

Packing Selection Guidelines for Sliding-Stem Valves

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This bulletin provides information and insight to help you select packing systems properly. The following application guidelines have been developed to aid in the packing selection process. It is important to note that these guidelines were developed based on the results of numerous tests on various packing systems conducted in the Emerson Process Management™ laboratory. Exceeding these guidelines might result in reduced service life.

The traditional valve selection process includes selecting a valve design based on pressure and temperature capabilities, flow characteristics, material compatibility, and other factors. One such major factor is packing selection, which has gained significant attention over the years due to stringent environmental and safety concerns.

Proper packing selection is being driven by USA Clean Air Act Amendments and subsequent EPA (Environmental Protection Agency) regulations, as well as our customers' increasing concern for improved packing performance (less maintenance and longer life). Seal performance continues to be a focus item.

In the past, packing selection was primarily based on process temperature; that is, PTFE was selected for temperatures below 232°C (450°F) and graphite was selected for temperatures above 232°C (450°F). Considerations now include the effect of packing friction on process control, hysteresis, seal quality, and cycle life. Given the variety of process applications and installation conditions, these variables are difficult to quantify. A relative packing

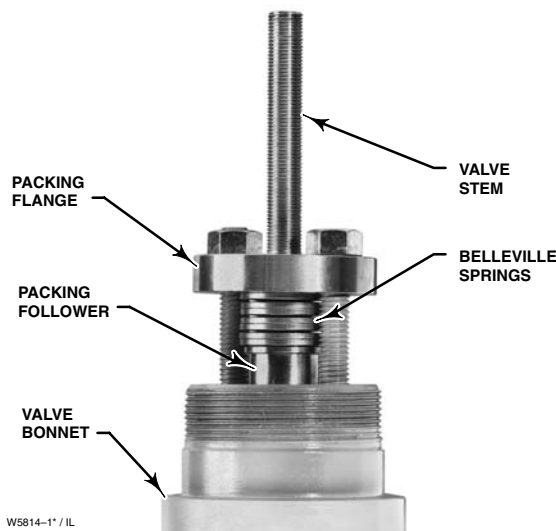


Figure 1. easy-e® Valve Bonnet with ENVIRO-SEAL® Packing

performance comparison can be made that provides an engineered approach to the packing selection process.

Clarification of trade names is required for proper understanding of the tables shown in this bulletin. From an Emerson Process Management engineering perspective, ENVIRO-SEAL® packing (figure 1) is defined as an advanced packing system using a “compact,” live-load spring design. From a user perspective, ENVIRO-SEAL packing is most typically thought of as an emission-reducing packing system. The HIGH-SEAL packing system is used in those applications having extreme pressures and temperatures. HIGH-SEAL packing uses two “large” live-load springs.

This bulletin will help extend your thinking of ENVIRO-SEAL packing as being suitable not only for those applications where the control of fugitive emissions is a requirement, but also for nonenvironmental applications involving higher temperatures and pressures. The use of ENVIRO-SEAL packing in nonenvironmental applications offers the benefit of lower ongoing maintenance costs.



