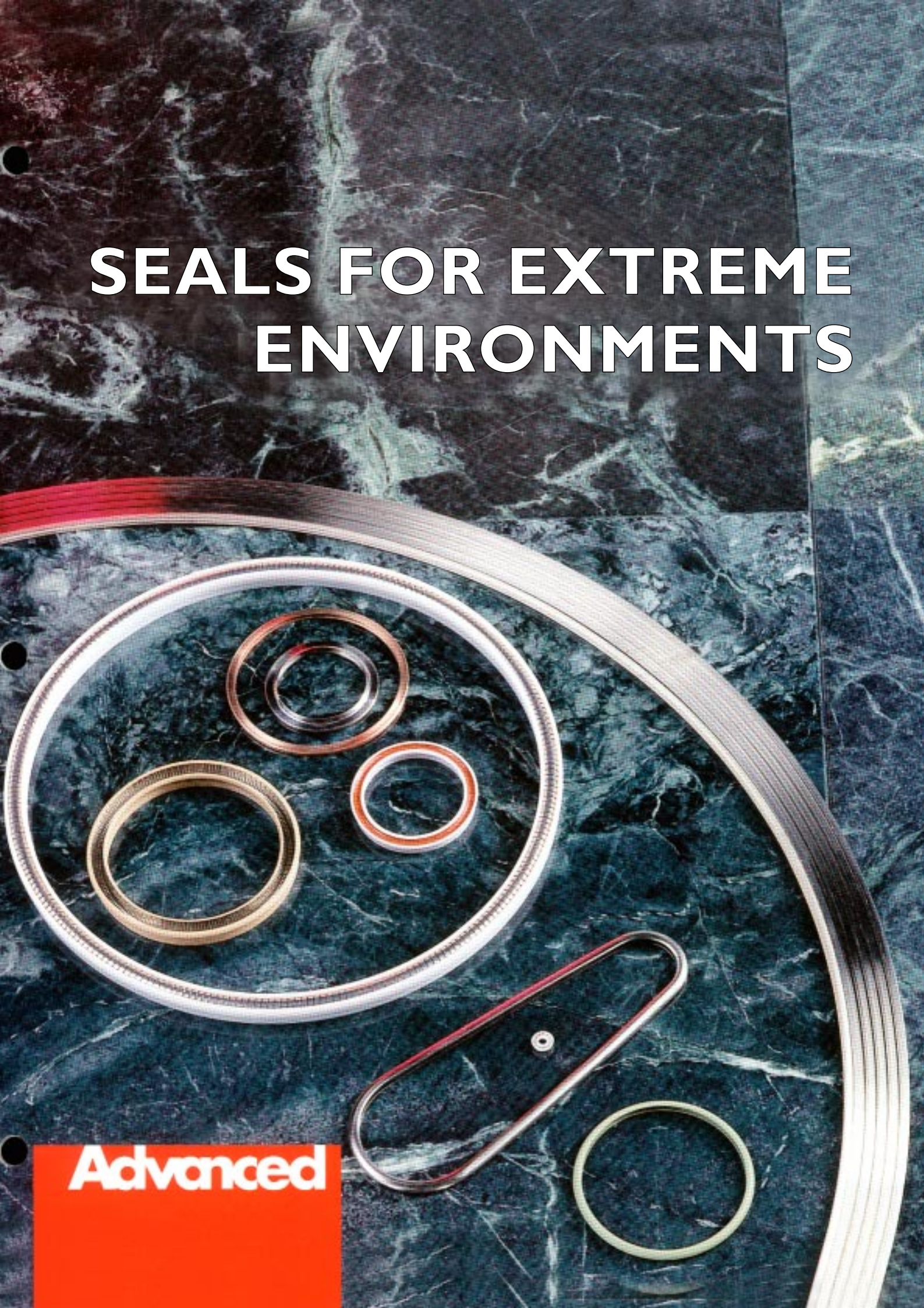
SEALS FOR EXTREME ENVIRONMENTS



Advanced

For over 40 years, Advanced Products has solved the toughest problems with "Seals for Extreme Environments"

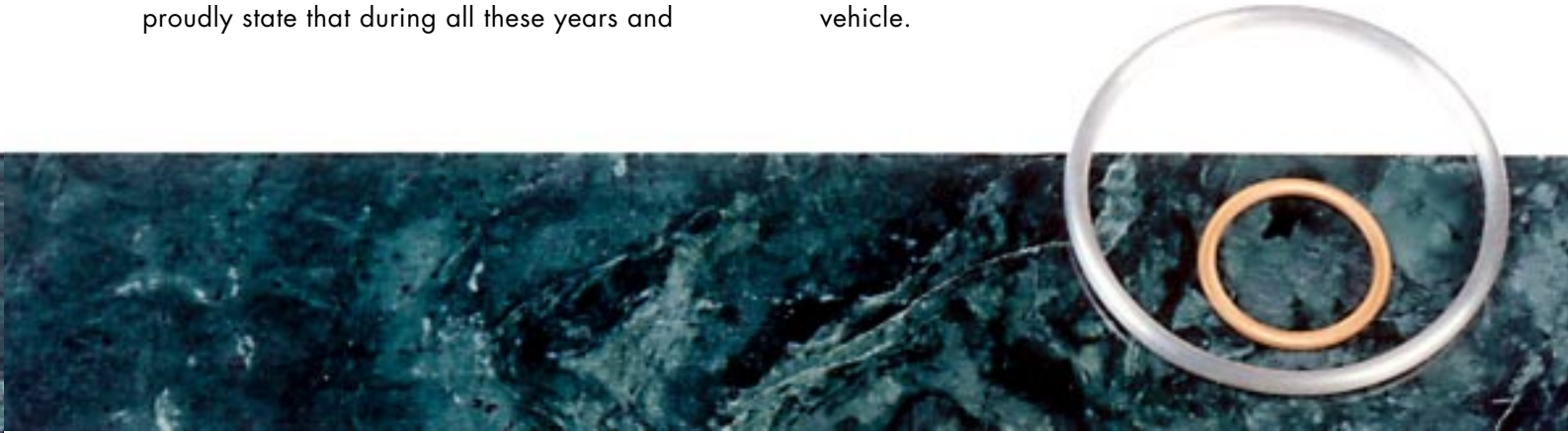
THE ADVANCED PRODUCTS COMPANY

The Advanced Products Company was founded in North Haven, Connecticut in 1954. The Company's first products were metal O-Rings for aircraft engines, a business that continues today.

In the late 1950's, the Company became very active with major nuclear prime contractors in defining the critical reactor pressure vessel closure-head sealing technology for the new pressurized water reactors and boiling water reactors then being designed for commercial power generation. Advanced Products supplied "Yankee Rowe" in Massachusetts, the first commercial nuclear plant; as well as "Savannah", the first nuclear powered merchant ship.

Today, we have supplied over 200 nuclear plants worldwide, as well as nuclear powered naval fleets, using both the original and well proven metal O-ring technology, and the high performance spring energized seals now available. We can proudly state that during all these years and millions of hours of plant operation, there has never been a seal failure in service.

