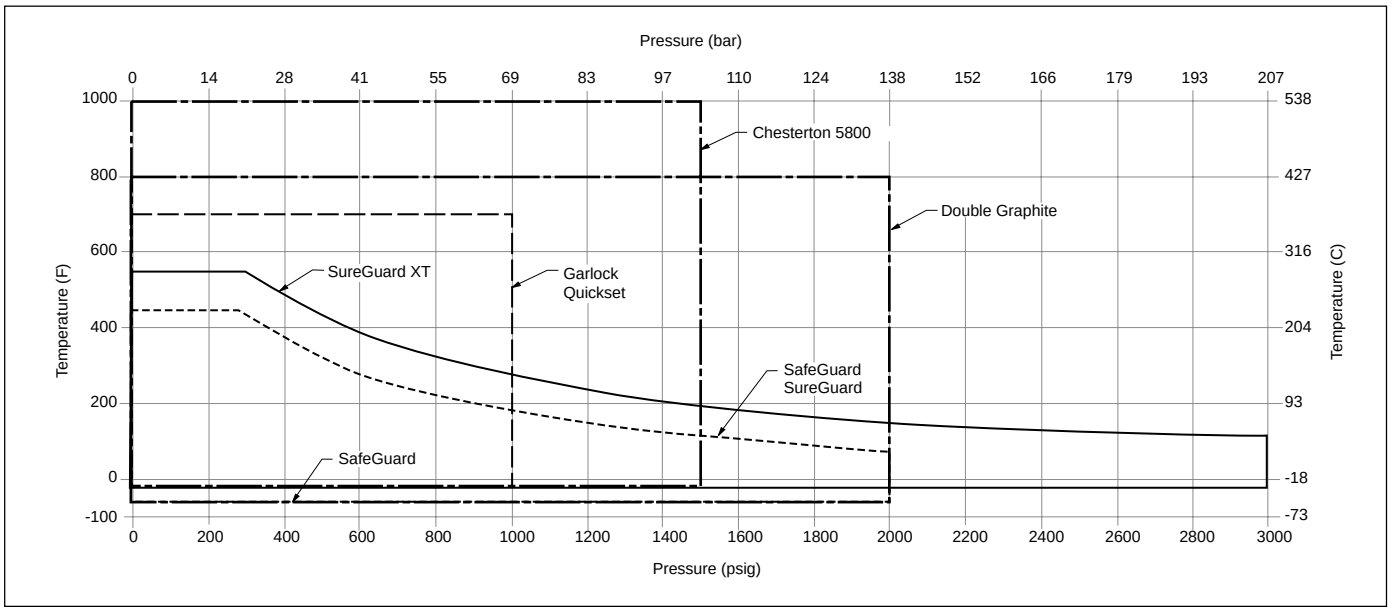


Figure 12: Environmental Packing - Temperature and Pressure Guidelines - Standard Packing Bore

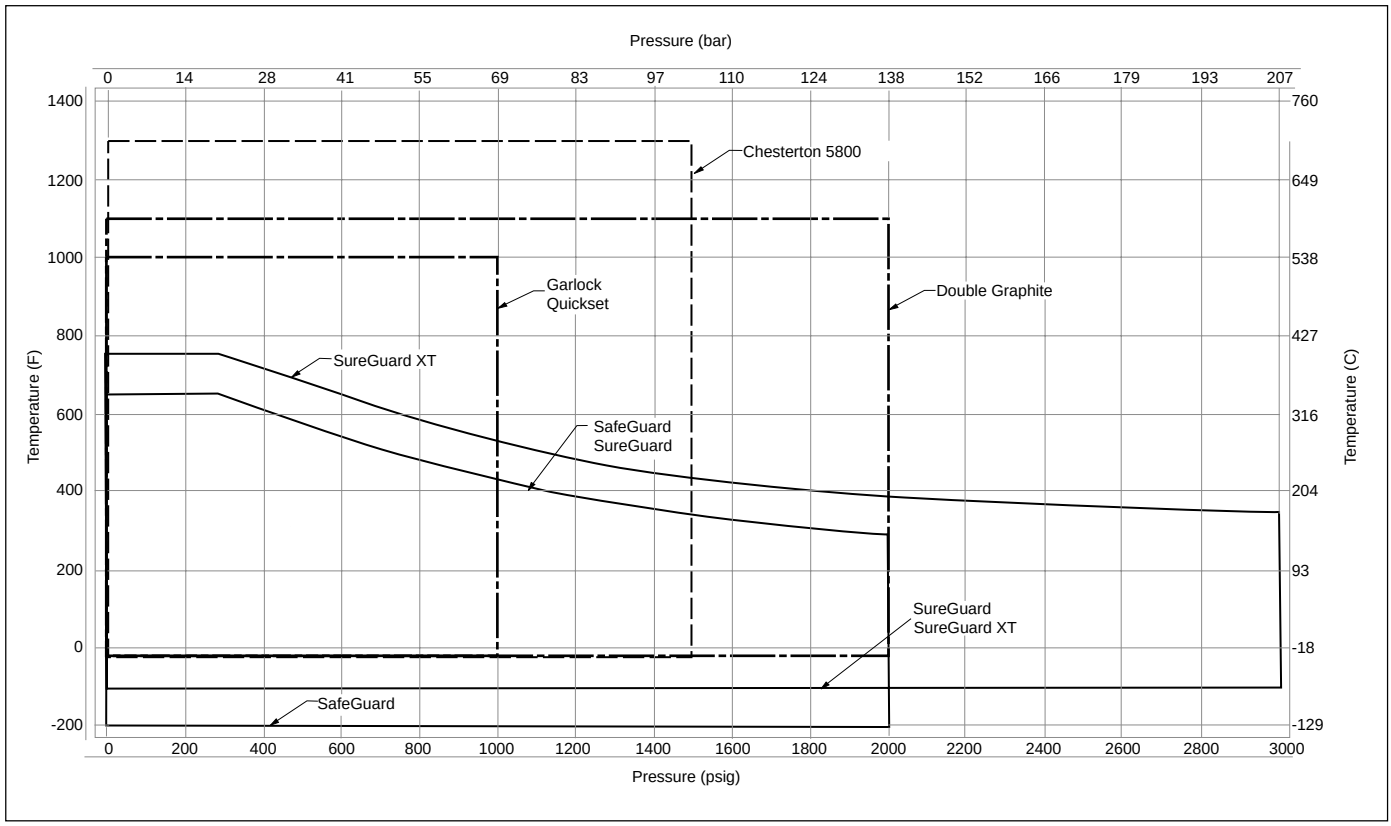


Figure 13: Environmental Packing - Temperature and Pressure Guidelines - Extended Packing Bore