Sliding-Stem Packing Selection

Table 1. Packing Selection Guidelines for Sliding-Stem Valves

Packing System	Maximum Pressure and Temperature Limits for 100 PPM Service ⁽¹⁾		Application Guideline for Nonenvironmental Service ⁽¹⁾		Seal Performance Index	Service Life Index	Packing Friction ⁽²⁾
	Metric	Imperial	Metric	Imperial			
Single PTFE V-Ring	20.7 bar -18 to 93°C	300 psi 0 to 200°F	See figure 3 -46 to 232°C	See figure 3 -50 to 450°F	Better	Long	Very low
Double PTFE V-Ring	---	---	See figure 3 -46 to 232°C	See figure 3 -50 to 450°F	Better	Long	Low
ENVIRO-SEAL PTFE	See figure 2 -46 to 232°C	See figure 2 -50 to 450°F	See figure 3 -46 to 232°C	See figure 3 -50 to 450°F	Best	Very long	Low
ENVIRO-SEAL Duplex	51.7 bar -46 to 232°C	750 psi -50 to 450°F	See figure 3 -46 to 232°C	See figure 3 -50 to 450°F	Best	Very long	Low
KALREZ® with PTFE (KVSP 400) ⁽³⁾	24.1 bar 4 to 204	350 psig 40 to 400°F	See figure 3 -40 to 204°C	See figure 3 -40 to 400°F	Best	Long	Low
KALREZ with Vespel® CR-6100 (KVSP 500) ⁽³⁾	24.1 bar 4 to 260°C	350 psig 40 to 500°F	See figure 3 -40 to 260°C	See figure 3 -40 to 500°F	Best	Long	Low
ENVIRO-SEAL Graphite ULF	103 bar -7 to 315°C	1500 psi 20 to 600°F	207 bar -198 to 371°C	3000 psi -325 to 700°F	Best	Very long	Medium
HIGH-SEAL Graphite ULF	103 bar -7 to 315°C	1500 psi 20 to 600°F	290 bar ⁽⁴⁾ -198 to 538°C	4200 psi ⁽⁴⁾ -325 to 1000°F	Best	Very long	Medium
Graphite Composite / HIGH-SEAL Graphite	---	---	290 bar ⁽⁴⁾ -198 to 649°C ⁽⁵⁾	4200 psi ⁽⁴⁾ -325 to 1200°F ⁽⁵⁾	Better	Very long	Very high
Braided Graphite Filament	---	---	290 bar -198 to 538°C ⁽⁵⁾	4200 psi -325 to 1000°F ⁽⁵⁾	Good	Moderate	High
Graphite ULF	---	---	290 bar -198 to 538°C	4200 psi -325 to 1000°F	Better	Very long	Medium

1. The values shown are only guidelines. These guidelines can be exceeded, but shortened packing life or increased leakage might result. The temperature ratings apply to the actual packing temperature, not to the process temperature.
2. See Catalog 14 for actual friction values.
3. The KALREZ pressure/temperature limits referenced in this bulletin are for Fisher valve applications only. DuPont may claim higher limits.
4. Except for the 9.5 mm (3/8 inch) stem, 110 bar (1600 psi).
5. Except for oxidizing service, -198 to 371°C (-325 to 700°F).

