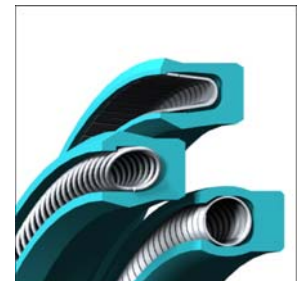


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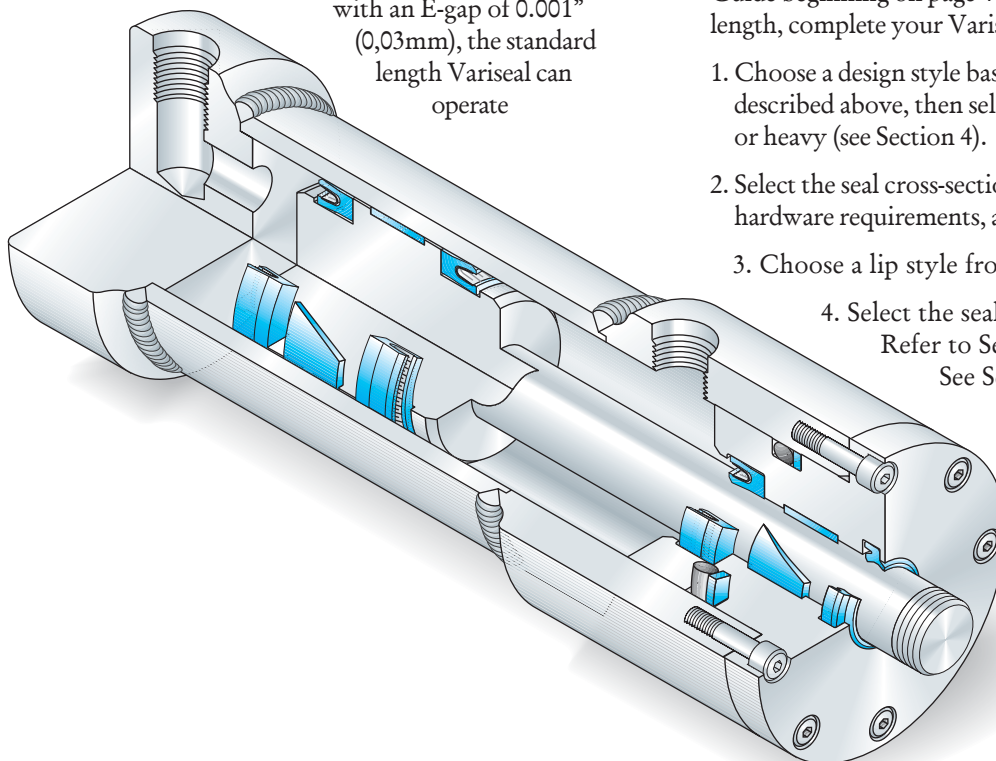
## 5-1 Design Considerations

The Variseal™ makes an excellent rod and piston seal because of its low friction, extensive chemical compatibility, wide temperature range, high pressure rating, and high speed capability. The Variseal provides an added measure of performance and reliability in applications that exceed the capability of conventional elastomeric seals (as summarized in Section 1). In Section 5, we review the various seal selection and hardware design considerations that apply specifically to rod and piston applications.

**Seal Length.** There are two versions of the basic Variseal design to consider—the *standard length* seal and the *extended heel*† version (see Figure 5.3 on page 46). Before choosing a seal length, review the operating pressure, temperature, and surface speed. The standard length Variseal is rated to 3000 psi (20.7 MPa). At higher pressure, or when high pressure is combined with high temperature or speed, use the extended heel Variseal. Above 10,000 psi (68.9 MPa), use the extended heel Variseal with a separate backup ring to minimize extrusion†.

**Pressure and E-gap.** The recommended maximum radial clearance or E-gap† is typically 0.003" (0,08mm) to obtain a pressure rating of 3000 psi (20.7 MPa) with the standard length Variseal. This pressure rating can be exceeded when operating at low to moderate (200°F or 93°C) temperatures, or when the clearance gap is reduced. For example, in slow

speed service at room temperature, with an E-gap of 0.001" (0,03mm), the standard length Variseal can operate



continuously at 10,000 psi (68.9 MPa). When the extrusion gap is greater than 0.003" (0,08mm), an extended heel Variseal is recommended. The thicker heel minimizes distortion at high pressures and temperatures. To reduce the E-gap and increase the pressure rating, a separate backup ring can be placed behind the seal. An assortment of backup ring designs and materials are described on pages 47-49.

**Temperature.** As operating temperatures rise, pressure ratings drop. Refer to Table 5.1 on page 46 to determine which Variseal length to use for various combinations of temperature and pressure.

**Speed.** A high surface speed can generate enough heat to soften the seal, making it more susceptible to extrusion. Using an extended heel Variseal in high speed reciprocating service will counteract this effect. The longer heel supports the body of the seal and guides the rod or piston to reduce sideloading. In addition, the nonstick property of the Variseal will keep it from rolling or twisting during high speed service.

**Design selection.** There are three styles of Variseal to choose from, based on the spring type used in each—Variseal M2 with the V-spring; Variseal W2 with the Slantcoil® spring; and Variseal H with the Helical spring. For a comparison of all three types, review the Seal Selection Guide beginning on page 48. After deciding on the basic seal length, complete your Variseal design selection as follows:

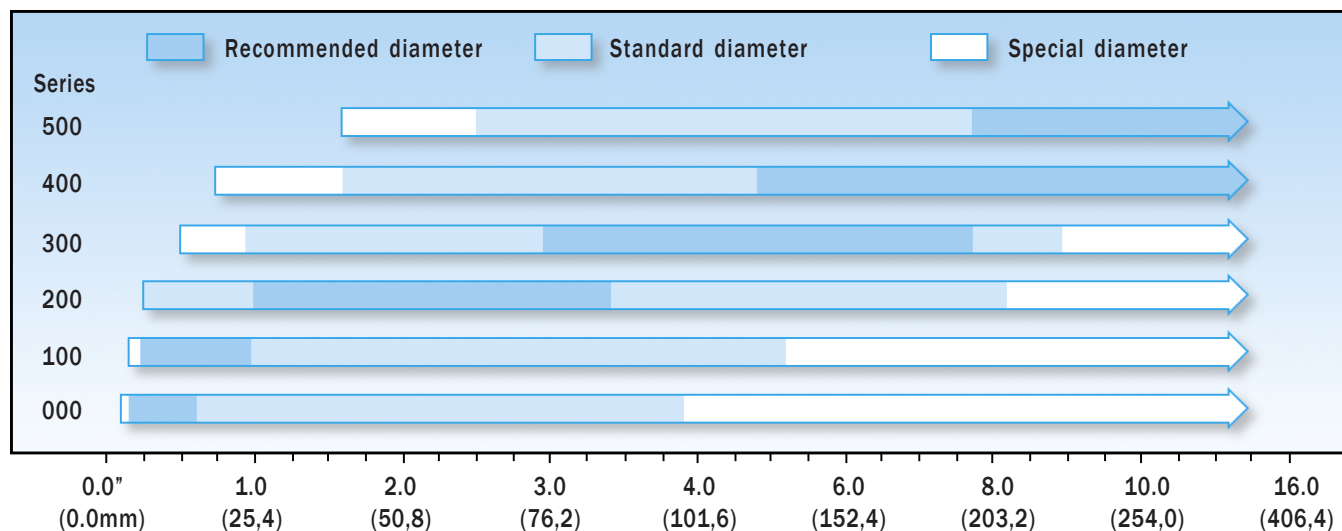
1. Choose a design style based on the spring type, as described above, then select a spring load—light, medium, or heavy (see Section 4).
2. Select the seal cross-section and diameter based on your hardware requirements, and Figure 5.1 on page 44.
3. Choose a lip style from Figure 5.2 on page 45.
4. Select the seal jacket and spring materials. Refer to Section 3 for the jacket material. See Section 4 for spring materials.

† See glossary for definitions of abbreviations, trade names, and technical terms.

# Rod and Piston Seals

## 5-2 Preliminary Hardware Design

Figure 5.1 – Cross-Section and Diameter Recommendations



Several aspects of hardware design should be considered during the early stages of the gland design and seal selection processes. These items—only briefly summarized on this page—are covered in more detail in Section 9.

**Cross-section and diameter.** The Variseal™ is manufactured in a wide range of diameters and cross-sections. The recommended diameter range for each standard cross-section is given above in Figure 5.1. The “recommended diameter” is considered to provide the best combination of flexibility and wear life for that cross-section. The “standard diameter” range indicates the sizes found in the standard size tables on pages 52-57. The “special diameter” range indicates diameters outside the range of standard sizes. Consult your local Variseal™ representative for further details.

**Gland style.** Certain glands styles are preferred over others, primarily to ease seal installation. Since these seals do not stretch like elastomeric O-rings, solid glands are not recommended. Split or stepped glands are preferred (see Section 9).

In a split or stepped gland, installation is accomplished without special tools. Careful handling of seals will keep them from being damaged during installation. Screw drivers and other tools with sharp edges should not be used to handle the seal. An advantage of the split gland is the ability to remove and reinstall the seal if needed. In a stepped gland, removing the seal without distorting it is a little more difficult, depending on the seal diameter, cross-section, and step height†.

† See glossary.

To prevent damage to seals during installation, it is important to provide adequate lead-in chamfers, and to eliminate nicks, scratches, and burrs from the installation path. The seal housing should also be free of scratches so leakage paths are not formed in the gland itself.

**Alignment.** Designing the hardware to improve dynamic alignment and to reduce sidelading will result in longer seal life with less potential for leakage. Some typical methods of improving hardware alignment are illustrated on page 123.

**Lubrication and coolant.** The presence of lubrication can significantly extend the seal’s wear life. A lubricant can also act as a coolant in applications where high speeds and pressures generate excessive heat. In such cases, a separate cooling system should be considered as another method of improving seal performance.

**Trouble prevention.** A careful review of the hardware during the design phase can prevent trouble from occurring later. We recommend reviewing the Trouble Prevention Chart at the beginning of Section 10, along with the hardware and installation guidelines in Section 9, before finalizing your hardware design.

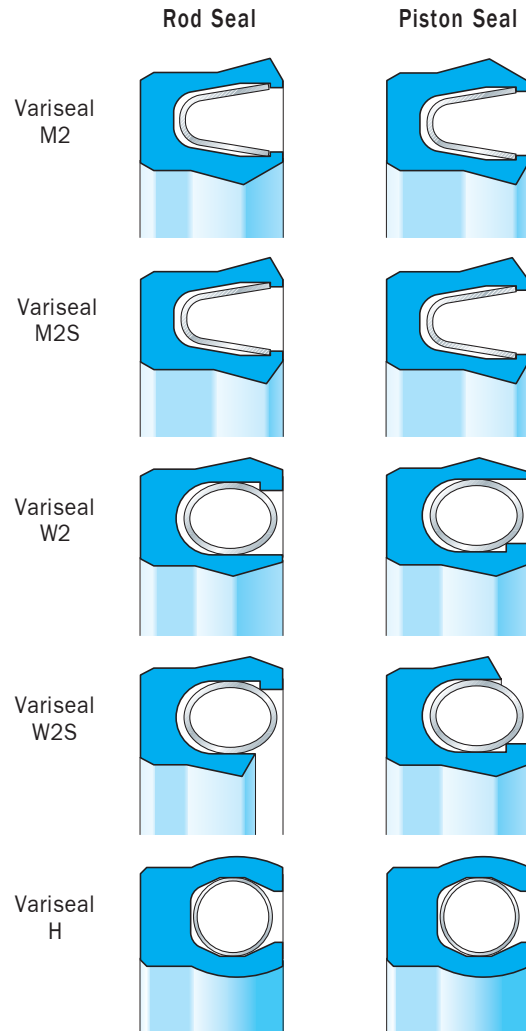
## 5-3 Variseal™ Lip Configurations

The Variseal M2 and W2 are available in four different lip configurations. The Variseal H is available in only one style. Use each style to suit application requirements as described below.