In addition to high profile nuclear applications, Advanced Products has always remained close to its foundations in the jet engine business. Today this extends to space applications including, for example, the Space Shuttle fuel and oxidizer systems as well as seals on the European "Ariane" satellite launch vehicle.

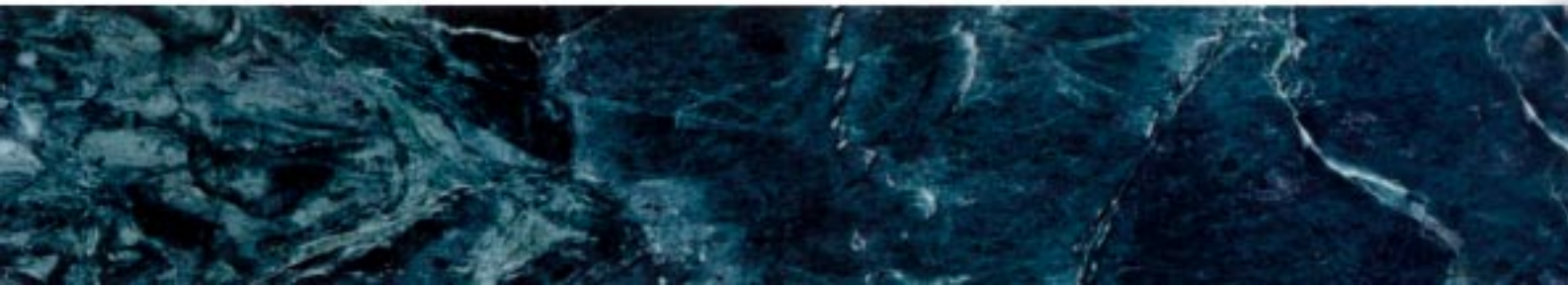


DEMANDING APPLICATIONS

To meet the demands of a growing market, Advanced Products N.V. Belgium was established in 1970 as a second major manufacturing center for the group. Advanced Products N.V. has also provided leadership and innovation in polymer seals for over 25 years, so that today, the Advanced Products Group worldwide offers one of the widest selections of jacket materials, spring materials and designs available. Time and time again, these are replacing traditional elastomeric seals wherever long life and high performance are needed.

Advanced Product's strength is in its diversity of products and applications, as evidenced by substantial business in the North Sea oil and gas fields, with valve seals meeting stringent API flame test and NACE corrosion resistance requirements.

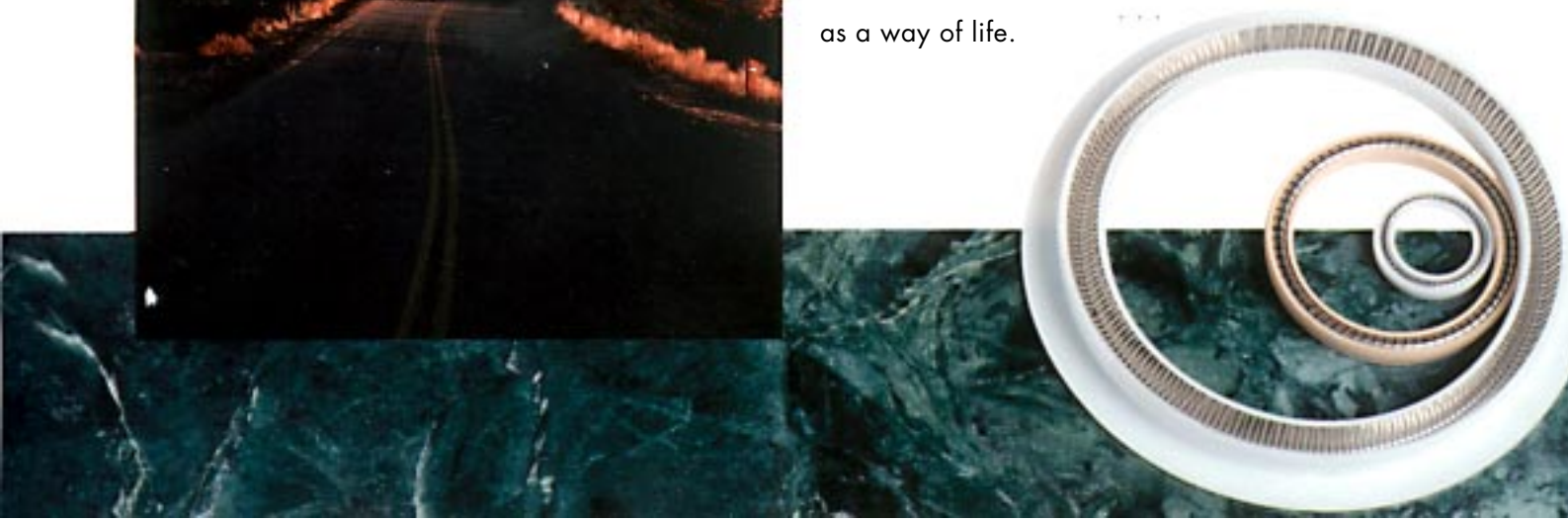
We also supply spring energized metal seals for very demanding applications on internal combustion engines including Indianapolis 500, Formula 1 racing cars and diesel engines where the combination of high temperatures and high frequency pressure pulsations provides a uniquely challenging environment. Our parts may be found in cylinder head "fire rings", exhaust manifold seals and turbo-charger seals.



With new products from R&D, tailored to meet customers needs, being the lifeblood of any company, we maintain engineering departments in both the U.S. and Europe. Our in house test capabilities include Helium leak detection mass spectroscopy, load/deflection measurement equipment, dynamic wear test rigs, and pressure and temperature cycling capability. Where necessary, we collaborate with outside test houses, universities and our customer's own engineering departments, for specialized performance and qualification testing.

As a major seal supplier for almost 40 years, we have access to substantial application data and a wealth of real life experience over untold operating hours. This practical know-how is supported by Finite Element Analysis, to combine the best of the old with the best of the new.

Making dependable seals for safety-critical and extreme applications goes beyond excellence in design and manufacturing. It also means a deep commitment to quality . . .
as a way of life.



Advanced

A GLOBAL RESOURCE

Our quality systems have been honed to meet the most rigorous demands of the nuclear industry, manned space flight and commercial & military aviation. We comply with 10CFR50 Appendix B and MIL-I-45208. We are also committed to ISO 9000, with some divisions of our company already approved and others becoming approved.

As well as an ever-expanding range of products and applications, Advanced Products is an energetic exporter, with some 50% of group sales outside the U.S. We have a manufacturing facility and European head office in Boom, Belgium plus sales offices in the United Kingdom, Germany and France, and a network of overseas distributors.

We are a proud family-owned New England Company, with deep roots in the Northeast. We have evolved and grown with the changing technologies and markets so that today, we stand confident and strong.

We believe today's urgent need to preserve the environment by reducing pollution, will place renewed demands on the seal industry which we stand ready to fulfill.