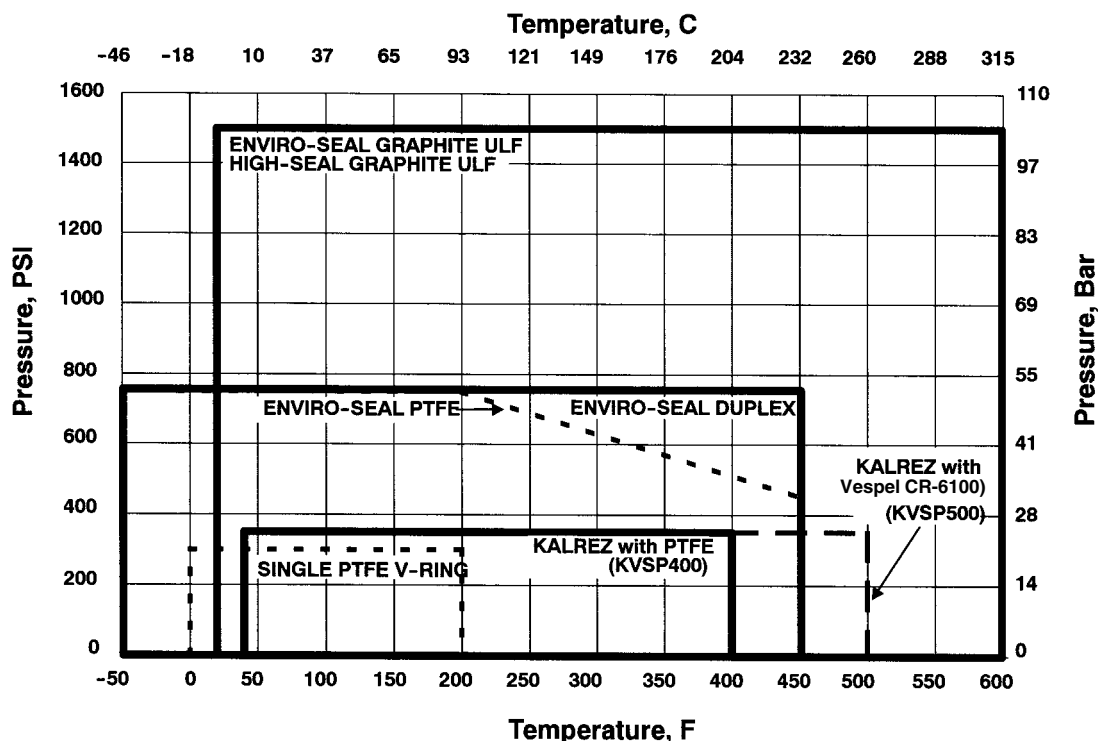
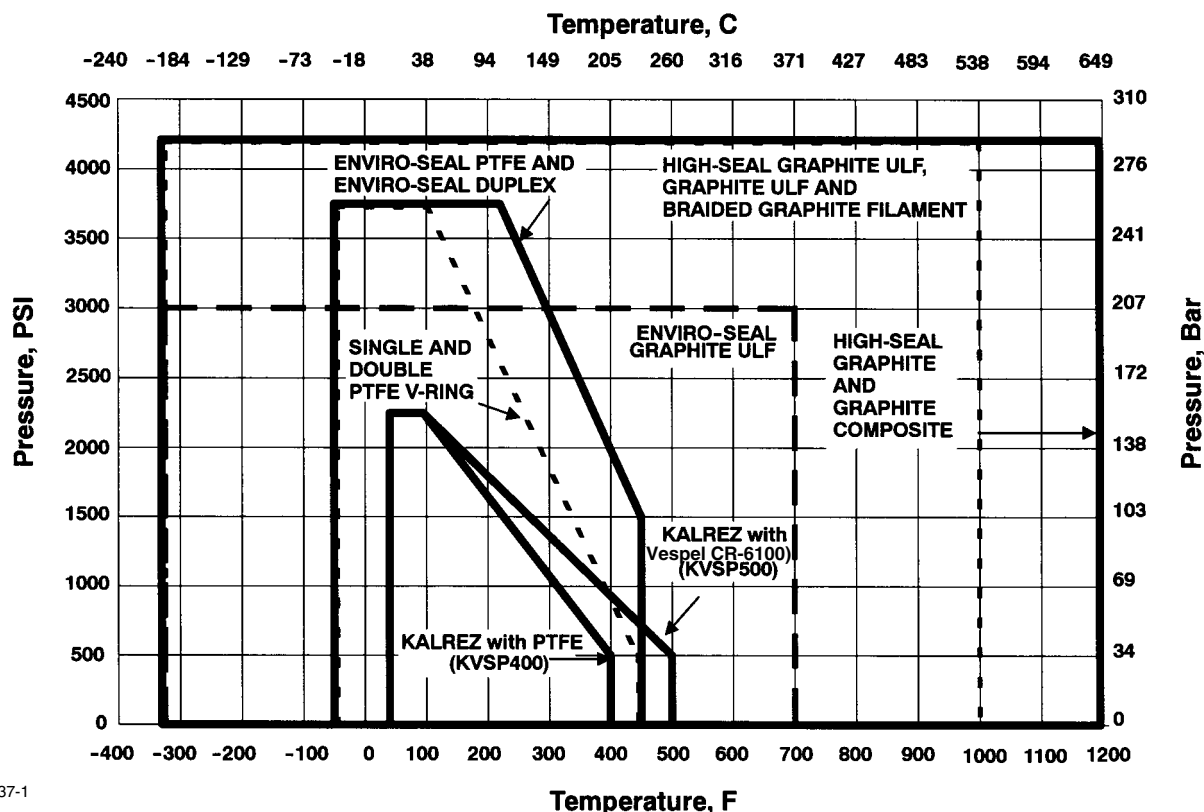


Figure 2. Applications Guidelines Chart for 100 PPM Service



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Figure 3. Applications Guidelines Chart for Nonenvironmental Service

The packing selection guidelines in table 1 present two categories of service conditions. The first category defines packing systems designed for environmental or fugitive emission applications where 100 ppmv (parts per million volume) seal performance is required, using EPA Method 21 as the measurement technique (see figure 2). The second category defines application guidelines for nonenvironmental services (see figure 3). Depending on category requirements, different pressure/temperature guidelines have been established for the packing systems. In addition, a given packing design has certain characteristics

concerning seal performance, service life, and friction. The pressure and temperature guidelines and the relative comparison of these characteristics are defined in table 1, figure 2, and figure 3.