**Style M2, W2 and H.** Styles M2, W2 and H are the standard lip configurations for the V-spring, Slantcoil® and Helical springs respectively. Because the Variseal M2 and W2 styles are typically used in dynamic applications, the lip configuration is asymmetrical. For rod seals, the I.D. lip of the Variseal M2 and W2 is thicker than the O.D. lip. This allows for increased wear resulting in longer seal life. Likewise for piston seals, the O.D. lip is machined thicker for longer life. Chamfers are machined into both I.D. and O.D. lips to aid in installation, but installing the Variseal heel first is still preferred. The Variseal H is usually recommended for static applications and therefore the sealing lips are machined symmetrical. Rather than chamfers on the leading edges of the Variseal H, both lips are machined with a radius that maximizes the loading properties of the Helical spring.

**Style M2S and W2S.** For the V-spring and Slantcoil spring, an alternative “scraper” lip design is offered. This style is also asymmetrical but the dynamic lip has a chamfer that is machined at a much sharper angle. Upon installation in the seal gland, the sharper angle on the chamfer creates an effective wiping action for viscous and/or abrasive media. Again the dynamic “scraper” lip is on the I.D. for rod seals and on the O.D. for piston seals. The Variseal H is not available in a scraper version since dynamic motion is typically not recommended for this style of seal.

Figure 5.2 – Lip Styles for Variseal M2, W2, and H



\* See glossary.

# Rod and Piston Seals

## 5-4 High Pressure Seals

In high pressure service, the seal must be properly supported to prevent jacket distortion resulting from extrusion into the clearance gap<sup>†</sup>. There are two designs types to choose from: the high pressure Variseal—also called extended heel design—and the Corner Reinforced Variseal with backup ring. When using the standard length Variseal at high pressures, distortion at the back of the spring cavity may cause fracture of the sealing lip. The high pressure Variseal has an extended heel that minimizes such distortion. See Figure 5.3.

Select a seal material with higher strength for high pressure service. Compounds such as T09, T40, T13, and other highly filled Turcon® blends are more extrusion resistant, temperature resistant, and long wearing at high speeds and pressures.

**Figure 5.3 – Extended heel minimizes extrusion damage**



**Backup rings.** The best way to prevent extrusion is to design the hardware with the smallest possible clearance gap behind the seal. When this is not possible due to tolerance stack-ups or other considerations, a separate backup ring can be placed behind the seal to close the gap. Table 5.3 on the next page shows the typical backup ring designs and their performance features. Before deciding to add a backup ring, we recommend modifying the hardware to reduce the clearance gap. Customized backup ring designs can be supplied for unusual situations. Consult your local Variseal representative for details.

**Backup materials.** Backup rings are made from high strength polymers or metals. Their function is to support the seal, and not to act as a seal themselves. Material selection depends on service conditions such as media pressure, size of extrusion gap, operating temperature, surface speed, and chemical compatibility. Another factor that may affect your material choice is the thermal expansion rate of the backup ring material in relation to the housing material.

**Plastics.** Backup rings are often made from plastics such as Nylon® or Delrin® for their ease of machining, availability,

low cost, and anti-galling properties. High modulus thermoplastics<sup>†</sup> (such as PEEK<sup>†</sup>) are used where pressure and temperature levels require backups with higher strength and wider chemical compatibility.

**Metals.** We strongly recommend that you consult the factory concerning any application with high pressures or temperatures requiring the use of metal backup rings. Metal rings are used in conditions such as the following:

1. Pressures over 20,000 psi (137.9 MPa) or where pressure and temperature combinations are severe.
2. High temperature service, where the thermal expansion of the backup ring must be consistent with the expansion of the housing material.
3. High pressure static or very slow service (as in pressure intensifiers), but only when the metal backup ring will not gall the mating surface.

Typical material selections include mild steel, stainless steel, aluminum bronze, and high nickel alloys. For further details refer to the Backup Ring Material Selection Guide on page 26.

**Pressure versus temperature.** Variseal pressure ratings are affected by temperature. See the table below to compare pressure ratings for the standard length Variseal, the extended heel design, and the seal with backup design.

**Table 5.1 – Maximum Pressure Ratings<sup>1</sup> at Temperature**

| Temperature     | Maximum pressure rating |               |                   |
|-----------------|-------------------------|---------------|-------------------|
|                 | Standard length         | Extended heel | Corner Reinforced |
| -200°F (-129°C) | 4000 psi (27.6 MPa)     | 12,000 (82.7) | 18,000 (124.1)    |
| 70° (21°)       | 3000 (20.7)             | 10,000 (68.9) | 15,000 (103.4)    |
| 250° (121°)     | 2500 (17.2)             | 8000 (55.2)   | 12,000 (82.7)     |
| 400° (204°)     | 2000 (13.8)             | 4000 (27.6)   | 10,000 (68.9)     |
| 550° (288°)     | 1000 (6.9)              | 3000 (20.7)   | 8000 (55.2)       |

<sup>1</sup> All ratings are based on Turcon T09 seal material in static or slow reciprocating service with a 0.003" (0.08mm) extrusion gap.

<sup>†</sup> See glossary.



## 5-5 Backup Ring and Support Ring Designs

Figure 5.4 – Gland Length G

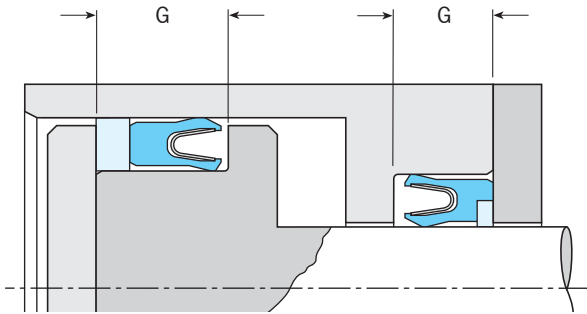
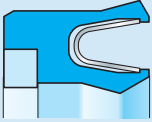
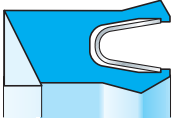
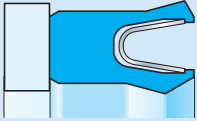
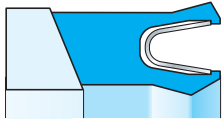
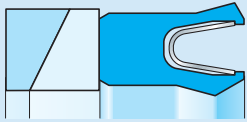


Table 5.2 – Minimum Gland Length G by Series<sup>1</sup>

| Series | Corner Reinforced | Angled Inserts | Rectangular   | Tapered Cam Ring | Dual Cammed   |
|--------|-------------------|----------------|---------------|------------------|---------------|
| 000    | 0.149" (3,78mm)   | 0.192 (4,88)   | 0.199 (5,05)  | 0.210 (5,33)     | 0.235 (5,97)  |
| 100    | 0.183 (4,65)      | 0.247 (6,27)   | 0.258 (6,55)  | 0.274 (6,96)     | 0.311 (7,90)  |
| 200    | 0.235 (5,97)      | 0.319 (8,10)   | 0.330 (8,38)  | 0.355 (9,02)     | 0.403 (10,24) |
| 300    | 0.334 (8,48)      | 0.458 (11,63)  | 0.464 (11,79) | 0.508 (12,90)    | 0.573 (14,55) |
| 400    | 0.475 (12,07)     | 0.634 (16,10)  | 0.645 (16,38) | 0.704 (17,88)    | 0.789 (20,04) |
| 500    | 0.787 (19,99)     | 1.024 (26,01)  | 1.037 (26,34) | 1.128 (28,65)    | 1.254 (31,85) |

Table 5.3 – Backup Ring Designs

| Seal/backup cross-section                                                                                          | Pressure Rating        | Description / application                                                                                                                                                                                                                              |
|--------------------------------------------------------------------------------------------------------------------|------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|  <b>Corner Reinforced</b>       | 15,000 psi (103.4 MPa) | A square cross-section insert used to add extrusion resistance to the standard extended heel design. Most cost effective method of upgrading the extended heel pressure rating.                                                                        |
|  <b>Angled Insert</b>           | 20,000 (137.9)         | A tapered insert mated with the seal adds support to a high pressure Variseal™ design, when gland length does not allow for a separate backup ring behind the seal. The design shown is for a rod seal, with the backup ring on the I.D. surface.      |
|  <b>Rectangular Backup Ring</b> | 20,000 (137.9)         | Most backup rings are made with this rectangular cross-section. Plastics which will deform slightly under load are used, so that fluid pressure acting on the ring causes it to expand radially, closing the extrusion gap.                            |
|  <b>Tapered Cam Ring</b>        | 30,000 (206.8)         | For pressures to 30,000 psi (206.8 MPa), a heavier tapered ring behind the seal allows it to “ramp up” under increasing pressure to keep the extrusion gap closed. This design has a matching taper on the heel of the seal.                           |
|  <b>Dual Cammed Rings</b>       | 30,000+ (206.8+)       | A matched set of tapered rings is used for pressures above 30,000 psi (206.8 MPa) where gland diameters change due to extreme pressure. The design shown is for a rod seal. The direction of the ramp would be reversed for a piston seal arrangement. |

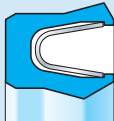
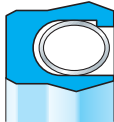
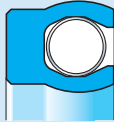
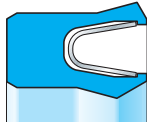
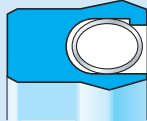
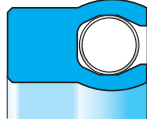
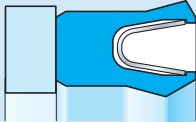
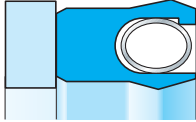
Information in this chart is intended only as a guide. Ratings may be higher or lower depending on hardware and service conditions. Seals should be tested under actual service conditions to determine the suitability of a design. Consult your local Variseal™ representative for applications greater than 30,000 psi (206.8 MPa)

<sup>1</sup> See definition of “seal series” in glossary.

# Rod and Piston Seals

## 5-6 Rod and Piston Seal Selection Guide

Table 5.4 – Rod and Piston Seal Selection Guide

| Cross-section and series             |                                                                                                               | Pressure Rating     | Temperature Range                            | Low Pressure Sealing | Description / Application                                                                                                                                                                         |
|--------------------------------------|---------------------------------------------------------------------------------------------------------------|---------------------|----------------------------------------------|----------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Standard Length Variseal™            |  M2                          | 3000 psi (20.7 MPa) | -320° to 575°F <sup>2</sup> (-196° to 302°C) | E <sup>1</sup>       | For general purpose static, reciprocating and slow rotary service. Applications include hydraulic and pneumatic cylinders actuators, valve stems, disconnects, nozzles, etc.                      |
|                                      |  W2                          | 3000 (20.7)         | -320° to 450° (-196 to 232°)                 | G                    | For applications similar to above that instead require close control of friction or torque, or with wider hardware tolerances or eccentricities; and for very small diameters and cross-sections. |
|                                      |  H                           | 3000 (20.7)         | -200° to 575° (-129° to 302°)                | E                    | For static and slow dynamic applications only. Good sealing for light gases, cryogenics, and vacuum; also tight sealing on less than ideal surface finishes.                                      |
| High Pressure Extended heel Variseal |  M2 High Pressure          | 10,000 (68.9)       | -320° to 575° (-196° to 302°)                | E                    | For greater extrusion resistance in applications with high pressures and/or temperatures, such as hydraulic cylinders, pressure accumulators, valve stems, etc.                                   |
|                                      |  W2 High Pressure          | 10,000 (68.9)       | -320° to 450° (-196° to 232°)                | G                    | Same as above but with a Slantcoil® spring load. The Slantcoil spring handles more sideloading without taking a compression set; and it offers closer control of friction.                        |
|                                      |  H High Pressure           | 10,000 (68.9)       | -200° to 575° (-129° to 302°)                | E                    | Same as above but with helical spring for very high unit loading in static service only.                                                                                                          |
| Variseal with Backup Rings           |  M2 High Pressure & Backup | 20,000 (137.9)      | -320° to 575° (-196° to 302°)                | E                    | For high pressure cylinders or vessels that require an anti-extrusion ring to support the seal. Backup rings are made from various high modulus plastics or metals. See pages 26 and 27.          |
|                                      |  W2 High Pressure & Backup | 20,000 (137.9)      | -320° to 450° (-196° to 232°)                | G                    | Same as above but with Slantcoil spring, which will not take a set when overcompressed in service or during installation into stepped glands.                                                     |

Unless otherwise stated, performance values shown in this table are based on Turcon® seal materials at 70°F (21°C) in static or slow service with the recommended E-gap from Tables 5.5, 5.6, 5.8, and 5.10.