High Quality Packing Systems
Environmental Packing

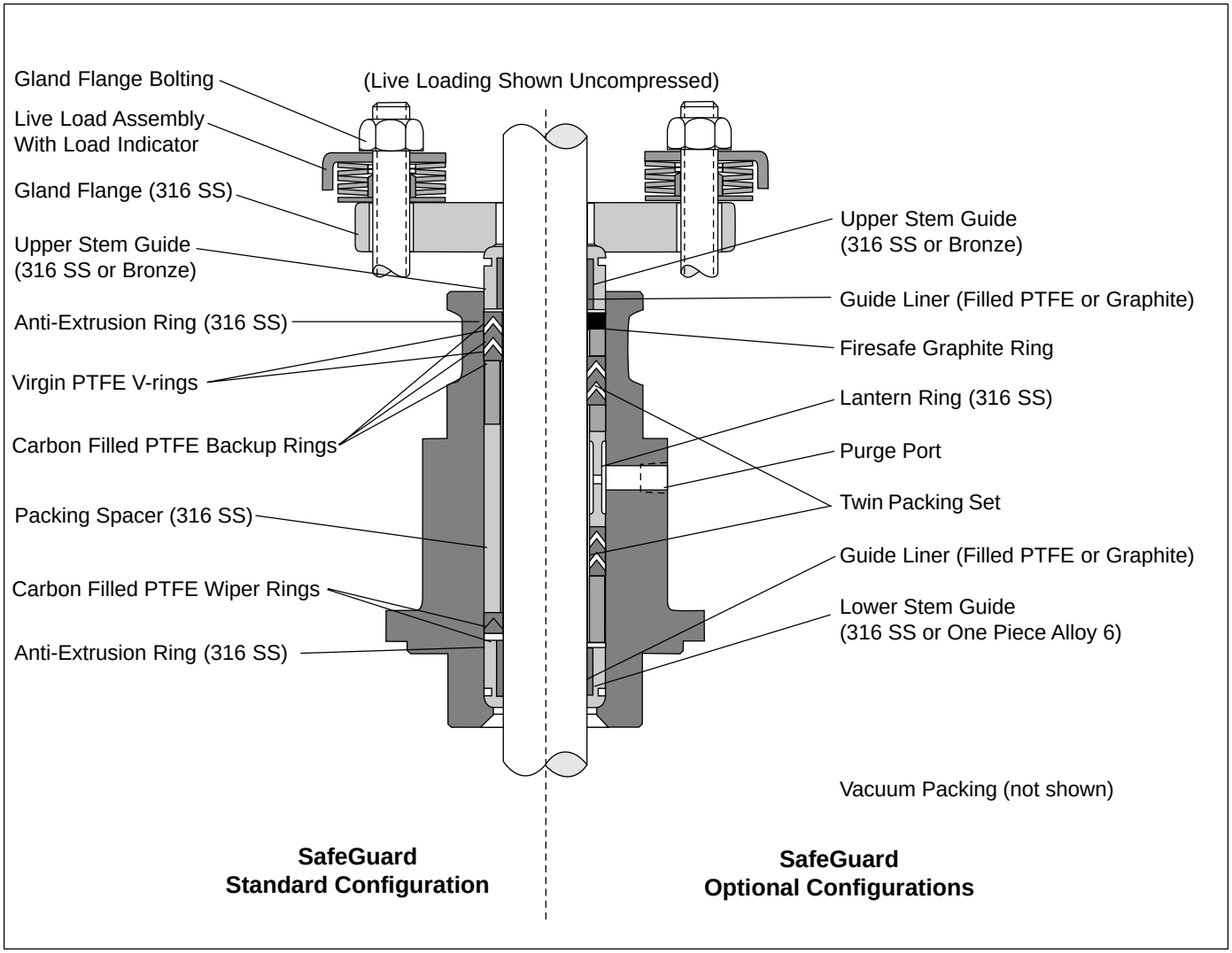


Figure 14: SafeGuard Standard and Optional Configurations

SafeGuard Packing System

The SafeGuard packing system consists of a live-loaded, virgin and carbon-filled PTFE V-ring packing set. The entire set is designed to reduce the negative effects of cold flow while enhancing PTFE's excellent sealing and low friction characteristics. The packing set is always live-loaded to compensate for PTFE cold-flow. The live-load kit has an external load indicator to ensure proper packing torque and simplified maintenance. Due to the chemical inertness of PTFE, SafeGuard can be used in a variety of processes. SafeGuard is also a more economical fugitive emission solution than SureGuard or SureGuard XT.

A fire-safe SafeGuard option is available which, in the event of a fire, will provide a seal even if the primary packing set has been rendered useless by excessive heat. The fire-safe packing design meets the intent of the American Petroleum Institute (API) 607 fire safety requirements for external leakage. A twin packing set is also available with or without the fire-safe option. Although not shown in Figure 14, vacuum packing is also available.

High Quality Packing Systems
Environmental Packing

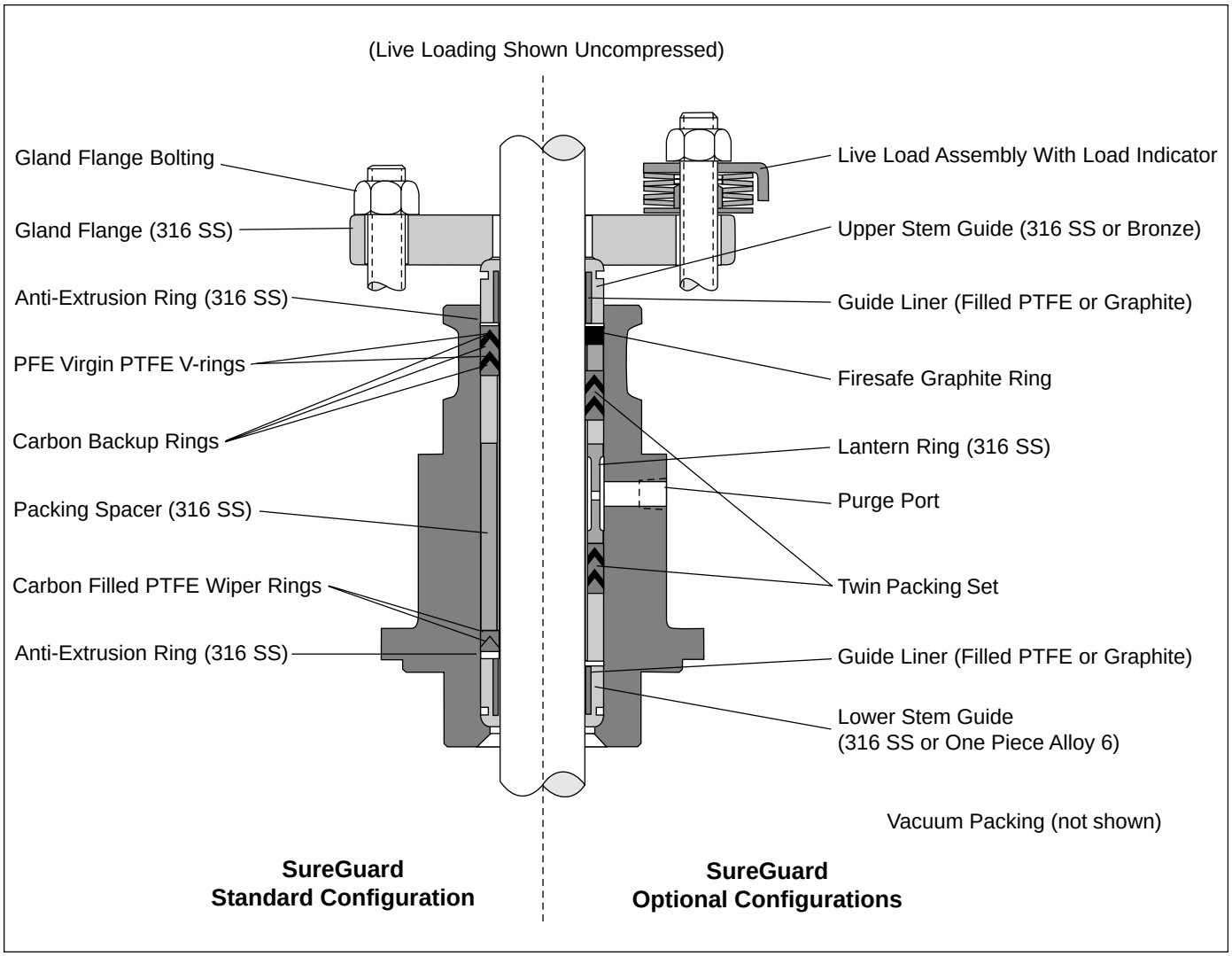


Figure 15: SureGuard Standard and Optional Configurations

SureGuard Packing System

The SureGuard packing system contains a V-ring packing set that utilizes perfluorelastomer (PFE) sealing rings and carbon-filled PTFE backup rings. This packing set utilizes the resiliency of an elastomer to maintain a tight, durable seal that will not easily cold-flow or extrude under pressure. Since elastomers under compression are inherently live-loaded, external loading is not required. However, external live-loading is beneficial in reducing maintenance in applications with frequent thermal or pressure gradients. Since PFE is nearly as chemically inert as PTFE, it can be used in many applications. This packing system is very reliable and if installed and maintained correctly, may consistently keep emission levels below 100 ppm. SureGuard is more economical than SureGuard XT.

A fire-safe SureGuard option is available which, in the event of a fire, will provide a seal even if the primary packing set has been rendered useless by excessive heat. The fire-safe packing design meets the intent of the American Petroleum Institute (API) 607 fire safety requirements for external leakage. A twin packing set is also available with or without the fire-safe option. Although not shown in Figure 15, vacuum packing is also available.