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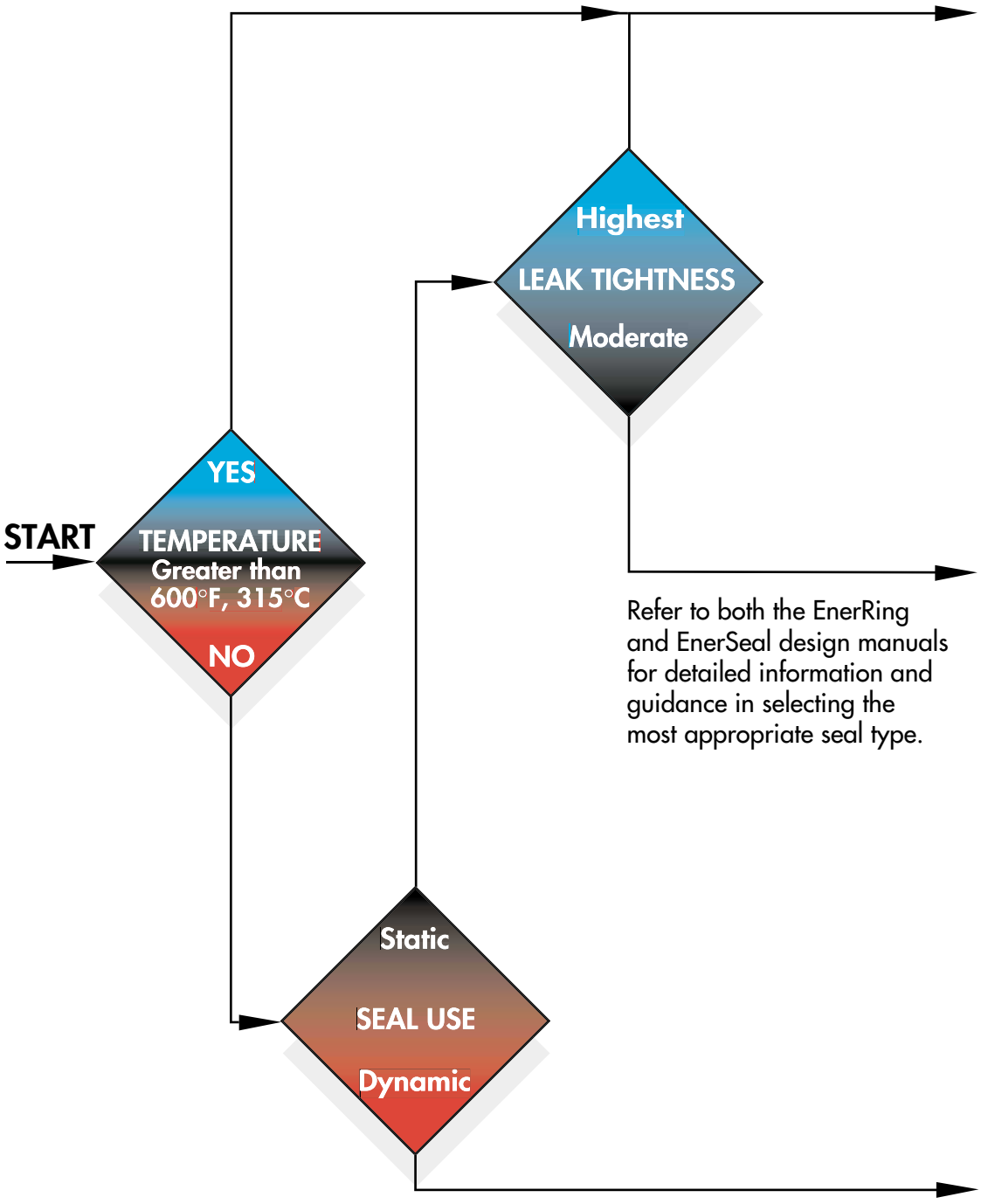
Advanced

Advanced Seal Selection Guidelines

Advanced Products offers *both* resilient metal seals and spring energized polymer seals satisfying the widest range of seal applications in the world. Use the flow diagram below for assistance in determining the best type of seal for your application.



Refer to both the EnerRing and EnerSeal design manuals for detailed information and guidance in selecting the most appropriate seal type.

EnerRing
Resilient Metal Seals

EnerSeal
Spring Energized Polymer Seals


ES0498

The Advanced Products EnerSeal

The spring energized polymeric EnerSeal® offers many of the well known advantages of the common rubber O-ring while avoiding many of its limitations. The EnerSeal has consequently become the seal of choice for many designers across a wide range of industries.

Advantages of EnerSeals

- **Control over the physical and chemical properties of the outer jacket**
  Jacket materials are available in a wide range of engineering-grade polymers, often with special additives to enhance, for example, wear-resistance or high-temperature strength. Many jackets are P.T.F.E. based, with its excellent inherent low friction characteristics and high degree of chemical inertness. Additionally, polymers are not prone to some of the problems associated with elastomeric seals including explosive decompression and stick slip. This 'engineered' jacket means that EnerSeals may be used successfully in the widest range of environments: high pressures, high and low temperatures and aggressive media (full details may be found in Section D).

- **Control over the contact pressure and springback**
  Use of a high grade internal spring ensures positive sealing even under low pressure, frigid conditions where elastomeric O-rings can leak. A variety of spring configurations and materials are available (see Section D) to suit all applications including food contact, sour gas etc.

- **Internally Pressure Energized**
  Under high pressures the internal hydrostatic pressure of the contained fluid energizes the seal and supplements the spring force which increases contact pressure and eliminates potential leakage.

- **Precision lathe-turned parts**
  EnerSeals are a precisely machined sealing system custom-designed and built to your specific dimensions. Although we offer selected sizes tailor-made for many popular national and international O-ring cavities, the fact is **all sizes are standard!** Our flexible, responsive manufacturing approach employing the latest in CAD/CAM means Advanced Products customers enjoy total design flexibility, rapid deliveries and the assurance of using the same proven EnerSeal products specified for rocket fuel systems, aircraft hydraulic controls and oil tools, deep within the earth's crust.

EnerSeal is a trademark of the Advanced Products Company.

How To Use The EnerSeal Design Manual

The Advanced Products EnerSeal line is available in a large variety of types, a virtually unlimited number of sizes, and numerous jacket materials and energizers to satisfy your sealing requirements. The EnerSeal Part Number identifies the seal.

XXX - X000000 - 00 - 00 - 0

- Energizer
- Jacket Material
- Cross Section
- Cavity Diameter (inches specified to three decimal places or millimeters specified to two decimal places).
- E for English Units (inches) *or* M for SI Unit (millimeters)
- EnerSeal Type

This design manual is clearly organized into sections to allow you to easily determine the Part Number of the EnerSeal that is right for your application.

Section B takes the guesswork out of selecting the best EnerSeal type for your application.

Section C is organized by EnerSeal type. Simply turn to the page for the EnerSeal type you selected and you will find all the sizes and dimensioning information you need on the two facing pages. This section also includes EnerSeal sizes for Standard Glands.

Section D helps you select the most appropriate jacket material and energizer for the operating conditions.

Section E provides the technical information about the seals, materials, and cavities. This section provides many answers and recommendations to your design questions and considerations.

Section F shows you just a sample of our custom seal design capabilities. Although most applications can be sealed with our standard EnerSeals, there are times when only a special seal will do. In these cases, please contact one of our Application Engineers at any of our worldwide offices and we will gladly develop a seal for you.