<sup>1</sup>E = Excellent G = good F = Fair P = Poor. <sup>2</sup>For temps above 500°F (260°C), please reference the Society of Plastics Industry's *Safe Handling Guide*.



## 5-7 Rod and Piston Seal Selection Guide

Table 5.4 – (continued)

| Variseal Series           | Temp                        | Sealing ability in |          |      | Maximum Pressure       | Rotary service <sup>2</sup> |                        |                   |                  | Friction Rating |
|---------------------------|-----------------------------|--------------------|----------|------|------------------------|-----------------------------|------------------------|-------------------|------------------|-----------------|
|                           |                             | Light Gases        | Solvents | Oils |                        | Temp.                       | Maximum pressure at    |                   |                  |                 |
|                           |                             |                    |          |      |                        |                             | 30 sfpm<br>(0,15 m/s)  | 100<br>(0,51)     | 250<br>(1,27)    |                 |
| M2                        | -320°F<br>(-196°C)          | F <sup>1</sup>     | n/a      | n/a  | 5000 psi<br>(34.5 MPa) | 70°F<br>(21°C)              | 3000 psi<br>(20.7 MPa) | 2000<br>(13.8)    | 1500<br>(10.3)   | G               |
|                           | 70°F<br>(21°)               | G                  | G        | E    | 3000<br>(20.7)         | 250°<br>(121°)              | 2500<br>(17.2)         | 1500<br>(10.3)    | 1000<br>(6.9)    |                 |
|                           | 550° <sup>2</sup><br>(288°) | E                  | E        | E    | 1500<br>(10.3)         | 550°<br>(288°)              | 1500<br>(10.3)         | 750<br>(5.2)      | 500<br>(3.4)     |                 |
| W2                        | -320°<br>(-196°)            | F                  | n/a      | n/a  | 5000<br>(34.5)         | 70°<br>(21°)                | 3000<br>(20.7)         | 2000<br>(13.8)    | 1500<br>(10.3)   | E               |
|                           | 70°<br>(21°)                | G                  | G        | G    | 3000<br>(20.7)         | 250°<br>(121°)              | 2500<br>(17.2)         | 1500<br>(10.3)    | 1000<br>(6.9)    |                 |
|                           | 450°<br>(232°)              | G                  | E        | E    | 2000<br>(13.8)         | 450°<br>(232°)              | 2000<br>(13.8)         | 1000<br>(6.9)     | 750<br>(5.2)     |                 |
| H                         | -200°<br>(-129°)            | E                  | n/a      | n/a  | 5000<br>(34.5)         | 70°<br>(21°)                | 3000<br>(20.7)         | NR                | NR               | F               |
|                           | 70°<br>(21°)                | E                  | G        | E    | 3000<br>(20.7)         | 250°<br>(121°)              | 1500<br>(10.3)         | NR                | NR               |                 |
|                           | 550°<br>(288°)              | E                  | G        | G    | 1500<br>(10.3)         | 550°<br>(288°)              | 500<br>(3.4)           | NR                | NR               |                 |
| M2 High Pressure          | -320°<br>(-196°)            | F                  | n/a      | n/a  | 15,000<br>(103.4)      | 70°<br>(21°)                | 10,000<br>(68.9)       | 5000<br>(34.5)    | 2500<br>(17.2)   | G               |
|                           | 70°<br>(21°)                | G                  | G        | E    | 10,000<br>(69.0)       | 250°<br>(121°)              | 8000<br>(55.2)         | 4000<br>(27.6)    | 1500<br>(10.3)   |                 |
|                           | 550°<br>(288°)              | E                  | E        | E    | 5000<br>(34.5)         | 550°<br>(288°)              | 5000<br>(34.5)         | 3000<br>(20.7)    | 1000<br>(6.9)    |                 |
| W2 High Pressure          | -320°<br>(-196°)            | F                  | n/a      | n/a  | 15,000<br>(103.4)      | 70°<br>(21°)                | 10,000<br>(68.9)       | 5000<br>(34.5)    | 2500<br>(17.2)   | E               |
|                           | 70°<br>(21°)                | G                  | G        | G    | 10,000<br>(69.0)       | 250°<br>(121°)              | 8000<br>(55.2)         | 4000<br>(27.6)    | 1500<br>(10.3)   |                 |
|                           | 450°<br>(232°)              | G                  | E        | E    | 5500<br>(37.9)         | 450°<br>(232°)              | 5500<br>(37.9)         | 3250<br>(22.4)    | 1250<br>(18.6)   |                 |
| H High Pressure           | -200°<br>(-129°)            | E                  | n/a      | n/a  | 15,000<br>(103.4)      | 70°<br>(21°)                | 10,000<br>(68.9)       | NR                | NR               | F               |
|                           | 70°<br>(21°)                | E                  | G        | E    | 10,000<br>(69.0)       | 250°<br>(121°)              | 7000<br>(48.3)         | NR                | NR               |                 |
|                           | 550°<br>(288°)              | E                  | G        | G    | 5000<br>(34.5)         | 550°<br>(288°)              | 5000<br>(34.5)         | NR                | NR               |                 |
| M2 High Pressure & Backup | -320°<br>(-196°)            | F                  | n/a      | n/a  | 30,000<br>(206.8)      | 70°<br>(21°)                | 20,000<br>(137.9)      | 15,000<br>(103.4) | 10,000<br>(68.9) | G               |
|                           | 70°<br>(21°)                | G                  | G        | E    | 20,000<br>(137.9)      | 250°<br>(121°)              | 17,500<br>(120.7)      | 10,000<br>(68.9)  | 7500<br>(51.7)   |                 |
|                           | 550°<br>(288°)              | E                  | E        | E    | 10,000<br>(69.0)       | 550°<br>(288°)              | 8000<br>(55.2)         | 6000<br>(41.4)    | 4000<br>(27.6)   |                 |
| W2 High Pressure & Backup | -320°<br>(-196°)            | F                  | n/a      | n/a  | 30,000<br>(206.8)      | 70°<br>(21°)                | 20,000<br>(137.9)      | 15,000<br>(103.4) | 10,000<br>(68.9) | E               |
|                           | 70°<br>(21°)                | G                  | G        | G    | 20,000<br>(137.9)      | 250°<br>(121°)              | 17,500<br>(120.7)      | 10,000<br>(68.9)  | 7500<br>(51.7)   |                 |
|                           | 450°<br>(232°)              | G                  | E        | E    | 10,500<br>(72.4)       | 450°<br>(232°)              | 8500<br>(58.6)         | 6250<br>(43.1)    | 4250<br>(29.3)   |                 |

Ratings in this chart are intended only as a guide. Values may be higher or lower depending on factors such as mating surface finish, hardness, dynamic alignment, sideloading, presence of lubrication or coolant, etc.

<sup>1</sup> E = Excellent G = good F = Fair P = Poor n/a = Not Applicable NR = Not Recommended.

<sup>2</sup> For temps above 500°F (260°C), please reference the Society of Plastics Industry's *Safe Handling Guide*.

# Rod and Piston Seals

## 5-8 Rod and Piston Seal Part Number System

Figure 5.5 – Metric Part Numbering System

| R                                                                                                       | V | A | 2                                                                                                                                               | N | 1 | 2                                                                                                                                            | 0 | 5 | -                                                     | T | 0 | 9                                                                                                      | S | M |
|---------------------------------------------------------------------------------------------------------|---|---|-------------------------------------------------------------------------------------------------------------------------------------------------|---|---|----------------------------------------------------------------------------------------------------------------------------------------------|---|---|-------------------------------------------------------|---|---|--------------------------------------------------------------------------------------------------------|---|---|
| Article                                                                                                 |   |   | Nominal cross-section                                                                                                                           |   |   | Classification                                                                                                                               |   |   | Spring material                                       |   |   |                                                                                                        |   |   |
| R = Rod<br>P = Piston                                                                                   |   |   | 0 = 000 series, 1,42 mm<br>1 = 100 series, 2,26<br>2 = 200 series, 3,10<br>3 = 300 series, 4,72<br>4 = 400 series, 6,07<br>5 = 500 series, 9,50 |   |   | - = Industrial<br>A = Aerospace                                                                                                              |   |   | S = Stainless steel<br>H = Hastelloy*<br>E = Elgiloy* |   |   |                                                                                                        |   |   |
| Seal design                                                                                             |   |   | Size #                                                                                                                                          |   |   | Seal material                                                                                                                                |   |   | Spring load                                           |   |   |                                                                                                        |   |   |
| Standard                                                                                                |   |   | Extended Heel                                                                                                                                   |   |   | N#### ; Ø < 1000 mm (Ø × 10.0)*<br>V#### ; Ø ≥ 1000 mm (Ø × 1.0)*<br><br>ie. 120.5 mm = 120.5 x 10 = N1205<br>1300.0 mm = 1300.0 x 1 = V1300 |   |   | See Tables 3.2-3.3<br>on pages 22-25.                 |   |   | L = Light<br>M = Medium<br>H = Heavy<br><br>V-spring only<br>D = Medium/silicone<br>E = Heavy/silicone |   |   |
| V A = Variseal™ M2<br>V C = Variseal M2S<br>V E = Variseal H<br>V J = Variseal W2<br>V V = Variseal W2S |   |   | V B = Variseal M2<br>V D = Variseal M2S<br>V F = Variseal H<br>V L = Variseal W2<br>V X = Variseal W2S                                          |   |   |                                                                                                                                              |   |   |                                                       |   |   |                                                                                                        |   |   |

Figure 5.6 – Inch Fractional Part Numbering System

| R                                                                                                 | V | A | C                                                                                                                                                   | N                                                                                                 | B | 2                               | 3 | 0                                                                                                                                                                                     | -                                                   | T | 0 | 9                                         | S | M |
|---------------------------------------------------------------------------------------------------|---|---|-----------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------|---|---------------------------------|---|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------|---|---|-------------------------------------------|---|---|
| Article                                                                                           |   |   | Nominal cross-section                                                                                                                               |                                                                                                   |   | Classification                  |   |                                                                                                                                                                                       | Spring material                                     |   |   |                                           |   |   |
| R = Rod<br>P = Piston                                                                             |   |   | A = 000 series, 0.062"<br>B = 100 series, 0.093<br>C = 200 series, 0.125<br>D = 300 series, 0.187<br>E = 400 series, 0.250<br>G = 500 series, 0.375 |                                                                                                   |   | - = Industrial<br>A = Aerospace |   |                                                                                                                                                                                       | S = Stainless steel<br>H = Hastelloy<br>E = Elgiloy |   |   |                                           |   |   |
| Seal design                                                                                       |   |   |                                                                                                                                                     | Size/Dash #                                                                                       |   |                                 |   | Seal material                                                                                                                                                                         |                                                     |   |   | Spring load                               |   |   |
| Standard                                                                                          |   |   |                                                                                                                                                     | Extended Heel                                                                                     |   |                                 |   | See Tables 3.2-3.3 on pages 22-25.                                                                                                                                                    |                                                     |   |   | V-spring only                             |   |   |
| VA = Variseal M2<br>VC = Variseal M2S<br>VE = Variseal H<br>VJ = Variseal W2<br>VV = Variseal W2S |   |   |                                                                                                                                                     | VB = Variseal M2<br>VD = Variseal M2S<br>VF = Variseal H<br>VL = Variseal W2<br>VX = Variseal W2S |   |                                 |   | NB### ; Inch nominal dash #<br>R#### ; Ø < 10.00 inch (Ø x 1000)*<br>K#### ; Ø ≥ 10.00 inch (Ø x 100)*<br><br>ie. 5.260 in = 5.260 x 1000 = R5260<br>11.465 in = 11.465 x 100 = K1147 |                                                     |   |   | L = Light<br>M = Medium<br>H = Heavy      |   |   |
|                                                                                                   |   |   |                                                                                                                                                     |                                                                                                   |   |                                 |   |                                                                                                                                                                                       |                                                     |   |   | D = Medium/silicone<br>E = Heavy/silicone |   |   |