High Quality Packing Systems
Environmental Packing

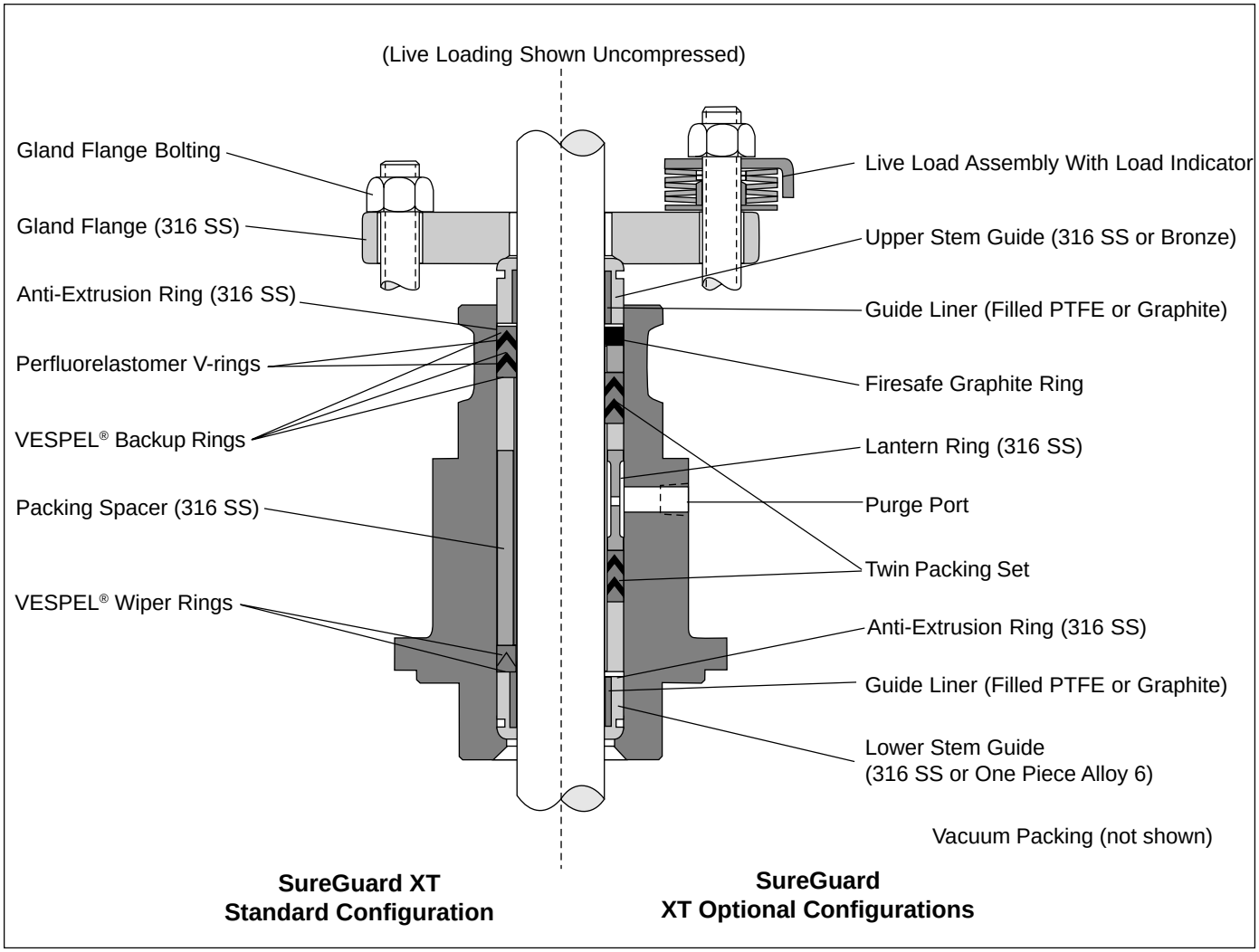


Figure 16: SureGuard XT Standard and Optional Configurations

SureGuard XT Packing System

The SureGuard XT packing system contains a V-ring packing set that utilizes perfluorelastomer (PFE) sealing rings and Vespel® backup rings. This packing set utilizes the resiliency of an elastomer to maintain a tight, durable seal that will not easily cold-flow or extrude under pressure. Since elastomers under compression are inherently live-loaded, external loading is not required. However, external live-loading is beneficial in reducing maintenance in applications with frequent thermal or pressure gradients. Vespel backup rings are utilized to extend the temperature and pressure limitations beyond the SureGuard packing system. The extrusion and cold-flow potential is virtually eliminated to provide superior sealing performance and life expectancy. This packing system is the most reliable and if installed and maintained correctly, may consistently keep emission levels below 100 ppm.

A fire-safe SureGuard XT option is available which, in the event of a fire, will provide a seal even if the primary packing set has been rendered useless by excessive heat. The fire-safe packing design meets the intent of the American Petroleum Institute (API) 607 fire safety requirements for external leakage. A twin packing set is also available with or without the fire-safe option. SureGuard XT with live loading is qualified for many European applications since it is TA Luft certified. Although not shown in Figure 16, vacuum packing is also available.

High Quality Packing Systems
Environmental Packing

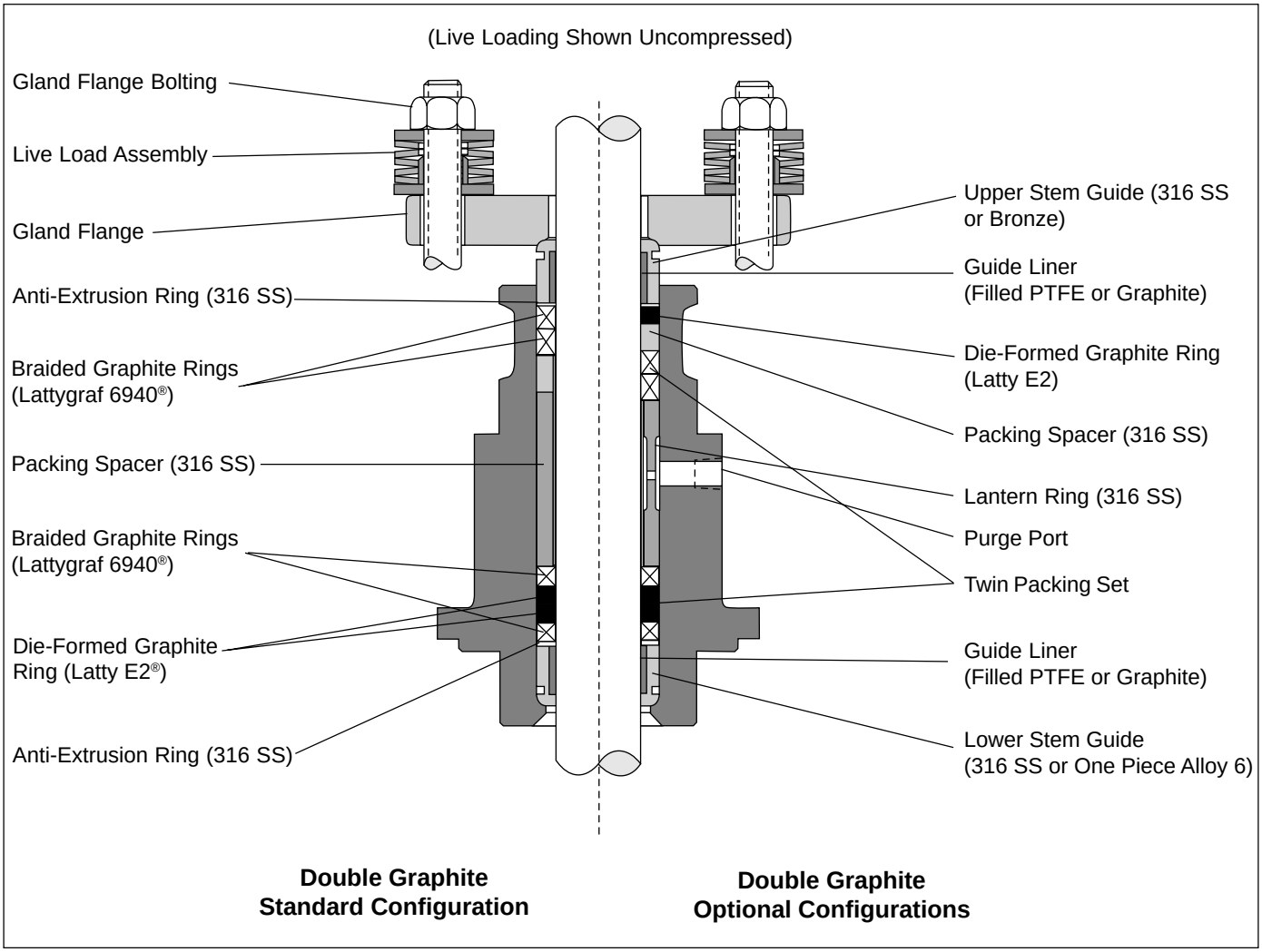


Figure 17: Double Graphite Standard and Optional Configurations

Double Graphite Packing System

The Double Graphite packing system is a unique, live-loaded, graphite packing system that utilizes braided and die-formed Latty® square packing rings. The braided rings are made from a graphite yarn that is Inconel wire reinforced and protected with a consumable anode material to protect against corrosion. The high-density, die-formed sealing rings are made from a high-purity expanded graphite, free of binders. Although this packing system has relatively high friction, it has the capability to seal at higher pressures and to seal through pressure gradients in a superior way.

Live-loading is standard on this packing set to maintain a near constant level of packing load through thermal and pressure gradients. This packing is qualified for many European applications since it is TA Luft certified. This packing is inherently fire-safe and comes with a twin packing option and a zinc anodic protection option.