Selecting the EnerSeal Type for your Application

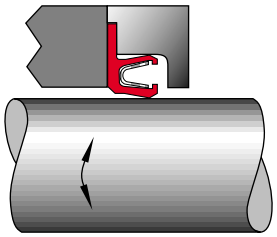
EnerSeals are produced in a number of standard designs which are applicable for use in a broad spectrum of the most commonly encountered applications. The **EnerSeal Type** is designated by the first three letters in the Part Number.

XXX - X000000 - 00 - 00 - 0

EnerSeal Type

The following flow diagrams are designed to provide a clear path to the appropriate EnerSeal type for your application. The applications are separated into three basic categories:

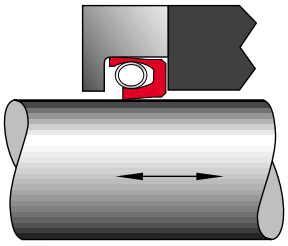
Dynamic Rotating Applications

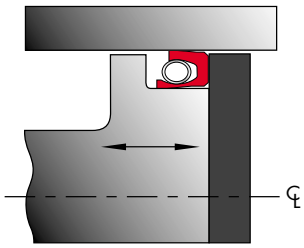


Go to page B–2

Dynamic Reciprocating Applications

Reciprocating Rod



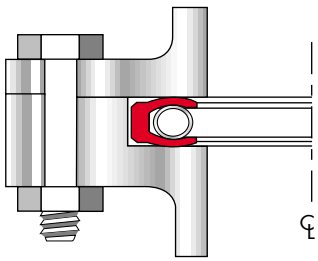


Piston

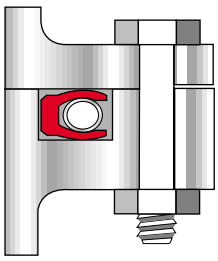
Go to page B–3

Static and Intermittent Dynamic Applications

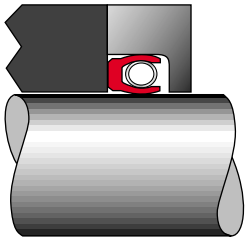
Static, face-type, internal or external pressure or vacuum applications, where the seal is seated in a groove, counterbore, or retaining plate. Intermittent dynamic installation such as valve stem where movement is slow and with low frequency.



Internal Pressure



External Pressure



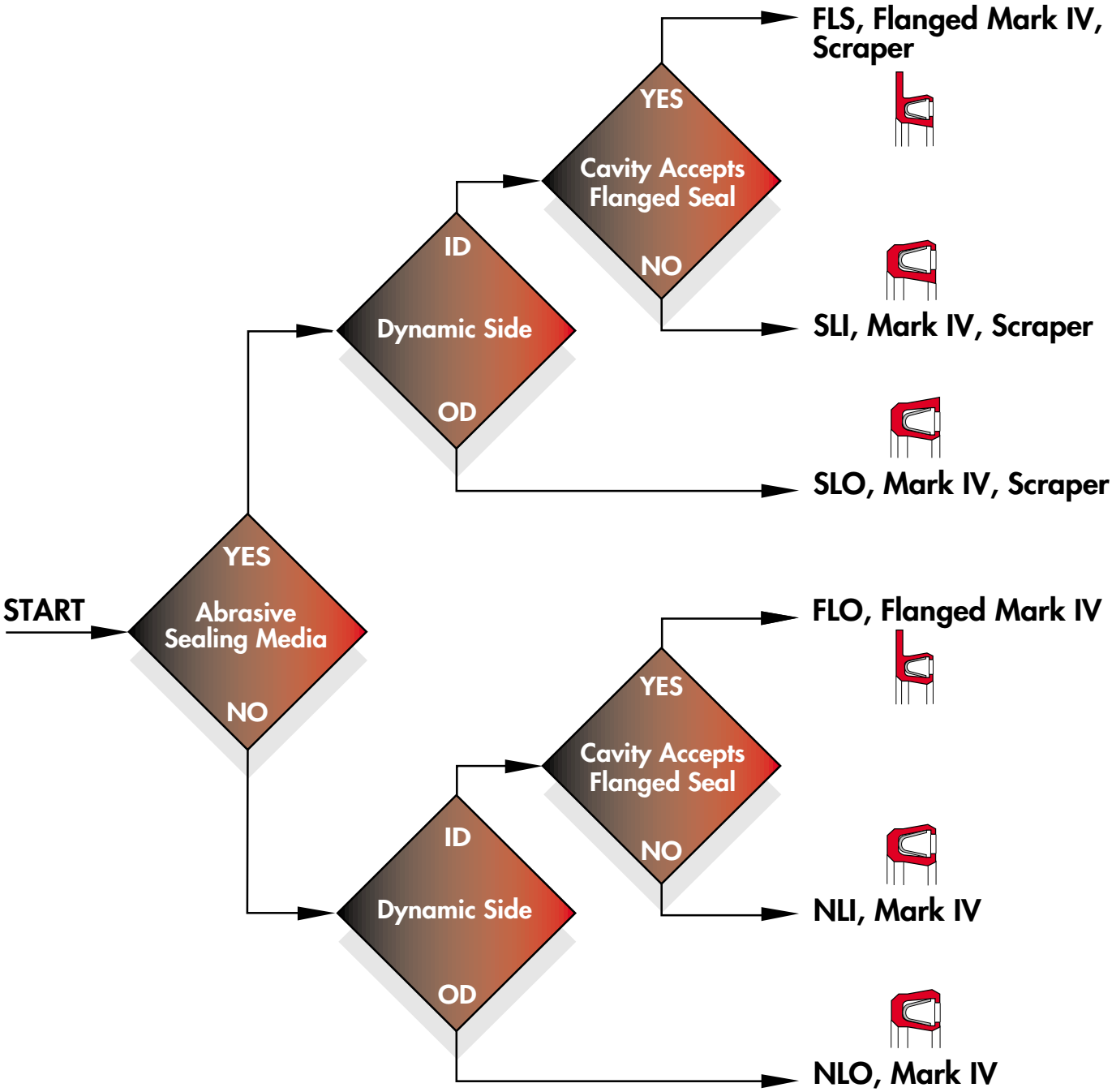
Go to page B–4

Refer to one of these three application diagrams on the following pages for easy selection of the right EnerSeal for you.