Figure 5.7 – AS4716 Part Numbering System

| R                                                                                                 | V | A                                                                                                 | 2                                                                                                                          | N                                                                                                                                                                           | M | 2 | 3                               | 0                                     | - | T                                                                                                      | 0 | 9           | S | M |
|---------------------------------------------------------------------------------------------------|---|---------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|---|---------------------------------|---------------------------------------|---|--------------------------------------------------------------------------------------------------------|---|-------------|---|---|
| Article                                                                                           |   |                                                                                                   | Nominal cross-section                                                                                                      |                                                                                                                                                                             |   |   | Classification                  |                                       |   | Spring material                                                                                        |   |             |   |   |
| R = Rod<br>P = Piston                                                                             |   |                                                                                                   | 0 = 000 series, 0.056"<br>1 = 100 series, 0.089<br>2 = 200 series, 0.122<br>3 = 300 series, 0.186<br>4 = 400 series, 0.239 |                                                                                                                                                                             |   |   | - = Industrial<br>A = Aerospace |                                       |   | S = Stainless steel<br>H = Hastelloy<br>E = Elgiloy                                                    |   |             |   |   |
| Seal design                                                                                       |   |                                                                                                   |                                                                                                                            | Size/Dash #                                                                                                                                                                 |   |   |                                 | Seal material                         |   |                                                                                                        |   | Spring load |   |   |
| Standard                                                                                          |   | Extended Heel                                                                                     |                                                                                                                            | NM### ; AS4716 dash #<br>R#### ; Ø < 10.00 inch (Ø x 1000)*<br>K#### ; Ø ≥ 10.00 inch (Ø x 100)*<br>ie. 5.260 in = 5.260 x 1000 = R5260<br>11.465 in = 11.465 x 100 = K1147 |   |   |                                 | See Tables 3.2-3.3<br>on pages 22-25. |   | L = Light<br>M = Medium<br>H = Heavy<br><br>V-spring only<br>D = Medium/silicone<br>E = Heavy/silicone |   |             |   |   |
| VA = Variseal M2<br>VC = Variseal M2S<br>VE = Variseal H<br>VJ = Variseal W2<br>VV = Variseal W2S |   | VB = Variseal M2<br>VD = Variseal M2S<br>VF = Variseal H<br>VL = Variseal W2<br>VX = Variseal W2S |                                                                                                                            |                                                                                                                                                                             |   |   |                                 |                                       |   |                                                                                                        |   |             |   |   |

\* If article = R, Ø is Rod Ø, if article = P, Ø is Bore Ø

## 5-9 Size Table - Metric Rod and Piston Glands

Figure 5.8 – Installation Drawing

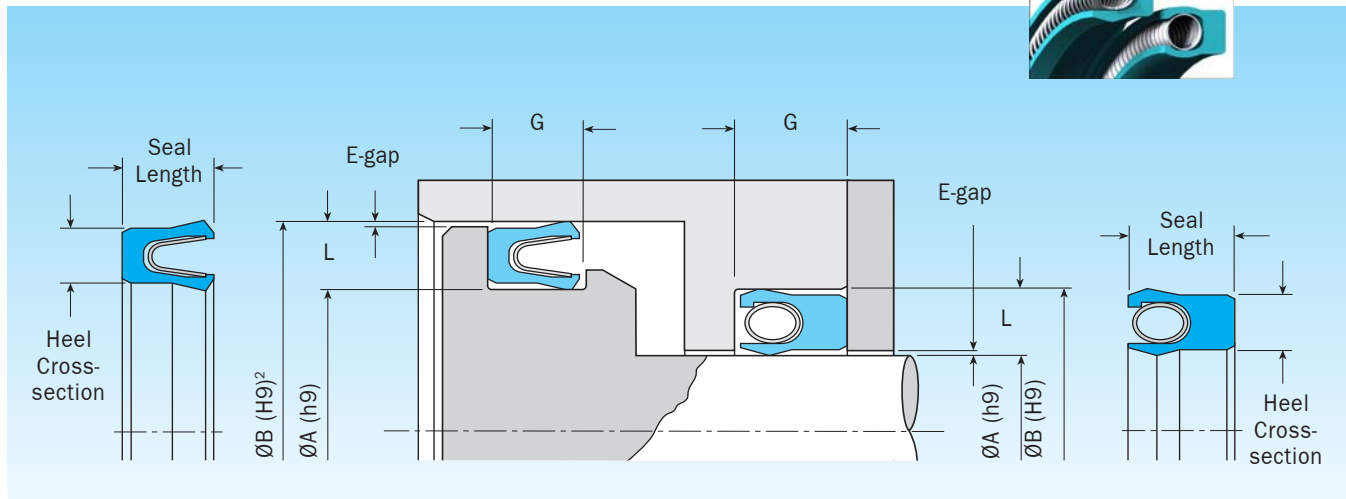


Table 5.5 – Installation Dimensions

| Series        |     | Heel                      | Seal               | L - Gland              | G                            | Maximum Extrusion Gap at Pressure <sup>1</sup> |                |                |                |
|---------------|-----|---------------------------|--------------------|------------------------|------------------------------|------------------------------------------------|----------------|----------------|----------------|
|               |     | Cross-section<br>(± 0,13) | Length<br>(± 0,13) | Cross-section<br>(Ref) | Gland Width<br>(+0,25/-0,00) | 300 psi<br>(2.1 MPa)                           | 1500<br>(10.3) | 3000<br>(20.7) | 5000<br>(34.5) |
| Standard Heel | 000 | 1,35 mm                   | 2,16 mm            | 1,42 mm                | 2,39 mm                      | 0,20 mm                                        | 0,10           | 0,08           | 0,05           |
|               | 100 | 2,11                      | 3,35               | 2,26                   | 3,58                         | 0,25                                           | 0,15           | 0,10           | 0,07           |
|               | 200 | 2,95                      | 4,29               | 3,10                   | 4,78                         | 0,35                                           | 0,20           | 0,15           | 0,08           |
|               | 300 | 4,55                      | 6,50               | 4,70                   | 7,14                         | 0,50                                           | 0,25           | 0,20           | 0,10           |
|               | 400 | 5,89                      | 8,89               | 6,07                   | 9,53                         | 0,60                                           | 0,30           | 0,25           | 0,12           |
|               | 500 | 9,30                      | 13,51              | 9,50                   | 15,00                        | 0,75                                           | 0,37           | 0,30           | 0,15           |
| Extended Heel | 000 | 1,35                      | 3,56               | 1,42                   | 3,78                         | 0,25                                           | 0,13           | 0,10           | 0,08           |
|               | 100 | 2,11                      | 4,42               | 2,26                   | 4,65                         | 0,33                                           | 0,20           | 0,13           | 0,10           |
|               | 200 | 2,95                      | 5,51               | 3,10                   | 5,97                         | 0,46                                           | 0,25           | 0,20           | 0,10           |
|               | 300 | 4,55                      | 7,87               | 4,70                   | 8,48                         | 0,64                                           | 0,33           | 0,25           | 0,13           |
|               | 400 | 5,89                      | 11,43              | 6,07                   | 12,07                        | 0,76                                           | 0,38           | 0,33           | 0,15           |
|               | 500 | 9,30                      | 18,50              | 9,50                   | 20,00                        | 0,87                                           | 0,50           | 0,40           | 0,20           |

Tables 5.5-5.9 provide the dimensions necessary to design the seal gland and perform basic dimensional inspection of Variseal™ M2, W2, and H designs.

The part number descriptions on the previous page include all of the options for specifying a standard radial Variseal. The tables on this and the following pages give dimensional data for standard Metric, Inch nominal, and AS4716 gland types. The AS4716 standard supersedes Mil-G-5514F; Variseal designs can be used in Mil-G-5514F glands.

For options not listed or requirements not available within the part number system, please contact your local Variseal representative.

Following is an example demonstrating the selection of a standard Variseal part number.

<sup>1</sup> Extrusion gap is at ambient temperatures. Pressure rating will be lower at higher temperatures.

<sup>2</sup> H9 and h9 are hole and shaft designations in the ANSI Standard for Clearance Locational Fits.

<sup>3</sup> See glossary.

### Part Number Example:

#### RVA200640-T29SM

The part number above is for a 200 series Variseal M2 with notches on the heel; made from Turcon® T29 and using a medium load stainless steel spring; for a non-aerospace, industrial application with a 64,00 mm rod.

This gland for this seal has the following dimensions:  
I.D. = 64,00mm, O.D. = 70,20mm, G = 4,78/5,03mm

The inspection dimensions for this seal are:  
Heel cross-section = 2,95 ± 0,13mm  
Seal length = 4,29 ± 0,13mm

The extrusion gap ranges from 0,35-0,08mm depending on the fluid pressure.

# Rod and Piston Seals

5-10 Size Table - Inch Fractional Rod and Piston Glands

Figure 5.9 - Installation Drawing

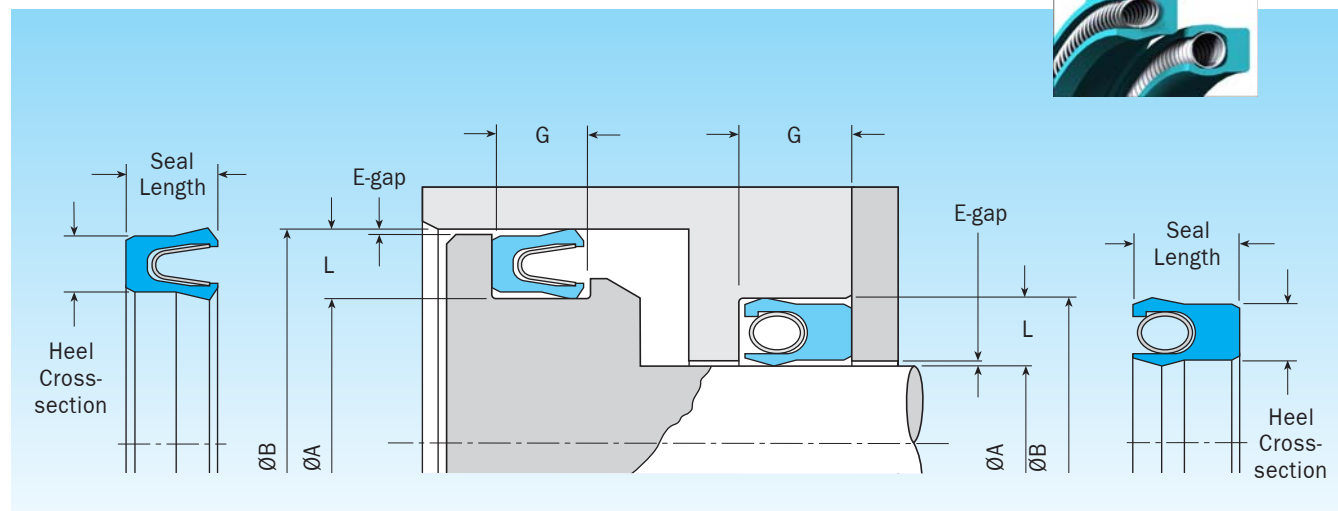


Table 5.6 - Installation Dimensions

| Series        | Heel Cross-section<br>(± 0.005) | Seal Length<br>(± 0.005) | L - Gland Cross-section<br>(Ref) | G Gland Width<br>(+0.010/-0.000) | Maximum Extrusion Gap at Pressure <sup>1</sup> |                |                |                |
|---------------|---------------------------------|--------------------------|----------------------------------|----------------------------------|------------------------------------------------|----------------|----------------|----------------|
|               |                                 |                          |                                  |                                  | 300 psi<br>(2.1 MPa)                           | 1500<br>(10.3) | 3000<br>(20.7) | 5000<br>(34.5) |
| Standard Heel | 000                             | 0.059"                   | 0.085"                           | 0.062"                           | 0.094"                                         | 0.008"         | 0.004          | 0.003          |
|               | 100                             | 0.088                    | 0.132                            | 0.093                            | 0.141                                          | 0.010          | 0.006          | 0.004          |
|               | 200                             | 0.119                    | 0.170                            | 0.125                            | 0.188                                          | 0.014          | 0.008          | 0.006          |
|               | 300                             | 0.180                    | 0.257                            | 0.187                            | 0.281                                          | 0.020          | 0.010          | 0.008          |
|               | 400                             | 0.243                    | 0.350                            | 0.250                            | 0.375                                          | 0.024          | 0.012          | 0.010          |
|               | 500                             | 0.367                    | 0.532                            | 0.375                            | 0.591                                          | 0.030          | 0.015          | 0.012          |
| Extended Heel | 000                             | 0.059                    | 0.140                            | 0.062                            | 0.149                                          | 0.010          | 0.005          | 0.004          |
|               | 100                             | 0.088                    | 0.174                            | 0.093                            | 0.183                                          | 0.013          | 0.008          | 0.005          |
|               | 200                             | 0.119                    | 0.217                            | 0.125                            | 0.235                                          | 0.018          | 0.010          | 0.008          |
|               | 300                             | 0.180                    | 0.310                            | 0.187                            | 0.334                                          | 0.025          | 0.013          | 0.010          |
|               | 400                             | 0.243                    | 0.450                            | 0.250                            | 0.475                                          | 0.030          | 0.015          | 0.013          |
|               | 500                             | 0.367                    | 0.728                            | 0.375                            | 0.787                                          | 0.035          | 0.020          | 0.015          |