High Quality Packing Systems
Environmental Packing

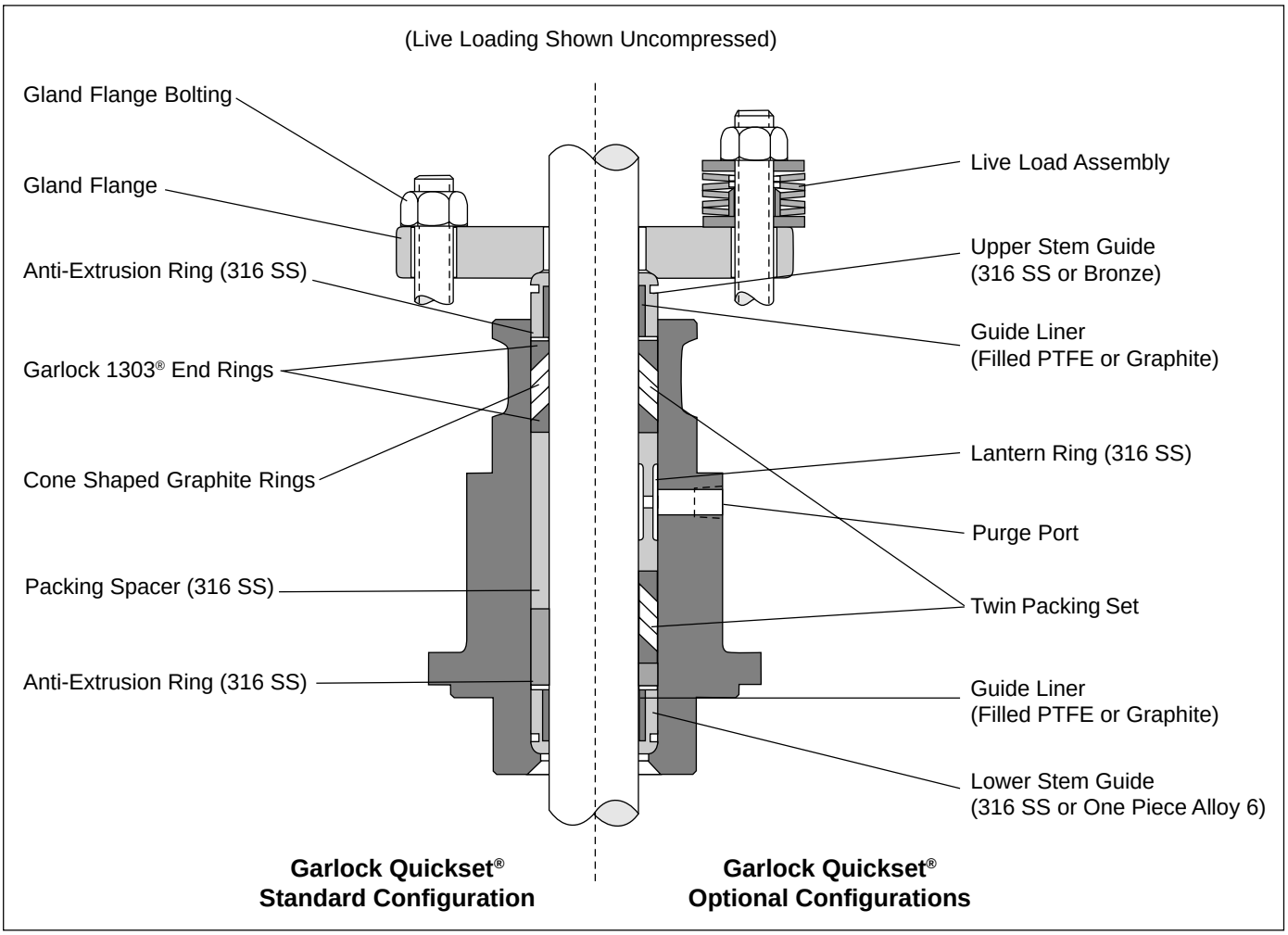


Figure 18: Garlock 9001® QuickSet Standard and Optional Configurations

Garlock 9001 QuickSet Packing System

The Garlock 9001 Quickset® packing system utilizes a unique packing set consisting of braided and die-formed cup-and-cone graphite packing rings. The sealing rings in this packing set are made of medium-density, high-purity graphite formed with an offset angle relative to the high density end rings that contain the sealing rings. This offset angle is advantageous to form a tight seal against a stem or shaft with relatively low packing gland load. This results in low friction and long life when installed and applied properly. At lower pressures, this packing is ideal for valves requiring precise control in high-temperature applications. The end rings of this packing set consist of Garlock 1303® braided graphite with an Inconel wire mesh reinforcement.

Live-loading is optional with this packing and is recommended in applications experiencing thermal gradients. Twin packing, zinc-based anodic protection and packing free of binders and lubricants are available with this packing.

High Quality Packing Systems
Environmental Packing

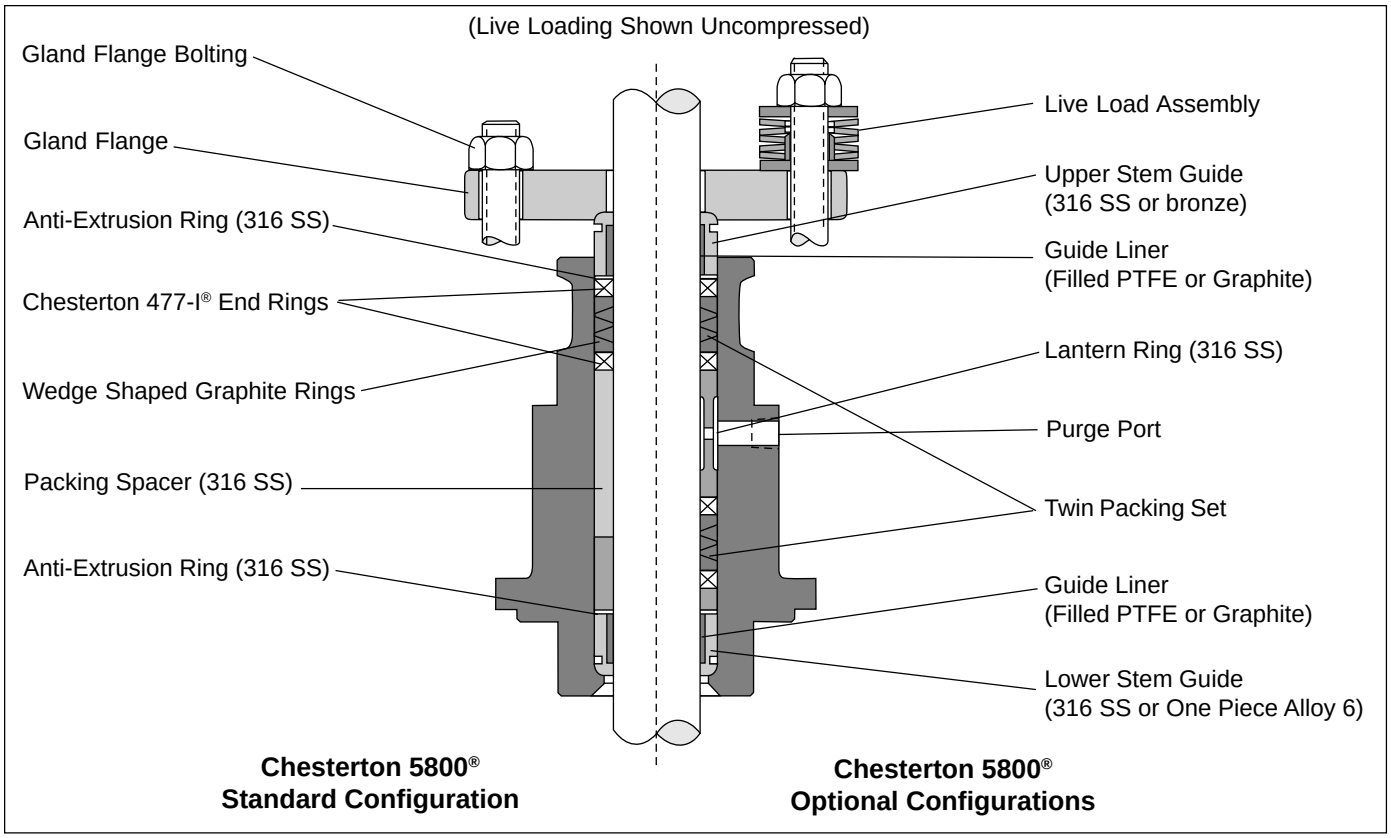


Figure 19: Chesterton 5800® Standard and Optional Configurations

Chesterton 5800 Packing System

The Chesterton 5800® packing system consists of die-formed, graphite wedge-shaped rings contained by Chesterton 477-I® square-end rings. The sealing rings in this packing set are made of high-density, high-purity graphite formed at mating angles to allow for greater radial packing movement when axial gland loads are applied. This results in an excellent stem or shaft seal with less friction than traditional square graphite packing sets. The end rings are a carbon fiber braided ring reinforced with Inconel wire. It provides stem or shaft wiping action and extrusion protection.

Live-loading is optional with this packing and is recommended in applications experiencing thermal gradients. Twin packing is also available as is packing free of binders and lubricants.

Valtek Guardian II Metal Bellows Seal

For applications requiring zero fugitive emissions, Guardian II metal bellows seal valves are available. This state-of-the-art bellows design provides full-cycle life of up to 5 million cycles while giving safe and reliable operation in precesses ranging from -320 to 1000° F (-196 to 538° C) and pressures to 1100 psig/76 barg.

The Valtek Guardian II has minimal welded joints and uses a metal shroud for additional protection. The shroud also serves as a pressure boundary increasing pressure rating and cycle life while reducing ‘bellows squirm.’

Other features include: availability of Inconel or Hastelloy C bellows, giving a broad range of fluid compatibilities; a one-gasket design that reduces potential leak paths while minimizing seals to monitor; reduced failure potential with the anti-rotation pin; standard Valtek packing materials; no special packing requirements needed; and a conservative size shorter than comparable diaphragm actuated valves. It is available in 0.5-inch through 8-inch globe valves with interchangeable, off-the-shelf parts.

More information on this product can be found in the Guardian II Metal Bellows Seal Control Valves technical bulletin available from your Valtek representative.