Seven packing selections are offered for environmental service: Single PTFE V-ring (Design E valves such as Design ED and EWT), ENVIRO-SEAL PTFE, ENVIRO-SEAL Duplex, KALREZ with PTFE, KALREZ with Vespel CR-6100, ENVIRO-SEAL graphite ULF, and HIGH-SEAL graphite ULF. Each of these options has different pressure/temperature service ranges.

Sliding-Stem Packing Selection

Single PTFE V-Ring Packing

The single PTFE V-ring arrangement uses a coil spring, as in the Design E valves, and meets the 100 ppmv criteria, assuming that the pressure does not exceed 20.7 bar (300 psi) and the temperature is between -18°C and 93°C (0°F and 200°F). This packing arrangement offers very good seal performance with the lowest packing friction.

ENVIRO-SEAL® PTFE Packing

The ENVIRO-SEAL PTFE arrangement is suitable for environmental applications on services up to 51.7 bar and 232°C (750 psi and 450°F). The sealing capability is superior. The ENVIRO-SEAL PTFE packing system is designed to operate at high stress. This gives the ENVIRO-SEAL PTFE packing system the ability to compensate for stem or packing bore imperfections. The high packing stress design approach also results in an increase in stem friction. Typically, this slight increase in stem friction does not cause problems, such as hysteresis, for actuator sizing or process control. It is good practice, however, to always verify actuator sizing whenever you select a different packing material.

ENVIRO-SEAL® Duplex Packing

ENVIRO-SEAL Duplex packing systems were developed, utilizing the benefits of both PTFE and graphite components. These special packing systems provide the capability of graphite packing along with low friction advantages of PTFE packing. Thus, ENVIRO-SEAL Duplex packing systems provide a low friction, low emission, fire-tested solution for applications with process temperatures below 232°C (450°F). ENVIRO-SEAL Duplex packing systems were successfully tested in accordance with API Standard 589, Fire Test Evaluation of Valve Stem Packing, first edition.

KALREZ® with PTFE Packing

The KALREZ pressure/temperature limits referenced in this bulletin are for Fisher valve applications only. DuPont may claim higher limits.

KALREZ with PTFE (KVSP-400) is limited to 24.1 bar and 204°C (350 psi pressure and 400°F) for environmental applications. It can be used to 103 bar (1500 psi) for some non-environmental applications. KALREZ with PTFE is currently available for Fisher sliding-stem valves with 9.5, 12.7, 19.1, 25.4, and 31.8 mm (3/8, 1/2, 3/4, 1-, and 1-1/4 inch) diameter stems. The system can be used with many sliding-stem valves, as shown in the KALREZ System--Sliding-Stem Valves instruction manual, Form 5364. KALREZ packing arrangements are also available for various Fisher rotary valves (see Fisher bulletin 59.3:042, Packing Selection Guidelines for Rotary Valves).

KALREZ® with Vespel® CR-6100 Packing

KALREZ packing is also available in KVSP-500 (260°C [500°F] service). The KVSP-500 series uses DuPont material called Vespel CR-6100, which is a carbon fiber-reinforced PTFE.

Note that KALREZ packing arrangements require that a controlled low stress be applied to the packing in order to seal properly and also have a longer life. This is achieved by using the same spring pack as ENVIRO-SEAL, but with a lower initial loading.

In contrast, the ENVIRO-SEAL PTFE packing system is designed to operate at high stress (approximately 5 times the KALREZ stress). This gives the ENVIRO-SEAL PTFE packing system the ability to tolerate less-than-perfect conditions and continue to seal reliably. For example, in changing installed valves to ENVIRO-SEAL PTFE packing, minor imperfections in the stem finish or packing bore can be tolerated because of the high stress design of the packing system.