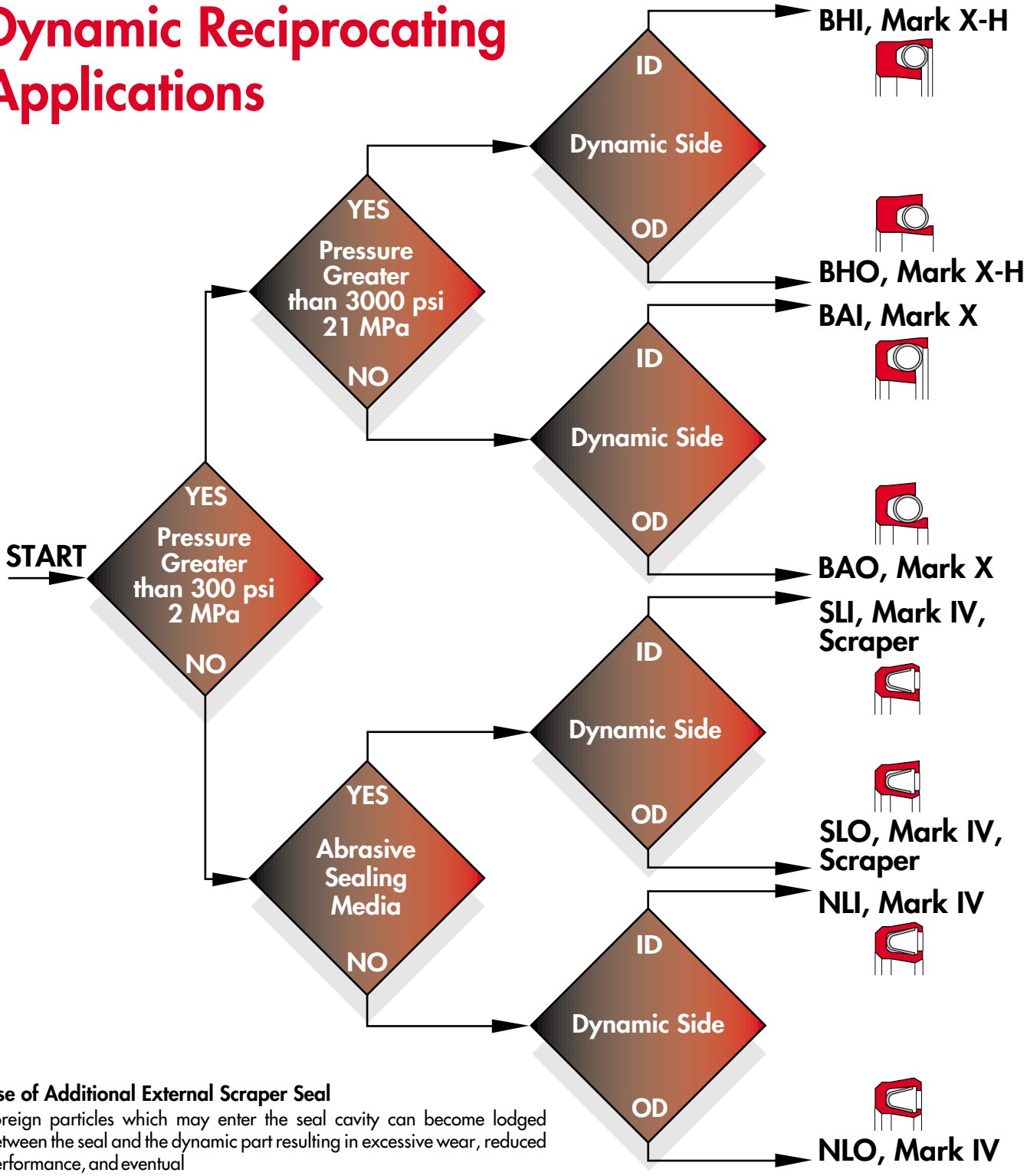
Dynamic Rotating Applications

When practical, a cavity which accepts a flanged seal is preferred, as this prevents seal rotation and optimizes seal performance.

Note: The seal selection guidelines for rotating applications assume moderate temperatures and rotational speeds. Refer to the Pressure-Velocity-Temperature guidelines on Page E-2 of the Technical Information Section to pre-qualify the seal for rotating applications.

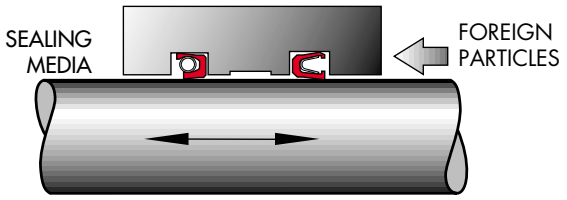


Dynamic Reciprocating Applications

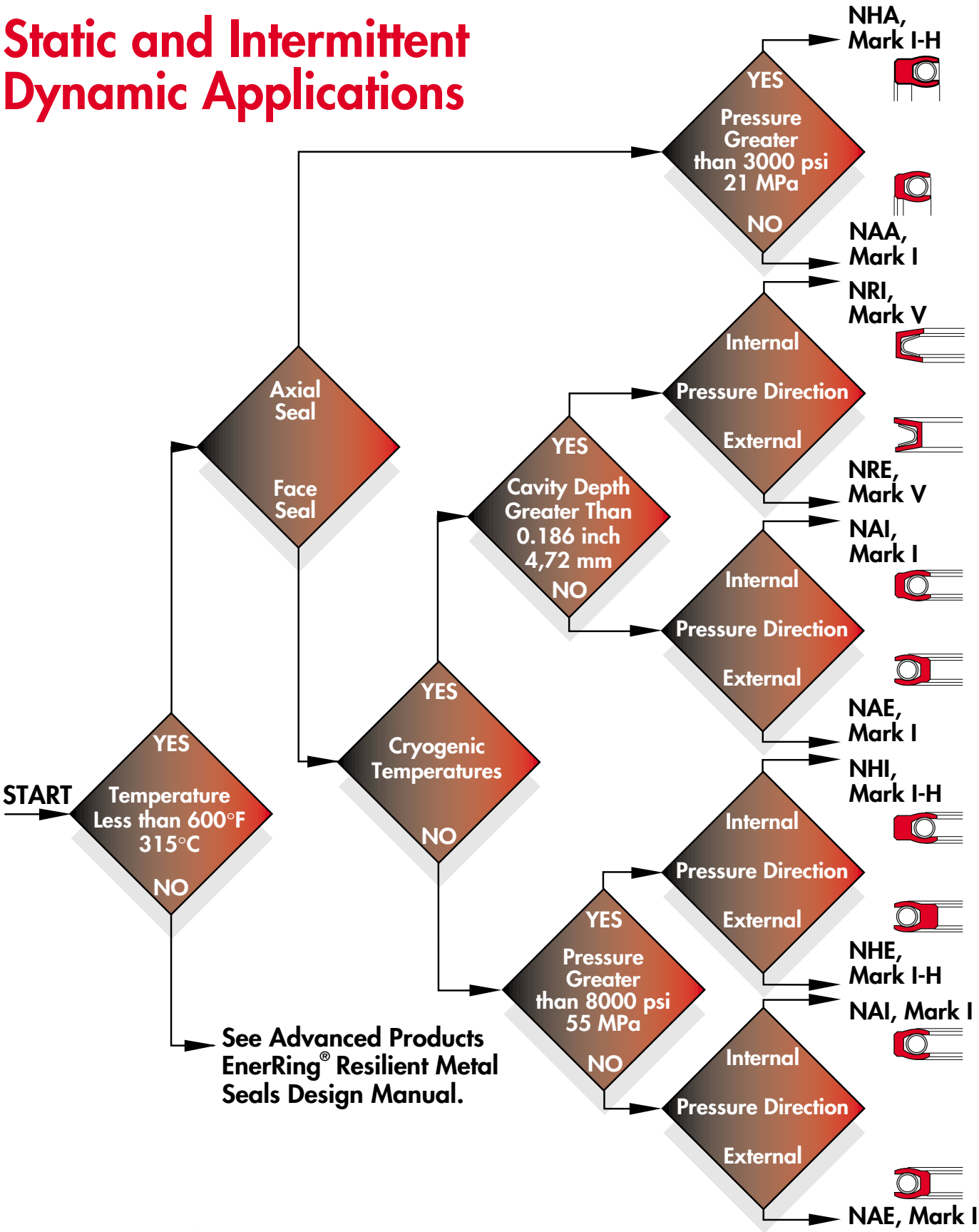


Use of Additional External Scraper Seal

Foreign particles which may enter the seal cavity can become lodged between the seal and the dynamic part resulting in excessive wear, reduced performance, and eventual media contamination. To keep the seal cavity free from outside particles, a Mark IV scraper seal (SLI or SLO) should be used in addition to the primary seal as shown.