High Quality Packing Systems
Environmental Packing for Valtek 2000

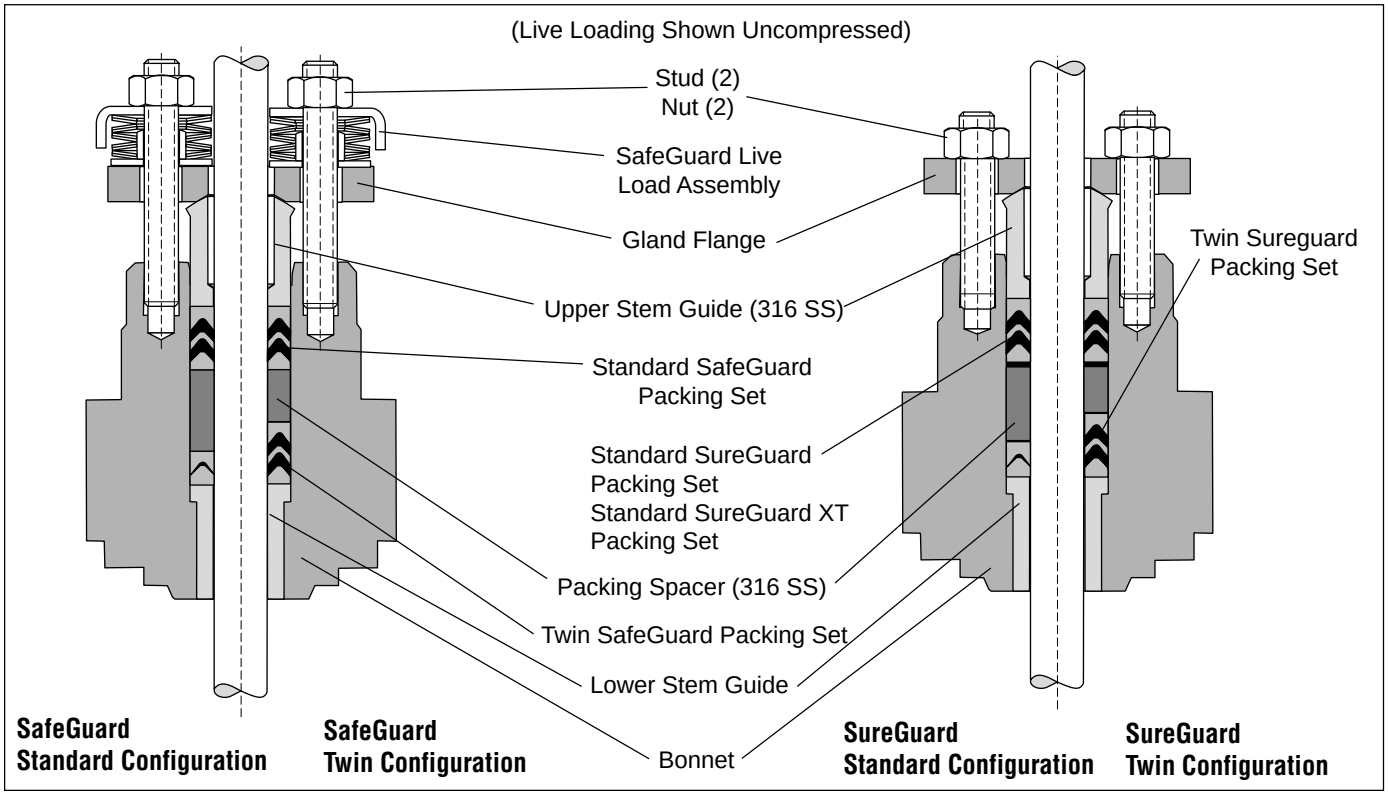


Figure 20: SafeGuard Configurations for Valtek 2000

Figure 21: SureGuard Configurations for Valtek 2000

SafeGuard and SureGuard in Valtek 2000

The Valtek 2000 utility control valve offers the standard and twin SafeGuard, SureGuard and SureGuard XT packing systems for 500 ppm service. External live loading may be used as an option.

The Valtek 2000 offers two non-environmental packing options as shown in Figures 32 and 33. A standard virgin PTFE V-ring packing is offered with internal live loading. Carbon or PTFE braided packing is also available.

The Valtek 2000 is available with Safeguard packing. The SafeGuard packing system consists of a live-loaded, virgin and carbon-filled PTFE V-ring packing set. The entire set is designed to reduce the negative effects of cold flow while enhancing PTFE's excellent sealing and low friction characteristics. The packing set is always live-loaded to compensate for PTFE cold-flow. The live-load kit has an external load indicator to ensure proper packing torque and simplified maintenance. Due to the chemical inertness of PTFE, SafeGuard can be used in a variety of processes. SafeGuard is also a more economical fugitive emission solution than SureGuard or SureGuard XT.

A fire-safe SafeGuard option is available which, in the event of a fire, will provide a seal even if the primary packing set has been rendered useless by excessive heat. The fire-safe packing design meets the intent of the American Petroleum Institute (API) 607 fire safety requirements for external leakage. A twin packing set is also available with or without the fire-safe option. Although not shown in Figure 14, vacuum packing is also available.

The Valtek 2000 is also available with SureGuard and SafeGuard XT packing. A fire-safe SureGuard option is available which, in the event of a fire, will provide a seal even if the primary packing set has been rendered useless by excessive heat. The fire-safe packing design meets the intent of the American Petroleum Institute (API) 607 fire safety requirements for external leakage. A twin packing set is also available with or without the fire-safe option. Although not shown in Figure 15, vacuum packing is also available.

High Quality Packing Systems
Non-environmental Packing Systems

Valtek Control Valve Non-Environmental Packing System Alternatives

Flowserve offers other packing systems for non-hazardous applications that may not require 500 ppm or less leakage. These systems have been used for years in many applications but may not be as reliable as the environmental packing systems and are typically more economical. These packing systems are: V-ring, braided square and combination graphite. Each of these packing systems come with material and configuration options. Table II lists these packing systems and provides information to assist the user in optimizing the selection based on the temperature, pressure, options required and the relative sealing performance, friction and expected service life.

The application limitations for non-environmental service are shown for standard packing bores in Figure 20 and for extended packing bores in Figure 21. These charts represent the acceptable temperature and pressure limitations for each packing system. Flowserve engineering should be contacted before any packing system is specified outside of its temperature and pressure limitations or if the chemical compatibility of the packing with the process is questioned.

Table II: Non-environmental Packing Selection Guidelines

Packing for Non-environmental Service											
Packing System	Packing Type and Material	Max. Pressure (psi/bar)		Temperature Range (1)				Options Available	Relative Sealing Performance (2)	Relative Friction Level (3)	Relative Expected Service Life (4)
				Standard Bonnets		Extended Bonnets					
				°F	°C	°F	°C				
Standard V-ring	Virgin PTFE V-ring	See Figures 9,10		-100 to 400	-73 to 204	-200 to 600	-129 to 316	Standard Twin/Purge Vacuum	0.50	0.10	0.85
	Filled PTFE V-ring	See Figures 9,10		-100 to 500	-73 to 260	-200 to 700	-129 to 371	Standard Twin/Purge Vacuum	0.55	0.15	0.90
Square Braided	Square braided PTFE fibers	See Figures 9,10		-100 to 500	-73 to 260	-200 to 700	-129 to 371	Standard Twin/Purge Live Loading	0.85	0.35	1.00
	Square braided carbon fibers (AFPI)	1500	102	-60 to 800 (5)	-51 to 427	-160 to 1100 (5)	-29 to 593	Standard Twin/Purge Live Loading	1.00	0.45	0.60
	Square braided graphite	3500	238	-60 to 1100 (5)	-51 to 593	-160 to 1400 (5)	-107 to 760	Standard Twin/Purge Live Loading Dry (8)	0.90	1.00	0.40
Combination Graphite	Combination of braided carbon rings and die-formed graphite square rings	4000	272	-60 to 1000 (5)	-51 to 537	-160 to 1300 (5)	-107 to 704	Standard Twin/Purge Live Loading Dry (8)	0.80	0.70	0.50

1. Temperatures are valve body temperature limits. Exceeding these limits may increase leakage and decrease service life.
2. Normalized index where 1.0 represents highest relative leakage.
3. Normalized index where 1.0 represents highest relative friction
4. Normalized index where 1.0 represents longest relative packing life.
5. The temperature of graphite packing should not exceed 800° F in an oxidizing service such as air.
6. "Dry" packing is void of binders or fillers.