The KALREZ with PTFE packing arrangement is basically the same packing concept as the Design E single PTFE V-ring packing, except two of the PTFE V-rings have been replaced with two KALREZ packing rings. The KALREZ packing rings can be identified by their black color.

Sliding-Stem Packing Selection

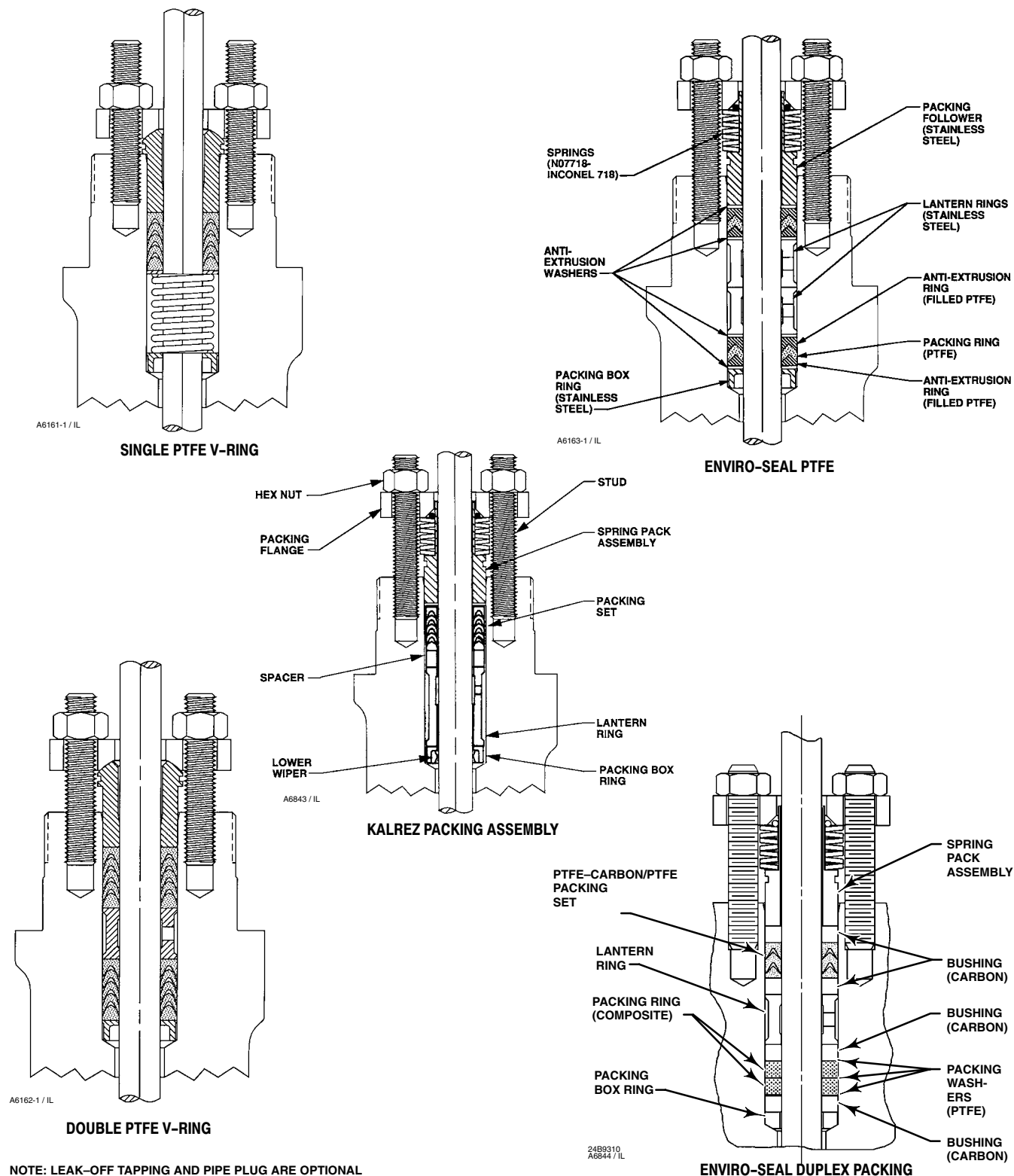


Figure 4. Typical Packing Examples

Sliding-Stem Packing Selection

ENVIRO-SEAL® Graphite ULF

ENVIRO-SEAL graphite ULF packing is designed primarily for environmental applications at elevated temperatures in excess of 232°C (450°F). It has a full temperature rating of -7°C to 316°C (20°F to 600°F) and still maintains the 100 ppmv leakage criteria. For best performance the service temperature should be at least 149°C (300°F). At temperatures below 149°C (300°F), packing wear may be accelerated compared to higher temperatures.