Table 5.7 - Standard Dash Sizes

| Dash#      | ØA     |         | ØB      |         |         |
|------------|--------|---------|---------|---------|---------|
| 000 Series |        |         |         |         |         |
| 006        | 0.125" | + 0.000 | 0.250"  | + 0.001 |         |
| 007        | 0.156  | − 0.001 | 0.281   | − 0.000 |         |
| 008        | 0.187  |         | 0.312   |         |         |
| 009        | 0.218  |         | 0.343   |         |         |
| 010        | 0.250  |         | 0.375   |         | + 0.002 |
| 011        | 0.312  |         | 0.437   |         | − 0.000 |
| 012        | 0.375  | + 0.000 | 0.500   |         |         |
| 013        | 0.437  | − 0.002 | 0.562   |         |         |
| 014        | 0.500  |         | 0.625   |         |         |
| 015        | 0.562  |         | 0.687   |         |         |
| 016        | 0.625  |         | 0.750   |         |         |
| 017        | 0.687  |         | 0.812   |         |         |
| 018        | 0.750  |         | 0.875   |         |         |
| 019        | 0.812  |         | 0.937   |         |         |
| 020        | 0.875  |         | 1.000   |         |         |
| 100 Series |        |         |         |         |         |
| 106        | 0.187" | + 0.000 | 0.375"  | + 0.002 |         |
| 107        | 0.219  | − 0.001 | 0.406   | − 0.000 |         |
| 108        | 0.250  |         | 0.437   |         |         |
| 109        | 0.312  |         | 0.500   |         |         |
| 110        | 0.375  |         | + 0.000 |         | 0.562   |
| 111        | 0.437  |         | − 0.002 |         | 0.625   |
| 112        | 0.500  |         | 0.687   |         |         |
| 113        | 0.562  |         | 0.750   |         |         |
| 114        | 0.625  |         | 0.812   |         |         |
| 115        | 0.687  |         | 0.875   |         |         |
| 116        | 0.750  |         | 0.937   |         |         |
| 117        | 0.812  |         | 1.000   |         |         |
| 118        | 0.875  |         | 1.062   |         |         |
| 119        | 0.937  |         | 1.125   |         |         |
| 120        | 1.000  |         | 1.187   |         |         |

<sup>1</sup> Extrusion gap is at ambient temperatures. Pressure rating will be lower at higher temperatures.

## 5-11 Size Table – Inch Fractional Rod and Piston Glands

Table 5.7 – (continued)

| Dash#      | ØA     |         | ØB     |        |
|------------|--------|---------|--------|--------|
| 121        | 1.062  | + 0.000 | 1.250  | +0.002 |
| 122        | 1.125  | - 0.002 | 1.312  | -0.000 |
| 123        | 1.187  |         | 1.375  |        |
| 124        | 1.250  |         | 1.437  |        |
| 125        | 1.312  |         | 1.500  |        |
| 126        | 1.375  |         | 1.562  |        |
| 127        | 1.437  |         | 1.625  |        |
| 128        | 1.500  |         | 1.687  |        |
| 129        | 1.562  |         | 1.750  |        |
| 130        | 1.625  |         | 1.812  |        |
| 131        | 1.687  |         | 1.875  |        |
| 132        | 1.750  |         | 1.937  |        |
| 133        | 1.812  |         | 2.000  |        |
| 134        | 1.875  |         | 2.062  |        |
| 135        | 1.937  |         | 2.125  |        |
| 136        | 2.000  |         | 2.187  |        |
| 137        | 2.062  |         | 2.250  |        |
| 138        | 2.125  |         | 2.312  |        |
| 139        | 2.187  |         | 2.375  |        |
| 140        | 2.250  |         | 2.437  |        |
| 142        | 2.375  |         | 2.562  |        |
| 144        | 2.500  |         | 2.687  |        |
| 146        | 2.625  |         | 2.812  |        |
| 148        | 2.750  |         | 2.937  |        |
| 149        | 2.812  |         | 3.000  | +0.003 |
| 151        | 3.000  | + 0.000 | 3.187  | -0.000 |
| 153        | 3.500  | - 0.003 | 3.687  |        |
| 155        | 4.000  |         | 4.187  |        |
| 157        | 4.500  |         | 4.687  |        |
| 159        | 5.000  |         | 5.187  |        |
| 161        | 5.500  |         | 5.687  |        |
| 200 Series |        |         |        |        |
| 202*       | 0.250" | + 0.000 | 0.500" | +0.002 |
| 204*       | 0.375  | - 0.002 | 0.625  | -0.000 |
| 206        | 0.500  |         | 0.750  |        |
| 208        | 0.625  |         | 0.875  |        |
| 209        | 0.687  |         | 0.937  |        |
| 210        | 0.750  |         | 1.000  |        |
| 211        | 0.812  |         | 1.062  |        |
| 212        | 0.875  |         | 1.125  |        |
| 213        | 0.937  |         | 1.187  |        |
| 214        | 1.000  |         | 1.250  |        |
| 215        | 1.062  |         | 1.312  |        |
| 216        | 1.125  |         | 1.375  |        |
| 217        | 1.187  |         | 1.437  |        |
| 218        | 1.250  |         | 1.500  |        |
| 219        | 1.312  |         | 1.562  |        |
| 220        | 1.375  |         | 1.625  |        |
| 221        | 1.437  |         | 1.687  |        |
| 222        | 1.500  |         | 1.750  |        |
| 223        | 1.625  |         | 1.875  |        |
| 224        | 1.750  |         | 2.000  |        |
| 225        | 1.875  |         | 2.125  |        |
| 226        | 2.000  |         | 2.250  |        |
| 227        | 2.125  |         | 2.375  |        |
| 228        | 2.250  |         | 2.500  |        |
| 229        | 2.375  |         | 2.625  |        |
| 230        | 2.500  |         | 2.750  |        |
| 231        | 2.625  |         | 2.875  |        |
| 300 Series |        |         |        |        |
| 316        | 0.875" | + 0.000 | 1.250" | +0.002 |
| 317        | 0.937  | - 0.002 | 1.312  | -0.000 |
| 318        | 1.000  |         | 1.375  |        |
| 319        | 1.062  |         | 1.437  |        |
| 320        | 1.125  |         | 1.500  |        |
| 321        | 1.187  |         | 1.562  |        |
| 322        | 1.250  |         | 1.625  |        |
| 323        | 1.312  |         | 1.687  |        |
| 324        | 1.375  |         | 1.750  |        |
| 325        | 1.500  |         | 1.875  |        |
| 326        | 1.625  |         | 2.000  |        |
| 327        | 1.750  |         | 2.125  |        |
| 328        | 1.875  |         | 2.250  |        |
| 329        | 2.000  |         | 2.375  |        |
| 330        | 2.125  |         | 2.500  |        |
| 331        | 2.250  |         | 2.625  |        |
| 332        | 2.375  |         | 2.750  |        |
| 333        | 2.500  |         | 2.875  |        |
| 334        | 2.625  |         | 3.000  | +0.003 |
| 335        | 2.750  |         | 3.125  | -0.000 |
| 336        | 2.875  |         | 3.250  |        |
| 337        | 3.000  | + 0.000 | 3.375  |        |
| 338        | 3.125  | - 0.003 | 3.500  |        |
| 339        | 3.250  |         | 3.625  |        |
| 340        | 3.375  |         | 3.750  |        |
| 341        | 3.500  |         | 3.875  |        |
| 342        | 3.625  |         | 4.000  |        |
| 343        | 3.750  |         | 4.125  |        |
| 344        | 3.875  |         | 4.250  |        |
| 345        | 4.000  |         | 4.375  |        |
| 346        | 4.125  |         | 4.500  |        |
| 347        | 4.250  |         | 4.625  |        |
| 348        | 4.375  |         | 4.750  |        |
| 349        | 4.500  |         | 4.875  |        |
| 350        | 4.625  |         | 5.000  |        |
| 351        | 4.750  |         | 5.125  |        |
| 400 Series |        |         |        |        |
| 352        | 4.875  | + 0.000 | 5.250  | +0.003 |
| 353        | 5.000  | - 0.003 | 5.375  | -0.000 |
| 355        | 5.250  |         | 5.625  |        |
| 357        | 5.500  |         | 5.875  |        |
| 359        | 5.750  |         | 6.125  |        |
| 361        | 6.000  |         | 6.375  |        |
| 363        | 6.500  |         | 6.875  |        |
| 365        | 7.000  |         | 7.375  |        |
| 367        | 7.500  |         | 7.875  |        |
| 369        | 8.000  | + 0.000 | 8.375  | +0.004 |
| 371        | 8.500  | - 0.004 | 8.875  | -0.000 |
| 373        | 9.000  |         | 9.375  |        |
| 375        | 9.500  |         | 9.875  |        |
| 377        | 10.000 |         | 10.375 |        |
| 401        | 1.500" | + 0.000 | 2.000" | +0.002 |
| 402        | 1.625  | - 0.002 | 2.125  | -0.000 |
| 403        | 1.750  |         | 2.250  |        |
| 404        | 1.875  |         | 2.375  |        |
| 405        | 2.000  |         | 2.500  |        |
| 406        | 2.125  |         | 2.625  |        |
| 407        | 2.250  |         | 2.750  |        |
| 408        | 2.375  |         | 2.875  |        |
| 409        | 2.500  |         | 3.000  | +0.003 |
| 410        | 2.625  |         | 3.125  | -0.000 |
| 411        | 2.750  |         | 3.250  |        |
| 412        | 2.875  |         | 3.375  |        |
| 413        | 3.000  | + 0.000 | 3.500  |        |
| 414        | 3.125  | - 0.003 | 3.625  |        |
| 415        | 3.250  |         | 3.750  |        |
| 416        | 3.375  |         | 3.875  |        |
| 417        | 3.500  |         | 4.000  |        |
| 418        | 3.625  |         | 4.125  |        |
| 419        | 3.750  |         | 4.250  |        |
| 420        | 3.875  |         | 4.375  |        |
| 421        | 4.000  |         | 4.500  |        |
| 422        | 4.125  |         | 4.625  |        |
| 423        | 4.250  |         | 4.750  |        |
| 424        | 4.375  |         | 4.875  |        |
| 425        | 4.500  |         | 5.000  |        |
| 426        | 4.625  |         | 5.125  |        |
| 427        | 4.750  |         | 5.250  |        |
| 428        | 4.875  |         | 5.375  |        |
| 429        | 5.000  |         | 5.500  |        |
| 431        | 5.250  |         | 5.750  |        |
| 433        | 5.500  |         | 6.000  |        |
| 435        | 5.750  |         | 6.250  |        |
| 437        | 6.000  |         | 6.500  |        |
| 439        | 6.500  |         | 7.000  |        |
| 441        | 7.000  |         | 7.500  |        |
| 443        | 7.500  |         | 8.000  | +0.004 |
| 445        | 8.000  | + 0.000 | 8.500  | -0.000 |
| 446        | 8.500  | - 0.004 | 9.000  |        |
| 448        | 9.500  |         | 10.000 |        |
| 450        | 10.500 |         | 11.000 |        |
| 452        | 11.500 |         | 12.000 |        |
| 454        | 12.500 |         | 13.000 |        |
| 456        | 13.500 |         | 14.000 |        |
| 458        | 14.500 |         | 15.000 |        |

\* These dash sizes not available with V-spring.