High Quality Packing Systems

Non-environmental Packing Systems

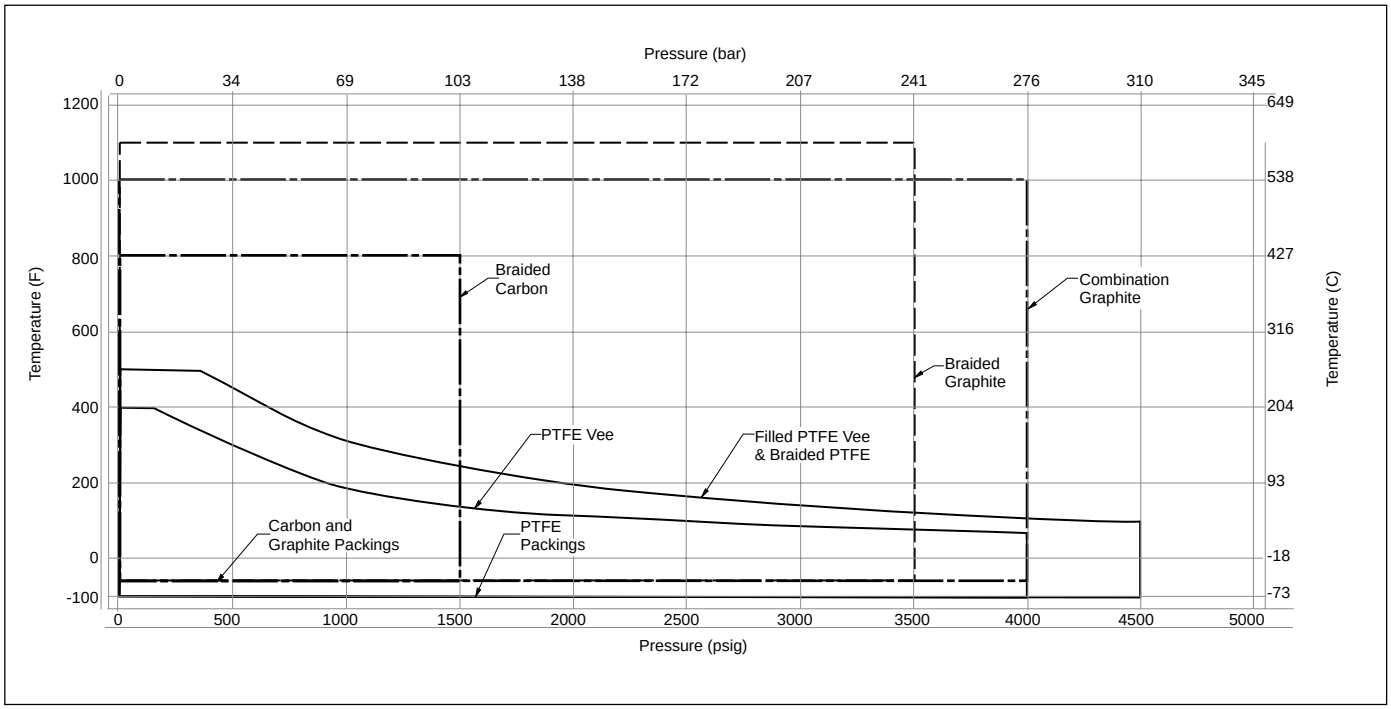


Figure 22: Non-environmental Packing - Temperature and Pressure Guidelines - Standard Packing Bore

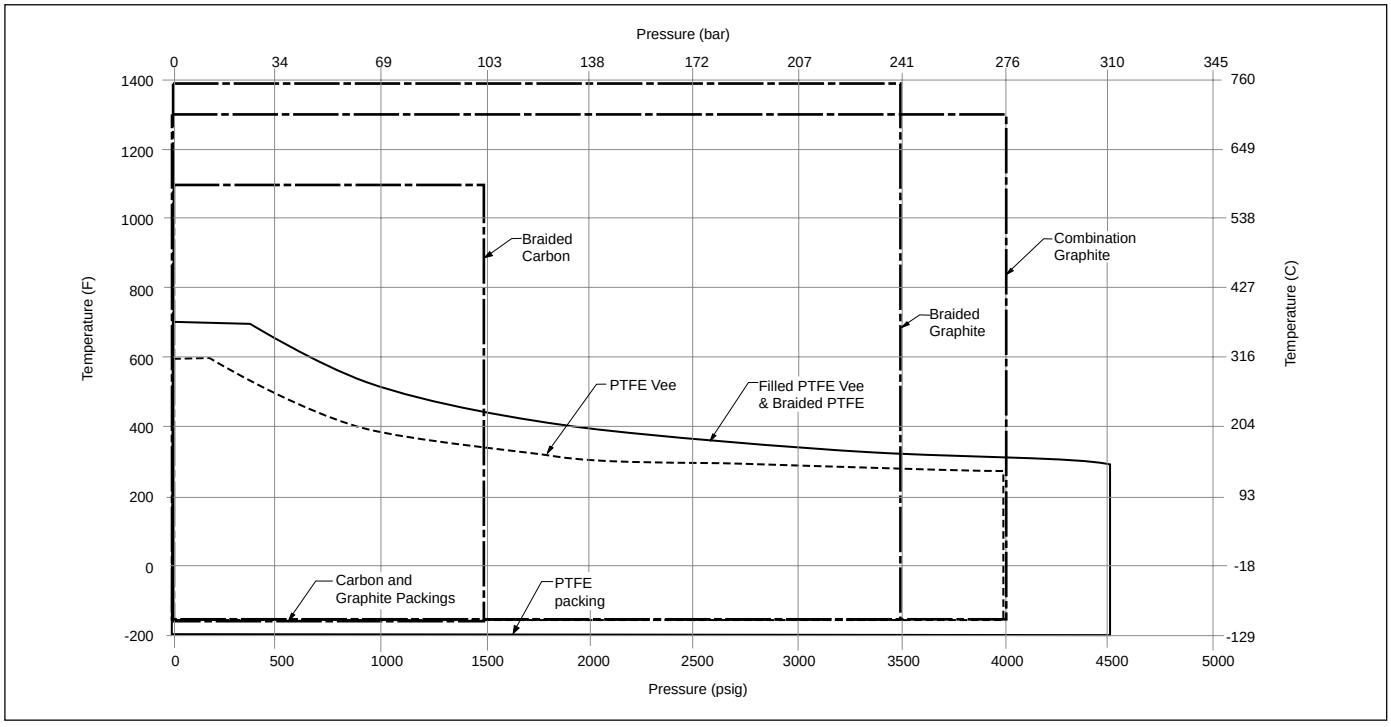
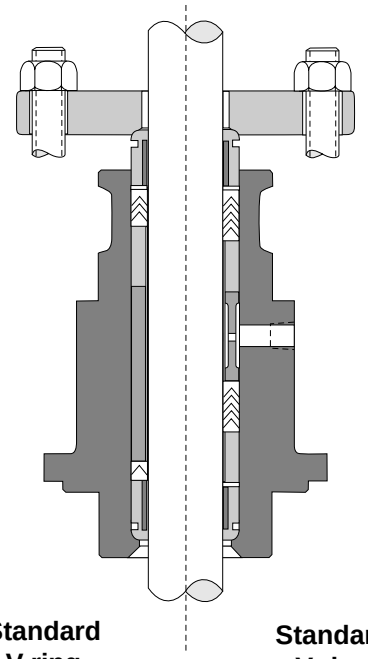


Figure 23: Non-environmental Packing - Temperature and Pressure Guidelines - Extended Packing Bore

High Quality Packing Systems

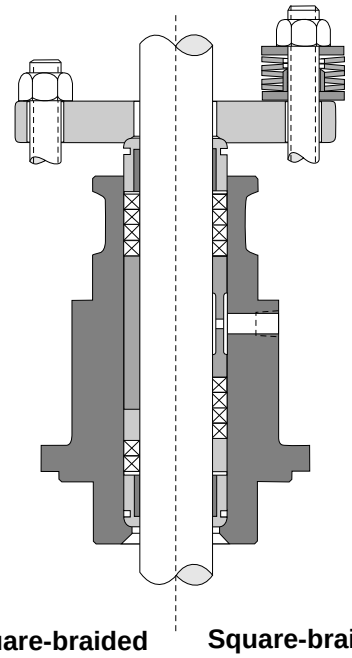
Non-environmental Packing Systems



Standard V-ring Standard Configuration

Standard V-ring Optional Configurations

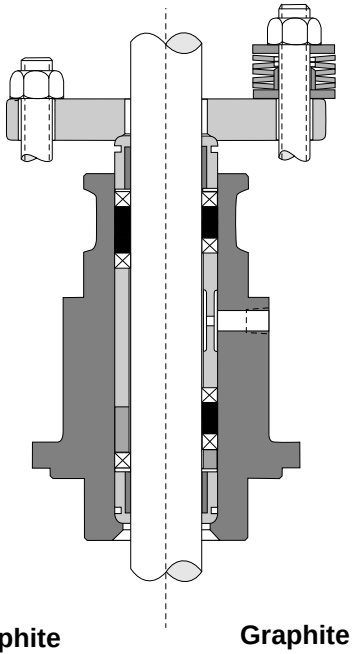
Figure 24: Standard V-ring - Standard and Optional Configurations