Static and Intermittent Dynamic Applications



EnerRing is a trademark of the Advanced Products Company.

Selecting the EnerSeal Size for your Application

EnerSeals are available in any diameter from 0.1 inch to 55 inches (2,5 mm to 1400 mm) and a variety of cross sections to fit the various cavity sizes you may have.

The EnerSeal size is designated in the part number as shown below.

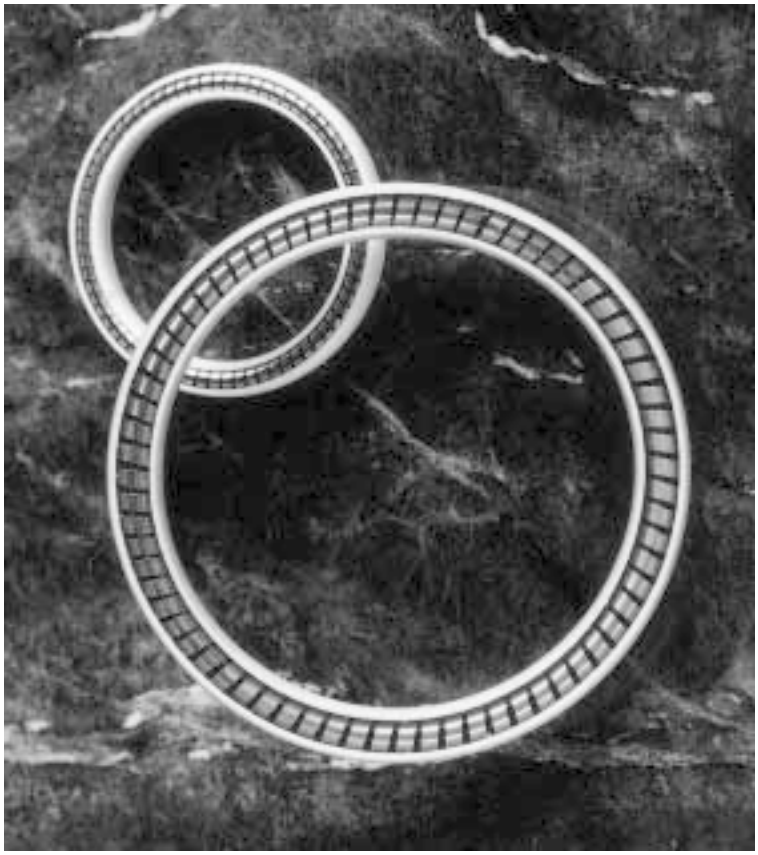
XXX - X000000 - 00 - 00 - 0

- 00 — EnerSeal Cross Section Code
- 000000 — Cavity Diameter (inches specified to three decimal places or millimeters specified to two decimal places)
- X — E for English Units (inches) or M for SI Units (millimeters)

Refer to the page of the EnerSeal type selected for your application to determine the appropriate diameter, cross section, and cavity dimensions.

Dimensions and Sizing Information for the Standard EnerSeals can be found on the following pages:

NAA Mark I Axial Seal

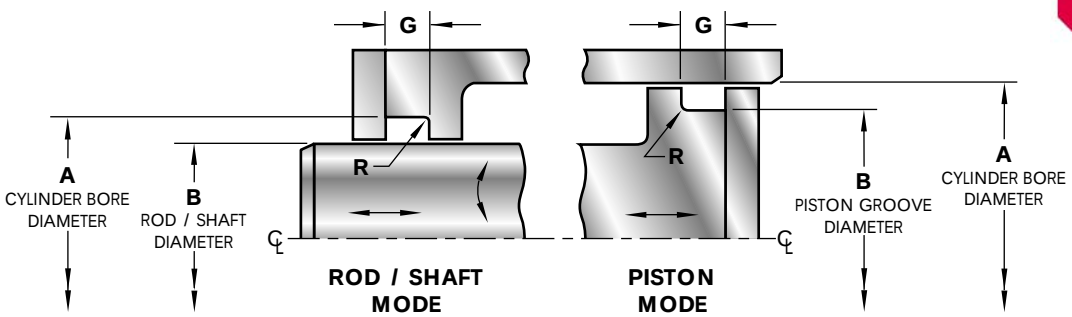


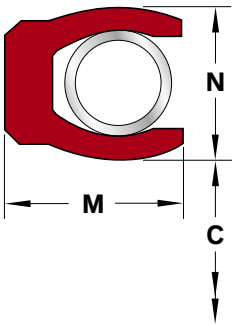
Applications:

- Excellent for both static and intermittent dynamic use, such as valve stems and swivel joints.
- Seals reciprocating or rotating movement, on either I.D. or O.D.
- Suitable for pressures to 3000 psi, 21 MPa.

Features:

- Best choice for installation into non-split cavities: short heel and helical spring energizers stretch easily and the rounded seal-lips won't "hang-up".
- Widest range of cross-sections and diameters available, including sizes for upgrading standard O-ring glands.
- Many high-resilience spring-energizer-options, including choice of light, medium and heavy loads (for friction control) and 'NACE' corrosion resistance for oil field use.
- Lowest cost elastomeric energizers available, all with excellent fatigue resistance.





NAA Cavity Dimensioning

NOMINAL CROSS SECTION	CROSS SECTION CODE	CAVITY				REFERENCE SEAL DIMENSIONS		
		B	A	G	R	C	N	M
		I.D. RANGE tolerance h8	O.D. tolerance H8	WIDTH	MAXIMUM RADIUS	I.D.	FREE HEIGHT	WIDTH
1/16 in (1,6 mm)	01	2,50 – 75,00	B+ 2,84	2,39 – 2,64	0,38	B – 0,3	1,7	2,0
3/32 in (2,4 mm)	02	3,00 – 180,00	B+ 4,52	3,58 – 3,84	0,64	B – 0,3	2,6	3,0
1/8 in (3,2 mm)	03	6,00 – 250,00	B+ 6,15	4,78 – 5,03	0,76	B – 0,4	3,4	3,9
3/16 in (4,7 mm)	04	12,50 – 300,00	B+ 9,45	7,14 – 7,39	0,76	B – 0,5	5,3	5,9
1/4 in (6,4 mm)	05	50,00 – 500,00	B+ 12,12	9,53 – 9,78	0,76	B – 0,7	6,7	8,0
3/8 in (9,5 mm)	06	150,00 – 1400,00	B+ 18,75	13,34 – 13,59	0,76	B – 1,1	10,4	11,7

Cross Section

Where space permits, use of the largest cross section seal is preferred.