# Rod and Piston Seals

5-12 Size Table - AS4716 Rod Glands

Figure 5.10 - Installation Drawing

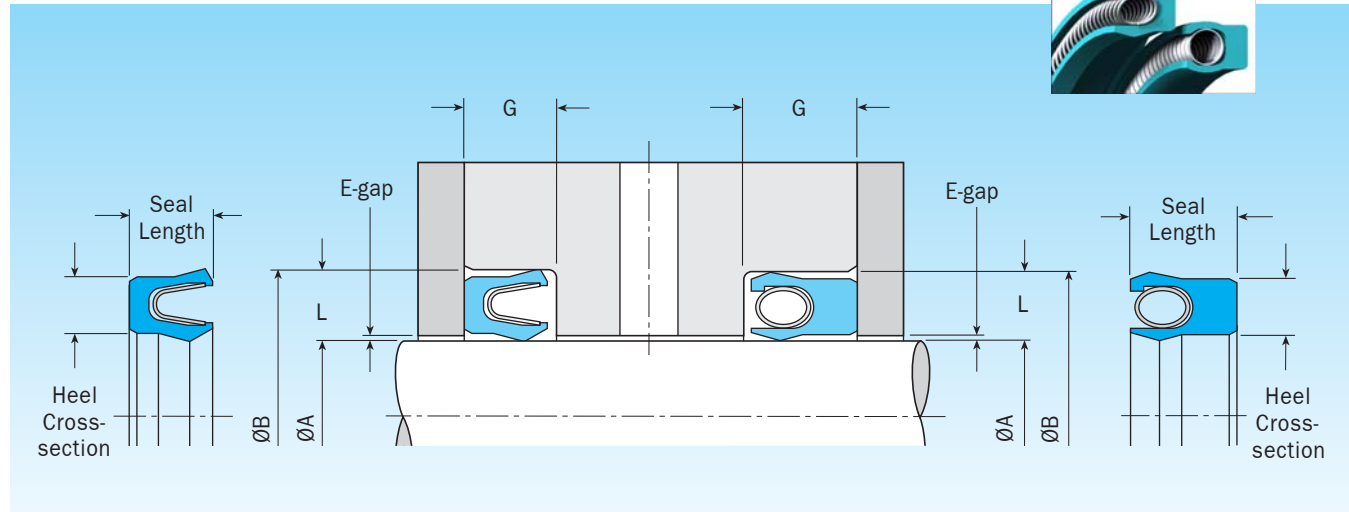


Table 5.8 - Installation Dimensions

| Series        | Heel Cross-section<br>(± 0.005) | Seal Length<br>(± 0.005) | L - Gland Cross-section<br>(Ref) | G Gland Width<br>(+0.010/-0.000) | Maximum Extrusion Gap at Pressure <sup>1</sup> |                |                |                |
|---------------|---------------------------------|--------------------------|----------------------------------|----------------------------------|------------------------------------------------|----------------|----------------|----------------|
|               |                                 |                          |                                  |                                  | 300 psi<br>(2.1 MPa)                           | 1500<br>(10.3) | 3000<br>(20.7) | 5000<br>(34.5) |
| Standard Heel | 000                             | 0.053"                   | 0.085"                           | 0.056"                           | 0.008"                                         | 0.004          | 0.003          | 0.002          |
|               | 100                             | 0.083                    | 0.132                            | 0.087                            | 0.010                                          | 0.006          | 0.004          | 0.003          |
|               | 200                             | 0.116                    | 0.170                            | 0.122                            | 0.014                                          | 0.008          | 0.006          | 0.003          |
|               | 300                             | 0.179                    | 0.257                            | 0.185                            | 0.020                                          | 0.010          | 0.008          | 0.004          |
|               | 400                             | 0.232                    | 0.350                            | 0.239                            | 0.024                                          | 0.012          | 0.010          | 0.005          |
| Extended Heel | 000                             | 0.053                    | 0.140                            | 0.056                            | 0.010                                          | 0.005          | 0.004          | 0.003          |
|               | 100                             | 0.083                    | 0.174                            | 0.087                            | 0.013                                          | 0.008          | 0.005          | 0.004          |
|               | 200                             | 0.116                    | 0.217                            | 0.122                            | 0.018                                          | 0.010          | 0.008          | 0.004          |
|               | 300                             | 0.179                    | 0.310                            | 0.185                            | 0.025                                          | 0.013          | 0.010          | 0.005          |
|               | 400                             | 0.232                    | 0.450                            | 0.239                            | 0.030                                          | 0.015          | 0.013          | 0.006          |

Table 5.9 - Standard Dash Sizes

| Dash#      | ØA     |         | ØB     |        | Dash#            | ØA    |         | ØB    |        | Dash# | ØA     |         | ØB     |        |
|------------|--------|---------|--------|--------|------------------|-------|---------|-------|--------|-------|--------|---------|--------|--------|
| 000 Series |        |         |        |        | 100 Series       |       |         |       |        |       |        |         |        |        |
| 006        | 0.123" | + 0.000 | 0.232" | +0.001 | 023              | 1.060 | + 0.000 | 1.170 | +0.002 | 106   | 0.185" | + 0.000 | 0.359" | +0.001 |
| 007        | 0.154  | - 0.001 | 0.264  | -0.000 | 024              | 1.123 | - 0.002 | 1.233 | -0.000 | 107   | 0.217  | - 0.001 | 0.392  | -0.000 |
| 008        | 0.185  |         | 0.294  |        | 025              | 1.185 |         | 1.295 |        | 108   | 0.248  |         | 0.423  |        |
| 009        | 0.217  |         | 0.327  |        | 026              | 1.248 |         | 1.358 |        | 109   | 0.310  |         | 0.486  |        |
| 010        | 0.248  |         | 0.359  |        | 027              | 1.310 |         | 1.420 |        | 110   | 0.373  | + 0.000 | 0.546  | +0.002 |
| 011        | 0.310  |         | 0.421  |        | 028              | 1.373 |         | 1.483 |        | 111   | 0.435  | - 0.002 | 0.609  | -0.000 |
| 012        | 0.373  |         | 0.484  |        | 029 <sup>†</sup> | 1.498 |         | 1.608 |        | 112   | 0.498  |         | 0.672  |        |
| 013        | 0.435  | + 0.000 | 0.545  | +0.002 | 030 <sup>†</sup> | 1.623 |         | 1.733 |        | 113   | 0.560  |         | 0.734  |        |
| 014        | 0.498  | - 0.002 | 0.608  | -0.000 | 031 <sup>†</sup> | 1.748 |         | 1.858 |        | 114   | 0.623  |         | 0.797  |        |
| 015        | 0.560  |         | 0.670  |        | 032 <sup>†</sup> | 1.873 |         | 1.983 |        | 115   | 0.685  |         | 0.859  |        |
| 016        | 0.623  |         | 0.733  |        | 033 <sup>†</sup> | 1.998 |         | 2.108 |        | 116   | 0.748  |         | 0.923  |        |
| 017        | 0.685  |         | 0.795  |        | 034 <sup>†</sup> | 2.123 |         | 2.233 |        | 117   | 0.810  |         | 0.985  |        |
| 018        | 0.748  |         | 0.858  |        | 035 <sup>†</sup> | 2.248 |         | 2.358 |        | 118   | 0.873  |         | 1.048  |        |
| 019        | 0.810  |         | 0.920  |        | 036 <sup>†</sup> | 2.373 |         | 2.483 |        | 119   | 0.935  |         | 1.110  |        |
| 020        | 0.873  |         | 0.983  |        | 037 <sup>†</sup> | 2.498 |         | 2.608 |        | 120   | 0.998  |         | 1.173  |        |
| 021        | 0.935  |         | 1.045  |        | 039 <sup>†</sup> | 2.748 |         | 2.858 |        | 121   | 1.060  |         | 1.235  |        |
| 022        | 0.998  |         | 1.108  |        | 041 <sup>†</sup> | 2.997 |         | 3.108 |        | 122   | 1.123  |         | 1.298  |        |
|            |        |         |        |        | 043 <sup>†</sup> | 3.497 |         | 3.608 |        |       |        |         |        |        |

<sup>1</sup>Extrusion gap is at ambient temperatures. Pressure rating will be lower at higher temperatures.

† These dash sizes extend beyond the AS4716 specification.



## 5-13 Size Table - AS4716 Rod Glands

Table 5.9 - (continued)