Square-braided Packing Standard Configuration

Square-braided Packing Optional Configurations

Figure 25: Square-braided Packing System



Graphite Combination Standard Configuration

Graphite Combination Optional Configurations

Figure 26: Combination Graphite Packing System

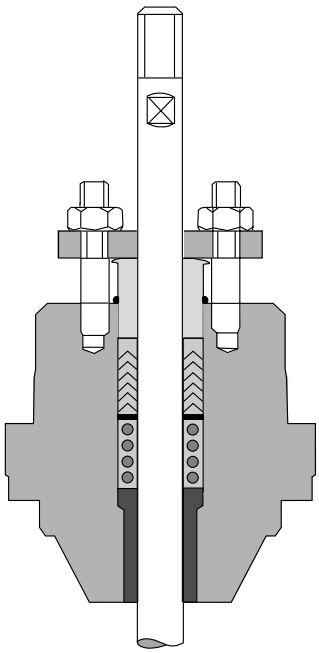


Figure 27: Valtek 2000 with PTFE V-ring Self-adjusting Packing System

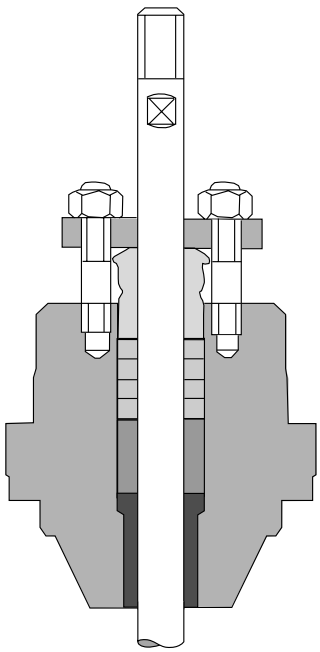


Figure 28: Valtek 2000 with Graphite Packing System

High Quality Packing Systems

Non-environmental Packing Systems

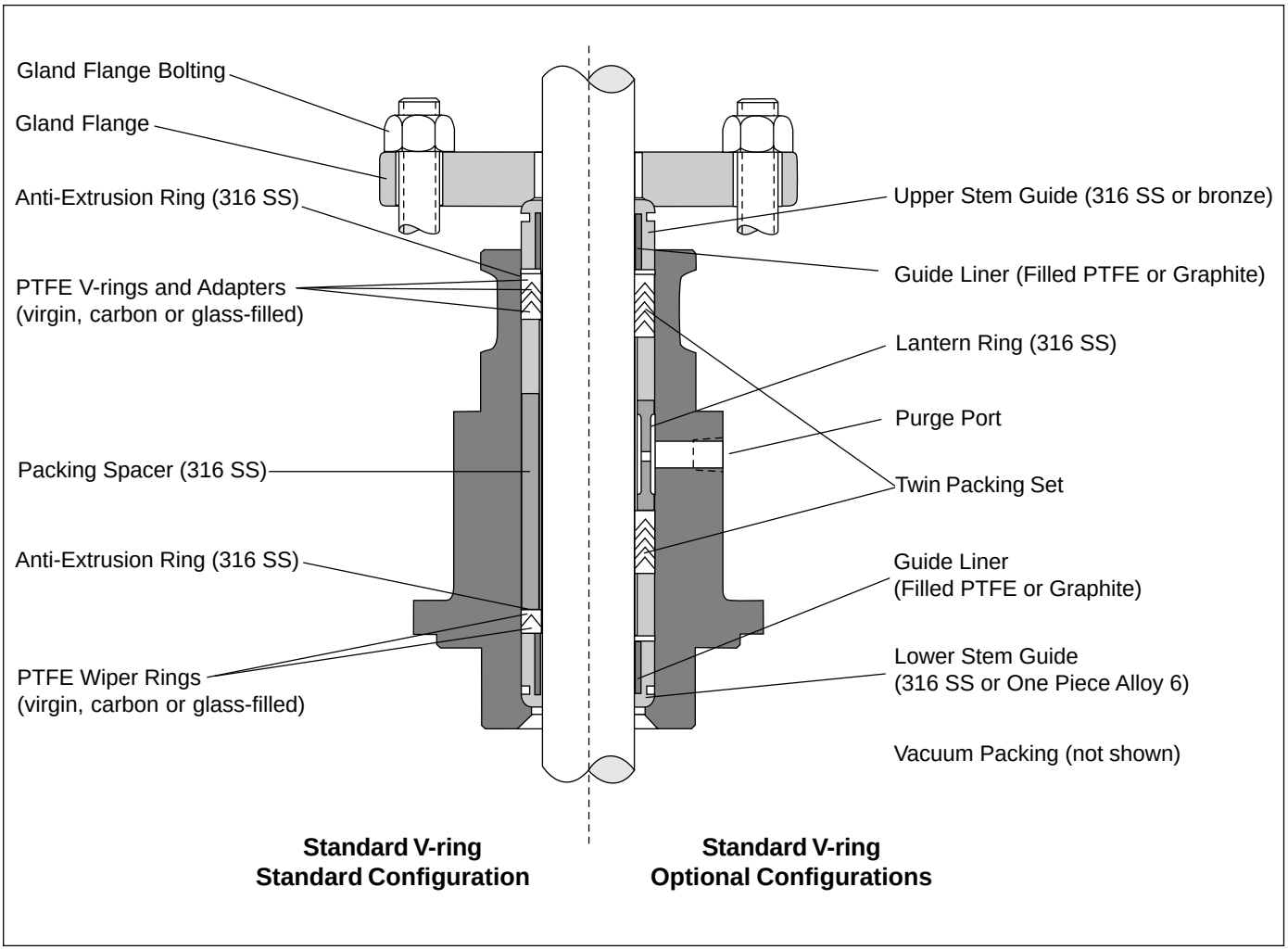


Figure 29: Standard V-ring - Standard and Optional Configurations

Standard V-ring Packing

The standard V-ring packing system consists of V-rings designed to minimize friction while maintaining good leakage control in a wide range of general and chemical applications. It is available in either virgin, glass or carbon-filled PTFE. Filled PTFE packing sets do not seal as effectively as virgin PTFE but will resist extrusion and cold-flow better at higher temperatures and pressures. This packing system is the most economical and has the lowest friction of all Valtek packing systems. Wiper rings are standard with most linear applications to protect the primary sealing rings.

Twin and vacuum packing options are available with this packing set. If live-loading is desired, a SafeGuard packing set should be used since it has been specifically designed to resist the extrusion inherent with live-loaded PTFE. Although not shown in Figure 29, vacuum packing is also available.

High Quality Packing Systems
Non-environmental Packing Systems

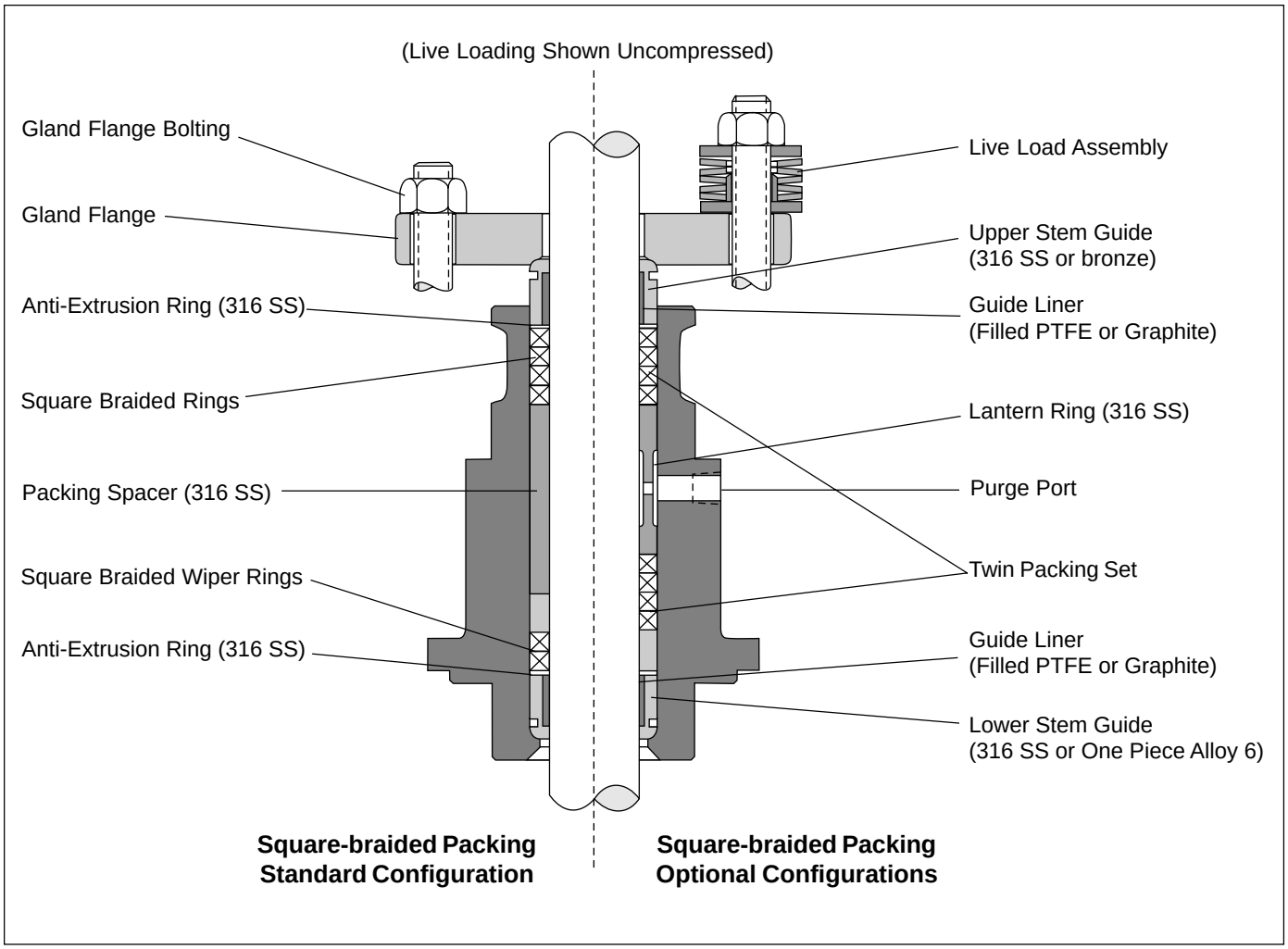


Figure 30: Square-braided Packing System

Square-braided Packing

The square braided packing system consists entirely of braided rings and is most commonly specified because of its long-life potential. This packing system comes in three material types: braided PTFE fiber, braided carbon fiber and braided flexible graphite. Each of these packing types come with a twin packing, and live-loading option.

Braided PTFE - This packing consists of a high-density, continuous-filament, lattice PTFE braid. It resists extrusion better than any other PTFE-based packing. It is also an excellent choice in many chemical applications.

Braided Carbon - This packing consists of a medium-density, lattice-carbon braid. It has an Inconel wire re-enforcement internally to resist extrusion. Square-carbon braided packing provides the advantages of high-temperature, fire-safe packing without the high friction associated with die-formed graphite packing. This packing can come with or without a zinc corrosion inhibitor.