Compared to PTFE packing systems, graphite packing systems operate at higher stress levels and have higher friction values for a given level of sealing. To combat this, most graphite systems incorporate a small amount of PTFE which acts primarily as a lubricant.

The patented ULF packing system, however, incorporates very thin PTFE layers inside the packing rings as well as thin PTFE washers placed on each side of the packing rings. This strategic placement of PTFE material minimizes control problems (such as slip-stick action), reduces friction, promotes sealing, and extends the cycle life of the packing set. (With slip-stick action, packing friction prevents the valve stem from moving until stem force increases enough to make the stem move suddenly.) While the PTFE components of the ULF packing set are critical to the overall performance of the packing set, they make up a very small volumetric percentage of the ULF packing set and therefore do not require additional follower travel. The ULF packing system has remarkably low stem friction at elevated temperatures, compared to other graphite packing systems. ENVIRO-SEAL Graphite ULF packing systems were successfully tested in accordance with API Standard 589, Fire Test Evaluation of Valve Stem Packing, second edition.

HIGH-SEAL Graphite ULF

The HIGH-SEAL graphite ULF packing system is identical to the ENVIRO-SEAL graphite ULF packing system below the packing follower. The primary advantage of the HIGH-SEAL packing system is the use of large diameter Belleville springs. These heavy duty springs offer additional follower travel and can be calibrated with a load scale. The load scale provides a visual indication of packing load as well

as packing wear, making it easier for you to determine when additional torquing might be required.

For ENVIRO-SEAL or HIGH-SEAL graphite ULF packing, the service life is very long, compared to other graphite packing arrangements. Both offer superior seal performance. The ULF packing system has remarkably low stem friction at elevated temperatures, compared to other graphite packing systems.

Nonenvironmental Services

For the nonenvironmental pressure/temperature guidelines, service life can be extended by using ENVIRO-SEAL and HIGH-SEAL packing systems. As service pressures and temperatures increase, the ENVIRO-SEAL packing systems provide a significant step change in performance, compared to the traditional single PTFE V-ring or braided graphite filament arrangements. For example, a Class 1500 (Design HP valve) application at 137 bar and 93°C (2000 psi and 200°F) frequently required packing maintenance. The HIGH-SEAL packing system with PTFE washers was installed, significantly reducing maintenance requirements. This system is rated to 290 bar and 371°C (4200 psi and 700°F). The ENVIRO-SEAL packing system or compact Belleville spring arrangement is rated to 207 bar and 371°C (3000 psi and 700°F).

HIGH-SEAL packing systems have a disadvantage, from an installation perspective. The disadvantage is that the actuator cannot be removed from the valve without removing the Belleville springs. You must release process pressure from the valve before removing the Belleville springs.

Table 1 shows that the braided graphite filament arrangement is limited to 103 bar (1500 psi). Due to its construction, braided graphite filament cannot sustain high packing stress levels. Over time, the braided graphite filament will break down and compress, and sealing force will be lost. Due to these characteristics, braided graphite filament will not provide the required seal performance for environmental services. The braided graphite filament arrangement is also susceptible to stick-slip action, which might cause process control deviations.