| Dash#      | ØA     |         | ØB     |         |
|------------|--------|---------|--------|---------|
| 123        | 1.185  |         | 1.360  |         |
| 124        | 1.248  | + 0.000 | 1.423  | + 0.002 |
| 125        | 1.310  | - 0.002 | 1.485  | - 0.000 |
| 126        | 1.373  |         | 1.548  |         |
| 127        | 1.435  |         | 1.610  |         |
| 128        | 1.498  |         | 1.673  |         |
| 129        | 1.560  |         | 1.735  |         |
| 130        | 1.623  |         | 1.798  |         |
| 131        | 1.685  |         | 1.860  |         |
| 132        | 1.748  |         | 1.923  |         |
| 133        | 1.810  |         | 1.984  |         |
| 134        | 1.873  |         | 2.047  |         |
| 135        | 1.936  |         | 2.110  |         |
| 136        | 1.998  |         | 2.172  |         |
| 137        | 2.061  |         | 2.235  |         |
| 138        | 2.123  |         | 2.297  |         |
| 139        | 2.186  |         | 2.360  |         |
| 140        | 2.248  |         | 2.422  |         |
| 141        | 2.311  |         | 2.485  |         |
| 142        | 2.373  |         | 2.547  |         |
| 143        | 2.436  |         | 2.610  |         |
| 144        | 2.498  |         | 2.672  |         |
| 145        | 2.561  |         | 2.735  |         |
| 146        | 2.623  |         | 2.797  |         |
| 148        | 2.748  |         | 2.922  |         |
| 149        | 2.811  |         | 2.985  |         |
| 151†       | 2.997  |         | 3.171  |         |
| 153†       | 3.497  |         | 3.671  |         |
| 155†       | 3.997  |         | 4.171  |         |
| 157†       | 4.497  | + 0.000 | 4.671  | + 0.003 |
| 159†       | 4.997  | - 0.003 | 5.171  | - 0.000 |
| 200 Series |        |         |        |         |
| 202†*      | 0.248" | + 0.000 | 0.489" | + 0.002 |
| 204†*      | 0.373  | - 0.002 | 0.614  | - 0.000 |
| 206†       | 0.498  |         | 0.739  |         |
| 208†       | 0.623  |         | 0.864  |         |
| 209†       | 0.685  |         | 0.926  |         |
| 210        | 0.748  |         | 0.989  |         |
| 211        | 0.810  |         | 1.051  |         |
| 212        | 0.873  |         | 1.115  |         |
| 213        | 0.935  |         | 1.177  |         |
| 214        | 0.998  |         | 1.240  |         |
| 215        | 1.060  |         | 1.302  |         |
| 216        | 1.123  |         | 1.365  |         |
| 217        | 1.185  |         | 1.427  |         |
| 218        | 1.248  |         | 1.490  |         |
| 219        | 1.310  |         | 1.552  |         |
| 220        | 1.373  |         | 1.615  |         |
| 221        | 1.435  |         | 1.677  |         |
| 222        | 1.498  |         | 1.740  |         |
| 223        | 1.623  |         | 1.865  |         |
| 224        | 1.748  |         | 1.990  |         |
| 225        | 1.873  |         | 2.115  |         |
| 226        | 1.998  |         | 2.240  |         |
| 227        | 2.123  |         | 2.365  |         |
| 228        | 2.248  |         | 2.490  |         |
| 229        | 2.373  |         | 2.615  |         |
| 230        | 2.498  |         | 2.740  |         |
| 231        | 2.623  |         | 2.865  |         |
| 300 Series |        |         |        |         |
| 316†       | 0.873" | + 0.000 | 1.245" | + 0.002 |
| 317†       | 0.935  | - 0.002 | 1.308  | - 0.000 |
| 318†       | 0.998  |         | 1.370  |         |
| 319†       | 1.060  |         | 1.432  |         |
| 320†       | 1.123  |         | 1.495  |         |
| 321†       | 1.185  |         | 1.557  |         |
| 322†       | 1.248  |         | 1.620  |         |
| 323†       | 1.310  |         | 1.682  |         |
| 324†       | 1.373  |         | 1.745  |         |
| 325        | 1.498  |         | 1.870  |         |
| 326        | 1.623  |         | 1.995  |         |
| 327        | 1.748  |         | 2.120  |         |
| 328        | 1.873  |         | 2.245  |         |
| 329        | 1.998  |         | 2.370  |         |
| 330        | 2.123  |         | 2.495  |         |
| 331        | 2.248  |         | 2.620  |         |
| 332        | 2.373  |         | 2.745  |         |
| 333        | 2.498  |         | 2.870  |         |
| 334        | 2.623  |         | 2.995  |         |
| 335        | 2.748  |         | 3.120  |         |
| 336        | 2.873  |         | 3.245  |         |
| 337        | 2.997  |         | 3.369  |         |
| 338        | 3.122  |         | 3.494  |         |
| 339        | 3.247  |         | 3.619  |         |
| 340        | 3.372  |         | 3.744  |         |
| 341        | 3.497  |         | 3.869  |         |
| 342        | 3.622  |         | 3.994  |         |
| 343        | 3.747  |         | 4.119  |         |
| 344        | 3.872  |         | 4.244  |         |
| 345        | 3.997  |         | 4.369  |         |
| 346        | 4.122  |         | 4.494  |         |
| 347        | 4.247  |         | 4.619  |         |
| 348        | 4.372  |         | 4.744  |         |
| 349        | 4.497  |         | 4.869  |         |
| 350†       | 4.622  | + 0.000 | 4.994  | + 0.003 |
| 351†       | 4.747  | - 0.003 | 5.119  | - 0.000 |
| 400 Series |        |         |        |         |
| 352†       | 4.872  | + 0.000 | 5.244  | + 0.003 |
| 353†       | 4.997  | - 0.003 | 5.369  | - 0.000 |
| 355†       | 5.247  |         | 5.619  |         |
| 357†       | 5.497  |         | 5.869  |         |
| 359†       | 5.747  |         | 6.119  |         |
| 361†       | 5.997  |         | 6.369  |         |
| 363†       | 6.497  |         | 6.869  |         |
| 365†       | 6.997  |         | 7.369  |         |
| 367†       | 7.497  |         | 7.869  |         |
| 369†       | 7.997  |         | 8.369  |         |
| 371†       | 8.497  |         | 8.869  |         |
| 373†       | 8.997  |         | 9.369  | + 0.004 |
| 375†       | 9.497  |         | 9.869  | - 0.000 |
| 377†       | 9.997  |         | 10.369 |         |
| 401†       | 1.498" | + 0.000 | 1.974" | + 0.002 |
| 402†       | 1.623  | - 0.002 | 2.099  | - 0.000 |
| 403†       | 1.748  |         | 2.224  |         |
| 404†       | 1.873  |         | 2.349  |         |
| 405†       | 1.998  |         | 2.474  |         |
| 406†       | 2.123  |         | 2.599  |         |
| 407†       | 2.248  |         | 2.724  |         |
| 408†       | 2.373  |         | 2.849  |         |
| 409†       | 2.498  |         | 2.974  |         |
| 410†       | 2.623  |         | 3.099  |         |
| 411†       | 2.748  |         | 3.224  |         |
| 412†       | 2.873  |         | 3.349  |         |
| 413†       | 2.997  |         | 3.474  |         |
| 414†       | 3.122  |         | 3.599  |         |
| 415†       | 3.247  |         | 3.724  |         |
| 416†       | 3.372  |         | 3.849  |         |
| 417†       | 3.497  |         | 3.974  |         |
| 418†       | 3.622  |         | 4.099  |         |
| 419†       | 3.747  |         | 4.224  |         |
| 420†       | 3.872  |         | 4.349  |         |
| 421†       | 3.997  |         | 4.474  |         |
| 422†       | 4.122  |         | 4.599  |         |
| 423†       | 4.247  |         | 4.724  |         |
| 424†       | 4.372  |         | 4.849  |         |
| 425        | 4.497  | + 0.000 | 4.974  | + 0.003 |
| 426        | 4.622  | - 0.003 | 5.099  | - 0.000 |
| 427        | 4.747  |         | 5.224  |         |
| 429        | 4.997  |         | 5.474  |         |
| 431        | 5.247  |         | 5.724  |         |
| 433        | 5.497  |         | 5.974  |         |
| 435        | 5.747  |         | 6.224  |         |
| 437        | 5.997  |         | 6.474  |         |
| 439        | 6.497  |         | 6.974  |         |
| 441        | 6.997  |         | 7.474  |         |
| 443        | 7.497  |         | 7.974  |         |
| 445        | 7.997  |         | 8.474  |         |
| 446        | 8.497  |         | 8.974  |         |
| 448        | 9.497  |         | 9.974  | + 0.004 |
| 450        | 10.497 |         | 10.974 | - 0.000 |
| 452        | 11.497 |         | 11.974 |         |
| 454        | 12.497 |         | 12.974 |         |
| 456        | 13.497 |         | 13.974 |         |
| 458        | 14.497 |         | 14.974 |         |
| 460        | 15.497 |         | 15.974 |         |

\* These dash sizes not available with V-spring.

† These dash sizes extend beyond the AS4716 specification.

# Rod and Piston Seals

5-14 Size Table - AS4716 Piston Glands

Figure 5.11 - Installation Drawing

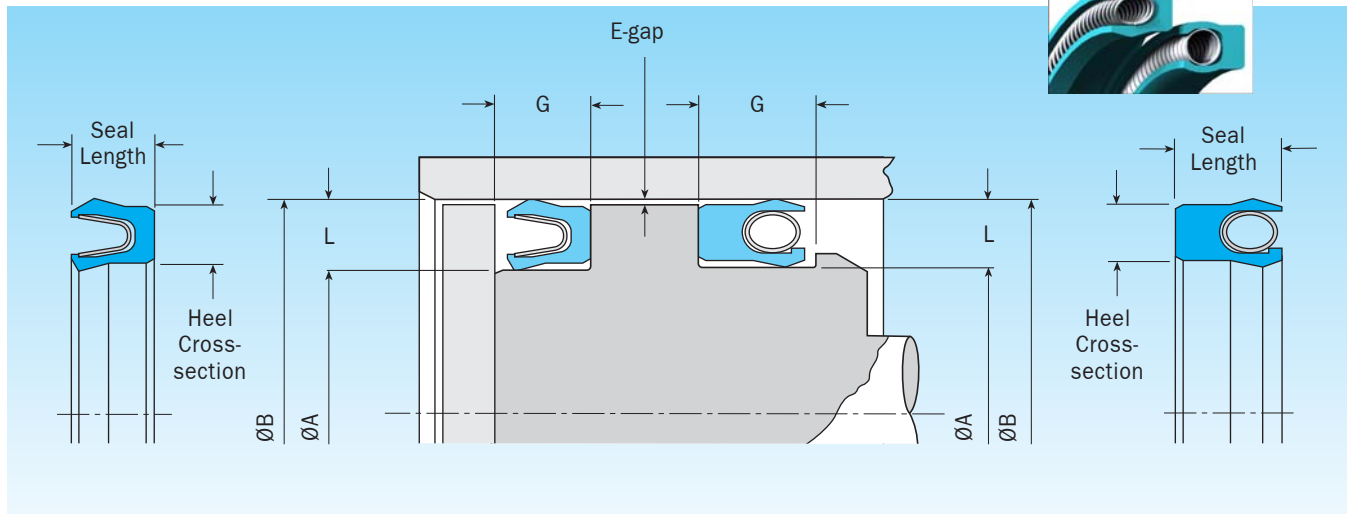


Table 5.10 - Installation Dimensions

| Series        | Heel Cross-section<br>(± 0.005) | Seal Length<br>(± 0.005) | L - Gland Cross-section<br>(Ref) | G Gland Width<br>(+0.010/-0.000) | Maximum Extrusion Gap at Pressure <sup>1</sup> |                |                |                |
|---------------|---------------------------------|--------------------------|----------------------------------|----------------------------------|------------------------------------------------|----------------|----------------|----------------|
|               |                                 |                          |                                  |                                  | 300 psi<br>(2.1 MPa)                           | 1500<br>(10.3) | 3000<br>(20.7) | 5000<br>(34.5) |
| Standard Heel | 000                             | 0.085"                   | 0.056"                           | 0.094"                           | 0.008"                                         | 0.004          | 0.003          | 0.002          |
|               | 100                             | 0.132                    | 0.087                            | 0.141                            | 0.010                                          | 0.006          | 0.004          | 0.003          |
|               | 200                             | 0.170                    | 0.122                            | 0.188                            | 0.014                                          | 0.008          | 0.006          | 0.003          |
|               | 300                             | 0.257                    | 0.185                            | 0.281                            | 0.020                                          | 0.010          | 0.008          | 0.004          |
|               | 400                             | 0.350                    | 0.239                            | 0.375                            | 0.024                                          | 0.012          | 0.010          | 0.005          |
| Extended Heel | 000                             | 0.140                    | 0.056                            | 0.150                            | 0.010                                          | 0.005          | 0.004          | 0.003          |
|               | 100                             | 0.169                    | 0.087                            | 0.183                            | 0.013                                          | 0.008          | 0.005          | 0.004          |
|               | 200                             | 0.205                    | 0.122                            | 0.235                            | 0.018                                          | 0.010          | 0.008          | 0.004          |
|               | 300                             | 0.311                    | 0.185                            | 0.334                            | 0.025                                          | 0.013          | 0.010          | 0.005          |
|               | 400                             | 0.417                    | 0.239                            | 0.475                            | 0.030                                          | 0.015          | 0.013          | 0.006          |

Table 5.11 - Standard Dash Sizes

| Dash#      | ØA     |         | ØB    |        |
|------------|--------|---------|-------|--------|
| 000 Series |        |         |       |        |
| 006        | 0.123" | + 0.000 | 0.235 | +0.001 |
| 007        | 0.154  | - 0.001 | 0.266 | -0.000 |
| 008        | 0.189  |         | 0.297 |        |
| 009        | 0.220  |         | 0.329 |        |
| 010        | 0.250  |         | 0.360 |        |
| 011        | 0.312  |         | 0.422 |        |
| 012        | 0.375  |         | 0.485 |        |
| 013        | 0.441  | + 0.000 | 0.550 | +0.002 |
| 014        | 0.504  | - 0.002 | 0.613 | -0.000 |
| 015        | 0.566  |         | 0.675 |        |
| 016        | 0.629  |         | 0.738 |        |
| 017        | 0.691  |         | 0.800 |        |
| 018        | 0.753  |         | 0.863 |        |
| 019        | 0.815  |         | 0.925 |        |
| 020        | 0.881  |         | 0.991 |        |
| 021        | 0.943  |         | 1.053 |        |
| 022        | 1.006  |         | 1.116 |        |

| Dash# | ØA    |         | ØB    |        |
|-------|-------|---------|-------|--------|
| 023   | 1.068 | + 0.000 | 1.178 | +0.002 |
| 024   | 1.131 | - 0.002 | 1.241 | -0.000 |
| 025   | 1.193 |         | 1.303 |        |
| 026   | 1.256 |         | 1.366 |        |
| 027   | 1.318 |         | 1.428 |        |
| 028   | 1.381 |         | 1.491 |        |
| 029†  | 1.506 |         | 1.616 |        |
| 030†  | 1.631 |         | 1.741 |        |
| 031†  | 1.757 |         | 1.867 |        |
| 032†  | 1.882 |         | 1.992 |        |
| 033†  | 2.008 |         | 2.118 |        |
| 034†  | 2.133 |         | 2.243 |        |
| 035†  | 2.258 |         | 2.368 |        |
| 036†  | 2.383 |         | 2.493 |        |
| 037†  | 2.508 |         | 2.618 |        |
| 039†  | 2.758 |         | 2.868 |        |
| 041†  | 3.008 |         | 3.118 |        |
| 043†  | 3.508 |         | 3.618 |        |

| Dash#      | ØA     |         | ØB     |         |
|------------|--------|---------|--------|---------|
| 100 Series |        |         |        |         |
| 106        | 0.187" | + 0.000 | 0.360" | + 0.001 |
| 107        | 0.225  | - 0.001 | 0.391  | - 0.000 |
| 108        | 0.256  |         | 0.422  |         |
| 109        | 0.308  |         | 0.485  |         |
| 110        | 0.379  | + 0.000 | 0.550  | + 0.002 |
| 111        | 0.441  | - 0.002 | 0.613  | - 0.000 |
| 112        | 0.502  |         | 0.675  |         |
| 113        | 0.565  |         | 0.738  |         |
| 114        | 0.627  |         | 0.800  |         |
| 115        | 0.689  |         | 0.863  |         |
| 116        | 0.751  |         | 0.925  |         |
| 117        | 0.817  |         | 0.991  |         |
| 118        | 0.879  |         | 1.053  |         |
| 119        | 0.942  |         | 1.116  |         |
| 120        | 1.003  |         | 1.178  |         |
| 121        | 1.066  |         | 1.241  |         |
| 122        | 1.128  |         | 1.303  |         |

<sup>1</sup>Extrusion gap is at ambient temperatures. Pressure rating will be lower at higher temperatures.