Braided Graphite - (Garlock 1303 FEP®) This packing consists of high-purity flexible graphite strands encapsulated with a fine Inconel filament mesh. These strands are then braided and die-formed to provide a high-density packing ring. Although the friction on this packing is high, it offers an excellent ability to resist wire-draw and blowout in high-pressure steam applications. This packing is also an excellent choice for fire-safe applications.

High Quality Packing Systems

Non-environmental Packing Systems

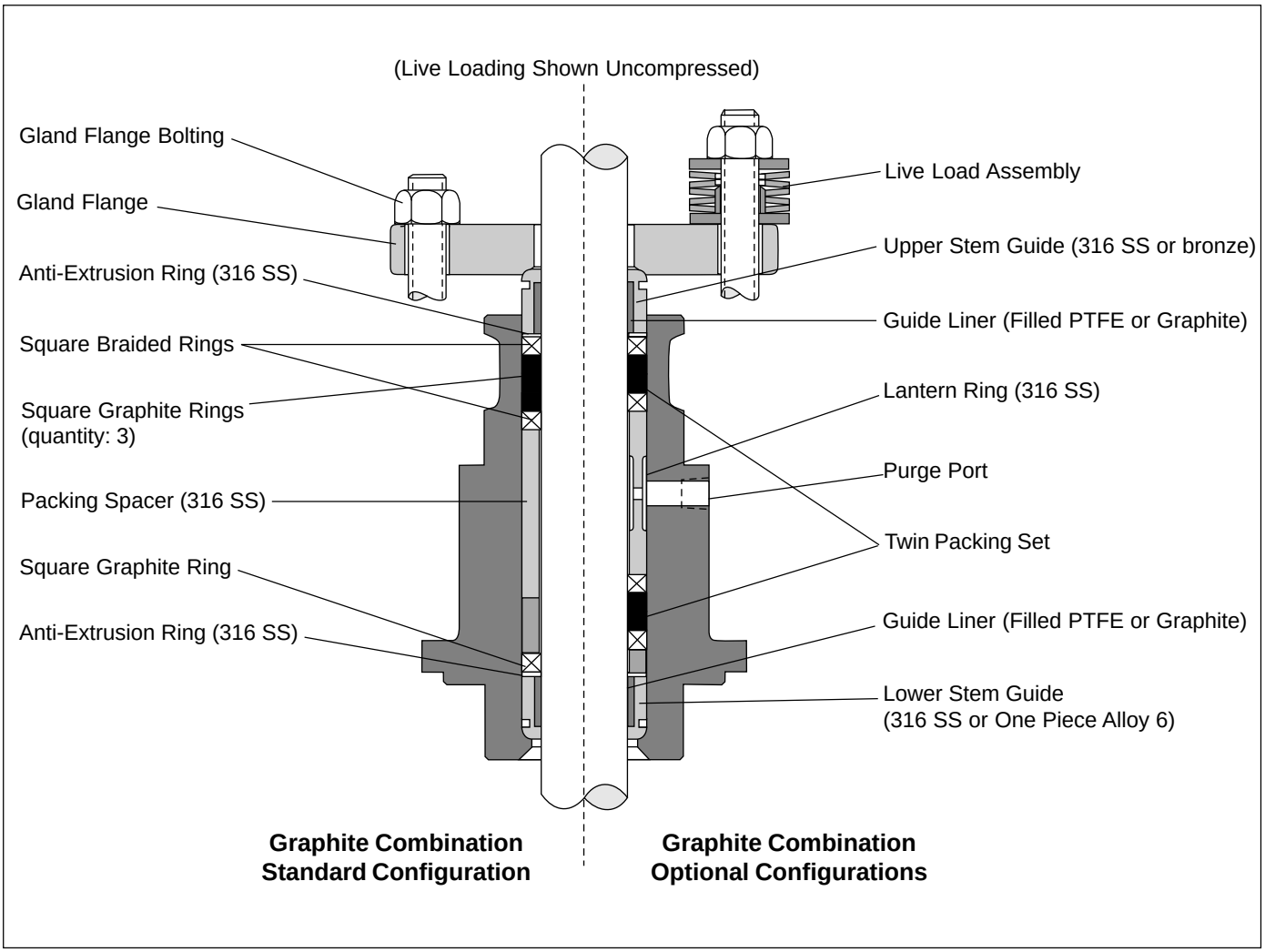


Figure 31: Combination Graphite Packing System

Combination Graphite Braid Packing

This packing consists of square carbon-braided end-rings on both sides of square, die-formed, graphite sealing rings. These sealing rings are made of die-formed graphite. The high density graphite rings are made of high-purity, flexible graphite ribbon. Although the friction of these packing sets are very high, they provide better sealing than carbon-braided packing. This packing may not be well suited for control applications requiring small step response because of high breakout friction.

This packing set is available as a twin set, is inherently fire-safe and may be live-loaded.

Standard V-ring Packing (page 20)

The standard V-ring packing system consists of V-rings designed to minimize friction while maintain good leakage control in a wide range of general and chemical applications. It is available in either virgin or PTFE. This packing system is the most economical and has the lowest friction of all Valtek packing systems.

If live-loading is desired, a SafeGuard packing set should be used since it has been specifically designed to resist the extrusion inherent with live-loaded PTFE.

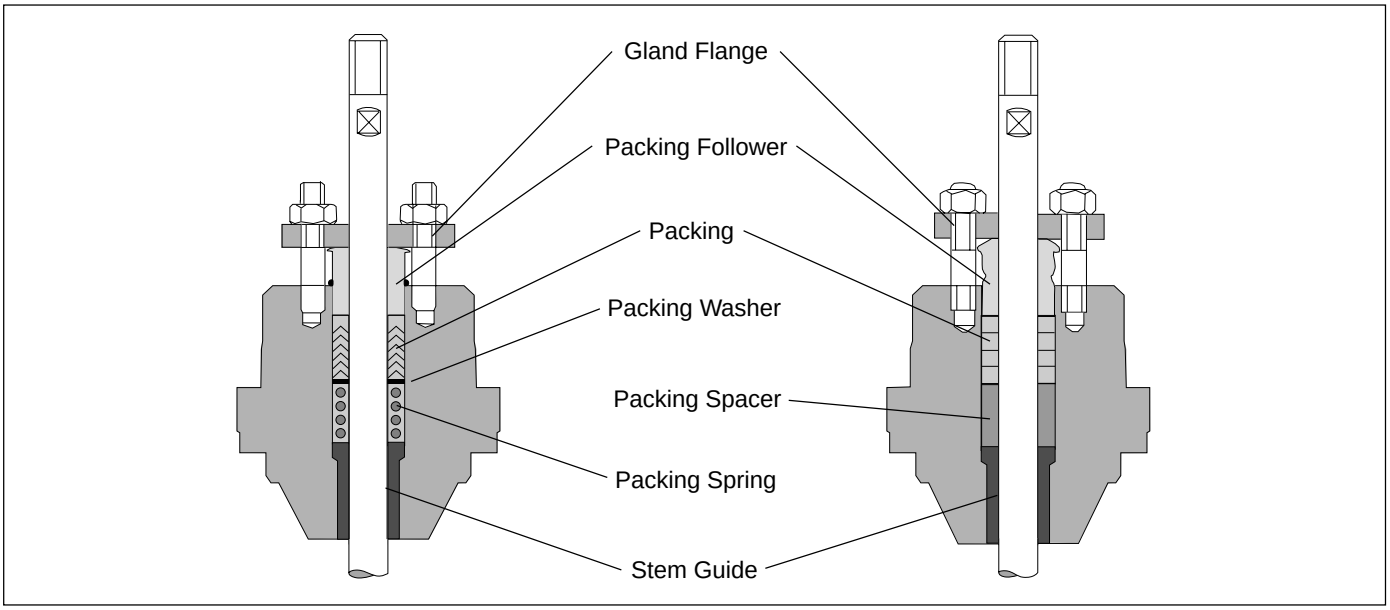


Figure 32: Valtek 2000 with PTFE V-ring Self-adjusting Packing System

Figure 33: Valtek 2000 with Graphite Packing System

Square Packing

Braided PTFE - This packing consists of a high-density, continuous-filament, lattice PTFE braid. It resists extrusion better than any other PTFE-based packing. It is also an excellent choice in many chemical applications, (not shown in this document).

Graphite - This packing consists of four, high-density, flexible graphite, die-formed rings. This packing is ideal for fire-safe, or high temperature applications.

For more information, contact:

For more information about Flowserve and its products, contact www.flowserve.com or call USA 972 443 6500

Regional Headquarters

1350 N. Mt. Springs Prkwy.
Springville, UT 84663
Phone 801 489 8611
Facsimile 801 489 3719

12 Tuas Avenue 20
Republic of Signapore 638824
Phone (65) 862 3332
Facsimile (65) 862 4940

12, av. du Québec, B.P. 645
91965, Courtaboeuf Cedex, France
Phone (33 1) 60 92 32 51
Facsimile (33 1) 60 92 32 99

Quick Response Centers

5114 Railroad Street
Deer Park, TX 77536 USA
Phone 281 479 9500
Facsimile 281 479 8511

104 Chelsea Parkway
Boothwyn, PA 19061 USA
Phone 610 497 8600
Facsimile 610 497 6680

1300 Parkway View Drive
Pittsburgh, PA 15205 USA
Phone 412 787 8803
Facsimile 412 787 1944