The **Tolerance Reference Table** can be found on Page E-11 of the Technical Data Section.
If specifying a diameter which is above the recommended diameter range, use the largest recommended diameter for the appropriate cross section to determine the cavity tolerances.

Part Number / Ordering

Example: To order a NAA Seal for a cavity with a 70,00 mm shaft (cavity I.D.) and a 76,15 mm bore (cavity O.D.), the part number should specify:

NAA - M007000 - 03 - 00 - 0

- 03 — EnerSeal Cross Section Code
- 007000 — Cavity I.D. (rod / shaft diameter or piston groove diameter) (to two decimal places)
- M — SI Units (millimeters)

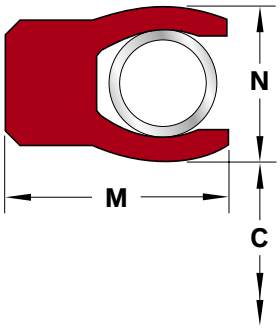
NHA Mark I-H Axial Seal

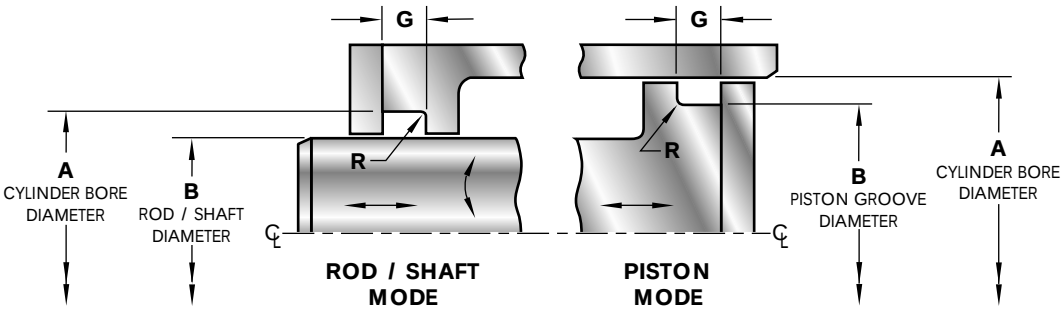
Features:

- Extended heel reduces the effects of extrusion.
- Good choice for installation into non-split cavities: helical spring-energizer stretches easily and the rounded seal-lips won't "hang-up".
- Widest range of cross-sections and diameters available, including sizes for upgrading standard O-ring glands.
- Many high-resilience spring-energizer-options, including choice of light, medium and heavy loads (for friction control) and 'NACE' corrosion resistance for oil field use.
- Lowest cost elastomeric energizers available, all with excellent fatigue resistance.

Applications:

- Excellent for both static and intermittent dynamic use, such as high pressure valve stems and swivel joints.
- Suitable for pressures up to 8000 psi, 55 MPa.
- Seals reciprocating or rotating movement, on either I.D. or O.D.





NHA Cavity Dimensioning

NOMINAL CROSS SECTION	CROSS SECTION CODE	CAVITY				REFERENCE SEAL DIMENSIONS		
		B	A	G	R	C	N	M
		I.D. RANGE tolerance h8	O.D. tolerance H8	WIDTH	MAXIMUM RADIUS	I.D.	FREE HEIGHT	WIDTH
1/16 in (1,6 mm)	01	2,50 – 75,00	B+ 2,84	3,78 – 4,04	0,38	B – 0,3	1,7	2,9
3/32 in (2,4 mm)	02	3,00 – 180,00	B+ 4,52	4,65 – 4,90	0,64	B – 0,3	2,6	3,9
1/8 in (3,2 mm)	03	6,00 – 250,00	B+ 6,15	5,97 – 6,22	0,76	B – 0,4	3,4	4,9
3/16 in (4,7 mm)	04	12,50 – 300,00	B+ 9,45	8,48 – 8,74	0,76	B – 0,5	5,3	6,9
1/4 in (6,4 mm)	05	50,00 – 500,00	B+ 12,12	12,07 – 12,32	0,76	B – 0,7	6,7	9,3
3/8 in (9,5 mm)	06	150,00 – 1400,00	B+ 18,75	15,80 – 16,05	0,76	B – 1,1	10,4	14,2

Cross Section

Where space permits, use of the largest cross section seal is preferred.

The **Tolerance Reference Table** can be found on Page E-11 of the Technical Data Section.
If specifying a diameter which is above the recommended diameter range, use the largest recommended diameter for the appropriate cross section to determine the cavity tolerances.

Part Number / Ordering

Example: To order a NHA Seal for a cavity with a 70,00 mm shaft (cavity I.D.) and a 76,15 mm bore (cavity O.D.), the part number should specify:

NHA - M007000 - 03 - 00 - 0

- 03 — EnerSeal Cross Section Code
- 007000 — Cavity I.D. (rod / shaft diameter or piston groove diameter) (to two decimal places)
- M — SI Units (millimeters)

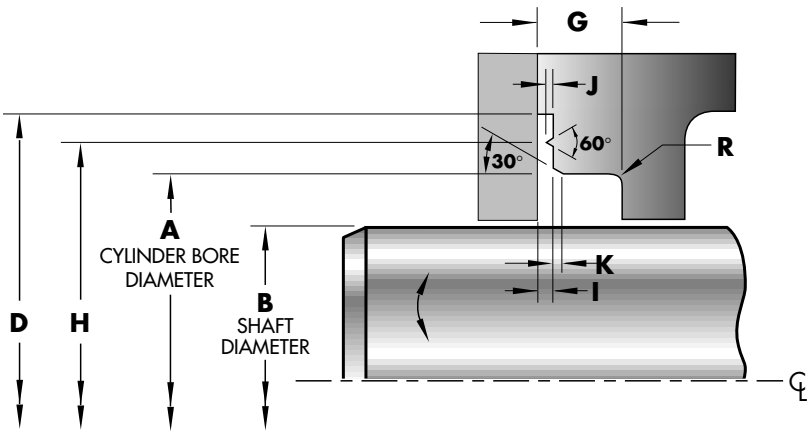
FLO Mark IV Flanged Axial I.D. Dynamic Seal

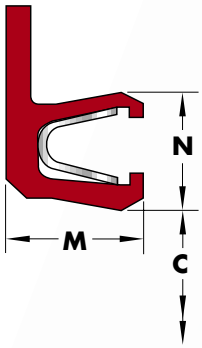
Applications:

- Best choice for sealing rotating shafts, such as pumps, motors and rotary actuators.
- Suitable for pressures to 3000 psi, 21 MPa (subject to PV guidelines – see page E-2).

Features:

- O.D. flange stabilizes seal, prevents seal rotation and resists thermally induced movement.
- Heavy I.D. seal-lip ensures longest life.
- Dual retained spring-energizer for maximum security.
- Low load high-compliance spring energizer.
- Many high-resilience spring-energizer-options, including choice of light, medium and heavy loads (for friction control) and 'NACE' corrosion resistance for oil field use.
- Available with silicone-filled cavity for food and drug applications.