† These dash sizes extend beyond the AS4716 specification.

5-15 Size Table – AS4716 Piston Glands

| Table 5.11 – (continued) |        |         |        |        |  |            |        |         |        |        |      |            |        |         |        |         |  |
|--------------------------|--------|---------|--------|--------|--|------------|--------|---------|--------|--------|------|------------|--------|---------|--------|---------|--|
| Dash#                    |        | ØA      |        | ØB     |  | Dash#      |        | ØA      |        | ØB     |      | Dash#      |        | ØA      |        | ØB      |  |
| 123                      | 1.191  | + 0.000 | 1.366  | +0.002 |  | 232        | 2.751  | + 0.000 | 2.993  | +0.002 |      | 352†       | 4.871  | + 0.000 | 5.243  | + 0.003 |  |
| 124                      | 1.253  | - 0.002 | 1.428  | -0.000 |  | 233        | 2.876  | - 0.002 | 3.118  | -0.000 |      | 353†       | 4.996  | - 0.003 | 5.368  | -0.000  |  |
| 125                      | 1.316  |         | 1.491  |        |  | 234        | 3.001  |         | 3.243  |        |      | 355†       | 5.246  |         | 5.618  |         |  |
| 126                      | 1.378  |         | 1.553  |        |  | 235        | 3.126  |         | 3.368  |        |      | 357†       | 5.496  |         | 5.868  |         |  |
| 127                      | 1.441  |         | 1.616  |        |  | 236        | 3.251  |         | 3.493  |        |      | 359†       | 5.746  |         | 6.118  |         |  |
| 128                      | 1.503  |         | 1.678  |        |  | 238        | 3.501  |         | 3.743  |        |      | 361†       | 5.996  |         | 6.368  |         |  |
| 129                      | 1.566  |         | 1.741  |        |  | 240        | 3.751  |         | 3.993  |        |      | 363†       | 6.496  |         | 6.868  |         |  |
| 130                      | 1.631  |         | 1.805  |        |  | 242        | 4.001  |         | 4.243  |        |      | 365†       | 6.996  |         | 7.368  |         |  |
| 131                      | 1.693  |         | 1.867  |        |  | 244        | 4.251  |         | 4.493  |        |      | 367†       | 7.496  |         | 7.868  |         |  |
| 132                      | 1.756  |         | 1.930  |        |  | 246        | 4.501  |         | 4.743  |        |      | 369†       | 7.996  |         | 8.368  |         |  |
| 133                      | 1.818  |         | 1.992  |        |  | 248†       | 4.751  | + 0.000 | 4.993  | +0.003 |      | 371†       | 8.496  |         | 8.868  |         |  |
| 134                      | 1.881  |         | 2.055  |        |  | 250†       | 5.001  | - 0.003 | 5.243  | -0.000 |      | 373†       | 8.996  |         | 9.368  | + 0.004 |  |
| 135                      | 1.944  |         | 2.118  |        |  | 252†       | 5.251  |         | 5.493  |        |      | 375†       | 9.496  |         | 9.868  | -0.000  |  |
| 136                      | 2.006  |         | 2.180  |        |  | 254†       | 5.501  |         | 5.743  |        |      | 377†       | 9.996  |         | 10.368 |         |  |
| 137                      | 2.069  |         | 2.243  |        |  | 256†       | 5.751  |         | 5.993  |        |      | 400 Series |        |         |        |         |  |
| 138                      | 2.131  |         | 2.305  |        |  | 258†       | 6.001  |         | 6.243  |        |      | 401†       | 1.498" | + 0.000 | 1.974" | + 0.002 |  |
| 139                      | 2.194  |         | 2.368  |        |  | 260†       | 6.501  |         | 6.743  |        |      | 402†       | 1.623  | - 0.002 | 2.099  | -0.000  |  |
| 140                      | 2.256  |         | 2.430  |        |  | 262†       | 7.001  |         | 7.243  |        |      | 403†       | 1.748  |         | 2.224  |         |  |
| 141                      | 2.319  |         | 2.493  |        |  | 264†       | 7.501  |         | 7.743  |        |      | 404†       | 1.873  |         | 2.349  |         |  |
| 142                      | 2.381  |         | 2.555  |        |  | 266†       | 8.001  |         | 8.243  |        |      | 405†       | 1.998  |         | 2.474  |         |  |
| 143                      | 2.444  |         | 2.618  |        |  | 268†       | 8.501  |         | 8.743  |        |      | 406†       | 2.123  |         | 2.599  |         |  |
| 144                      | 2.506  |         | 2.680  |        |  | 270†       | 9.001  |         | 9.243  |        |      | 407†       | 2.248  |         | 2.724  |         |  |
| 145                      | 2.569  |         | 2.743  |        |  | 300 Series |        |         |        |        | 408† | 2.373      |        | 2.849   |        |         |  |
| 146                      | 2.631  |         | 2.805  |        |  | 316†       | 0.869" | + 0.000 | 1.241" | +0.002 |      | 409†       | 2.498  |         | 2.974  |         |  |
| 148                      | 2.756  |         | 2.930  |        |  | 317†       | 0.931  | - 0.002 | 1.303  | -0.000 |      | 410†       | 2.623  |         | 3.099  |         |  |
| 149                      | 2.819  |         | 2.993  |        |  | 318†       | 0.994  |         | 1.366  |        |      | 411†       | 2.748  |         | 3.224  |         |  |
| 151†                     | 3.006  |         | 3.180  |        |  | 319†       | 1.056  |         | 1.428  |        |      | 412†       | 2.873  |         | 3.349  |         |  |
| 153†                     | 3.506  |         | 3.680  |        |  | 320†       | 1.119  |         | 1.491  |        |      | 413†       | 2.997  |         | 3.474  |         |  |
| 155†                     | 4.006  |         | 4.180  |        |  | 321†       | 1.181  |         | 1.553  |        |      | 414†       | 3.122  |         | 3.599  |         |  |
| 157†                     | 4.506  | + 0.000 | 4.680  | +0.003 |  | 322†       | 1.244  |         | 1.616  |        |      | 415†       | 3.247  |         | 3.724  |         |  |
| 159†                     | 5.006  | - 0.003 | 5.180  | -0.000 |  | 323†       | 1.306  |         | 1.678  |        |      | 416†       | 3.372  |         | 3.849  |         |  |
| 200 Series               |        |         |        |        |  | 324†       | 1.369  |         | 1.741  |        |      | 417†       | 3.497  |         | 3.974  |         |  |
| 202†*                    | 0.244" | + 0.000 | 0.485" | +0.002 |  | 325        | 1.495  |         | 1.867  |        |      | 418†       | 3.622  |         | 4.099  |         |  |
| 204†*                    | 0.372  | - 0.002 | 0.613  | -0.000 |  | 326        | 1.620  |         | 1.992  |        |      | 419†       | 3.747  |         | 4.224  |         |  |
| 206†                     | 0.497  |         | 0.738  |        |  | 327        | 1.746  |         | 2.118  |        |      | 420†       | 3.872  |         | 4.349  |         |  |
| 208†                     | 0.622  |         | 0.863  |        |  | 328        | 1.871  |         | 2.243  |        |      | 421†       | 3.997  |         | 4.474  |         |  |
| 209†                     | 0.684  |         | 0.925  |        |  | 329        | 1.996  |         | 2.368  |        |      | 422†       | 4.122  |         | 4.599  |         |  |
| 210                      | 0.750  |         | 0.991  |        |  | 330        | 2.121  |         | 2.493  |        |      | 423†       | 4.247  |         | 4.724  |         |  |
| 211                      | 0.812  |         | 1.053  |        |  | 331        | 2.246  |         | 2.618  |        |      | 424†       | 4.372  |         | 4.849  |         |  |
| 212                      | 0.874  |         | 1.116  |        |  | 332        | 2.371  |         | 2.743  |        |      | 425        | 4.497  | + 0.000 | 4.974  | + 0.003 |  |
| 213                      | 0.936  |         | 1.178  |        |  | 333        | 2.496  |         | 2.868  |        |      | 426        | 4.622  | - 0.003 | 5.099  | -0.000  |  |
| 214                      | 0.999  |         | 1.241  |        |  | 334        | 2.621  |         | 2.993  |        |      | 427        | 4.747  |         | 5.224  |         |  |
| 215                      | 1.061  |         | 1.303  |        |  | 335        | 2.746  |         | 3.118  |        |      | 429        | 4.997  |         | 5.474  |         |  |
| 216                      | 1.124  |         | 1.366  |        |  | 336        | 2.871  |         | 3.243  |        |      | 431        | 5.247  |         | 5.724  |         |  |
| 217                      | 1.186  |         | 1.428  |        |  | 337        | 2.996  |         | 3.368  |        |      | 433        | 5.497  |         | 5.974  |         |  |
| 218                      | 1.249  |         | 1.491  |        |  | 338        | 3.121  |         | 3.493  |        |      | 435        | 5.747  |         | 6.224  |         |  |
| 219                      | 1.311  |         | 1.553  |        |  | 339        | 3.246  |         | 3.618  |        |      | 437        | 5.997  |         | 6.474  |         |  |
| 220                      | 1.374  |         | 1.616  |        |  | 340        | 3.371  |         | 3.743  |        |      | 439        | 6.497  |         | 6.974  |         |  |
| 221                      | 1.436  |         | 1.678  |        |  | 341        | 3.496  |         | 3.868  |        |      | 441        | 6.997  |         | 7.474  |         |  |
| 222                      | 1.499  |         | 1.741  |        |  | 342        | 3.621  |         | 3.993  |        |      | 443        | 7.497  |         | 7.974  |         |  |
| 223                      | 1.625  |         | 1.867  |        |  | 343        | 3.746  |         | 4.118  |        |      | 445        | 7.997  |         | 8.474  |         |  |
| 224                      | 1.750  |         | 1.992  |        |  | 344        | 3.871  |         | 4.243  |        |      | 446        | 8.497  |         | 8.974  |         |  |
| 225                      | 1.876  |         | 2.118  |        |  | 345        | 3.996  |         | 4.368  |        |      | 448        | 9.497  |         | 9.974  | + 0.004 |  |
| 226                      | 2.001  |         | 2.243  |        |  | 346        | 4.121  |         | 4.493  |        |      | 450        | 10.497 |         | 10.974 | -0.000  |  |
| 227                      | 2.126  |         | 2.368  |        |  | 347        | 4.246  |         | 4.618  |        |      | 452        | 11.497 |         | 11.974 |         |  |
| 228                      | 2.251  |         | 2.493  |        |  | 348        | 4.371  |         | 4.743  |        |      | 454        | 12.497 |         | 12.974 |         |  |
| 229                      | 2.376  |         | 2.618  |        |  | 349        | 4.496  |         | 4.868  |        |      | 456        | 13.497 |         | 13.974 |         |  |
| 230                      | 2.501  |         | 2.743  |        |  | 350†       | 4.621  | + 0.000 | 4.993  | +0.003 |      | 458        | 14.497 |         | 14.974 |         |  |
| 231                      | 2.626  |         | 2.868  |        |  | 351†       | 4.746  | - 0.003 | 5.118  | -0.000 |      | 460        | 15.497 |         | 15.974 |         |  |

\* These dash sizes not available with V-spring.

† These dash sizes extend beyond the AS4716 specification.