Sliding-Stem Packing Selection

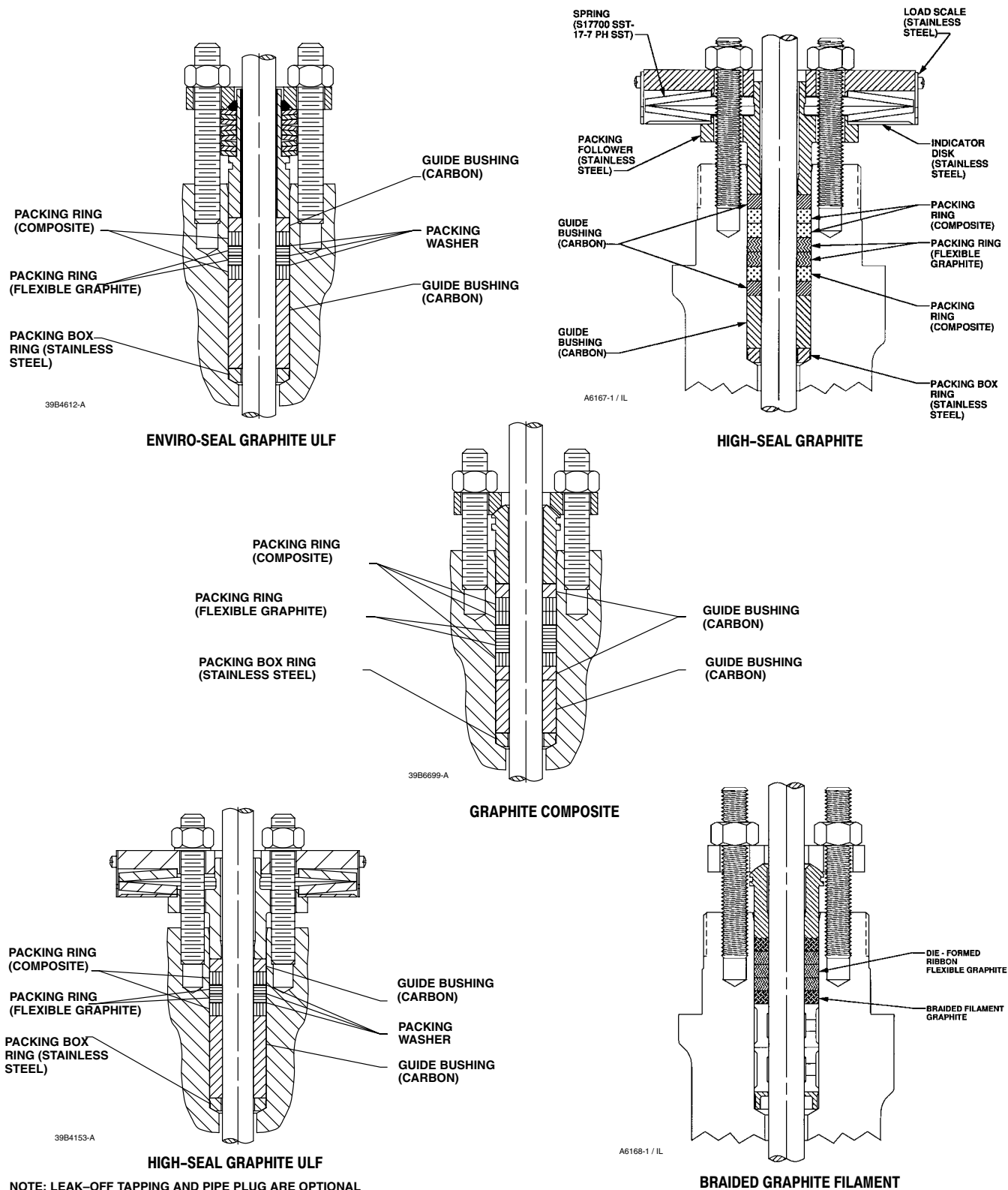


Figure 5. Typical Packing Examples

Sliding-Stem Packing Selection

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Conclusion

It is important to recognize that many parameters affect seal performance and service life. Even if the optimum design is selected, other factors such as stem finish, packing bore finish, and job site installation practices will have an effect on performance.

Emerson Process Management knowledge gained, as a result of the ENVIRO-SEAL and HIGH-SEAL packing development program, has provided an opportunity to help you “engineer” the packing selection. Proper selection has a bottom line result; that is, increased service life and reduced maintenance.

If you need a more detailed engineering discussion of the design principles affecting packing seal design, contact your Emerson Process Management sales office. They can provide you a copy of Technical Monograph TM-38, Control Valve Packing Systems.

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