FLO Cavity Dimensioning

NOMINAL CROSS SECTION	CROSS SECTION CODE	CAVITY								
		B	A	G	R	D	H	I	J	K
		I.D. RANGE tolerance h8	O.D. tolerance H8	WIDTH RANGE	MAX. RADIUS	FLANGE O.D. tolerance H11	tolerance H11	RANGE	RANGE	RANGE
1/16 in (1,6 mm)	01	3,00 – 76,00	B+ 2,84	2,39 – 2,64	0,38	B+ 7,00	B+ 5,00	0,56 – 0,64	0,25 – 0,35	0,40 – 0,50
3/32 in (2,4 mm)	02	5,00 – 180,00	B+ 4,52	3,58 – 3,84	0,64	B+ 9,00	B+ 7,00	0,56 – 0,64	0,25 – 0,35	0,80 – 1,00
1/8 in (3,2 mm)	03	12,50 – 250,00	B+ 6,15	4,78 – 5,03	0,76	B+ 12,50	B+ 10,00	0,66 – 0,74	0,30 – 0,40	1,00 – 1,20
3/16 in (4,7 mm)	04	22,00 – 300,00	B+ 9,45	7,14 – 7,39	0,76	B+ 17,50	B+ 13,50	0,96 – 1,04	0,41 – 0,51	1,30 – 1,60
1/4 in (6,4 mm)	05	50,00 – 685,00	B+ 12,12	9,53 – 9,78	0,76	B+ 22,000	B+ 17,00	1,16 – 1,24	0,56 – 0,66	1,70 – 2,00

NOMINAL CROSS SECTION	CROSS SECTION CODE	REFERENCE SEAL DIMENSIONS		
		C	N	M
		I.D.	FREE HEIGHT	WIDTH
1/16 in (1,6 mm)	01	B – 0,5	1,8	2,1
3/32 in (2,4 mm)	02	B – 0,6	2,8	3,3
1/8 in (3,2 mm)	03	B – 0,7	3,8	4,3
3/16 in (4,7 mm)	04	B – 1,0	5,7	6,7
1/4 in (6,4 mm)	05	B – 1,3	7,4	8,4

Cross Section

Where space permits, use of the largest cross section seal is preferred.

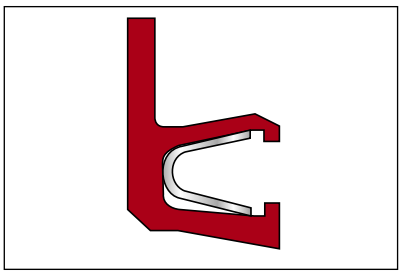
The **Tolerance Reference Table** can be found on Page E-11 of the Technical Data Section. If specifying a diameter which is above the recommended diameter range, use the largest recommended diameter for the appropriate cross section to determine the cavity tolerances.

Part Number / Ordering

Example: To order a FLO Seal for a cavity with a 70,00 mm shaft (cavity I.D.) and a 76,15 mm bore (cavity O.D.), the part number should specify:

FLO - M007000 - 03 - 00 - 0

- 03 — EnerSeal Cross Section Code
- 007000 — Cavity I.D. (shaft diameter) (to two decimal places)
- M — SI Units (millimeters)



FLS Mark IV Flanged Scraper Axial I.D. Dynamic Seal

For Mark IV Flanged Scraper Seal FLS simply specify FLS in the part number instead of FLO. All FLO cavity dimensions apply to the FLS EnerSeal.

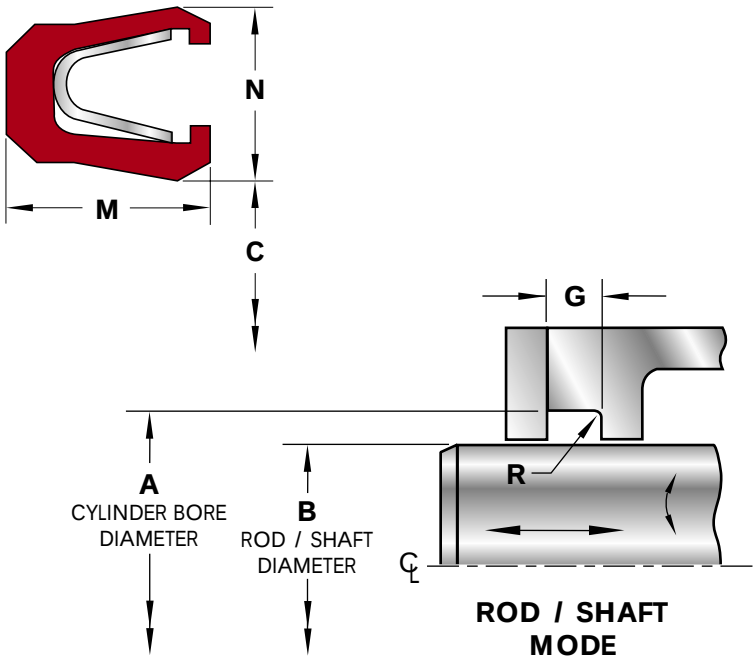
NLI Mark IV Axial I.D. Dynamic Seal

Applications:

- Ideal for sealing rotating shafts without a flange cavity. Typical applications include pumps, motors and rotary actuators.
- Used in low pressure reciprocating applications.
- Suitable for pressures to 3000 psi, 21 MPa (subject to PV guidelines – see page E-2).

Features:

- Heavy I.D. seal-lip ensures longest life.
- Available with scraper lip option (SLI) for abrasive media.
- Dual retained spring-energizer for maximum security.
- Low load high-compliance spring energizer.
- Many high-resilience spring-energizer-options, including choice of light, medium and heavy loads (for friction control) and 'NACE' corrosion resistance for oil field use.
- Available with silicone-filled cavity for food and drug applications.



NLI Cavity Dimensioning

NOMINAL CROSS SECTION	CROSS SECTION CODE	CAVITY				REFERENCE SEAL DIMENSIONS		
		B	A	G	R	C	N	M
		I.D. RANGE tolerance h8	O.D. tolerance H8	WIDTH	MAXIMUM RADIUS	I.D.	FREE HEIGHT	WIDTH
1/16 in (1,6 mm)	01	3,00 – 75,00	B+ 2,84	2,39 – 2,64	0,38	B – 0,5	1,8	2,1
3/32 in (2,4 mm)	02	5,00 – 180,00	B+ 4,52	3,58 – 3,84	0,64	B – 0,6	2,8	3,3
1/8 in (3,2 mm)	03	12,50 – 250,00	B+ 6,15	4,78 – 5,03	0,76	B – 0,7	3,8	4,3
3/16 in (4,7 mm)	04	22,00 – 300,00	B+ 9,45	7,14 – 7,39	0,76	B – 1,0	5,7	6,7
1/4 in (6,4 mm)	05	50,00 – 685,00	B+ 12,12	9,53 – 9,78	0,76	B – 1,3	7,4	8,4

Cross Section

Where space permits, use of the largest cross section seal is preferred.

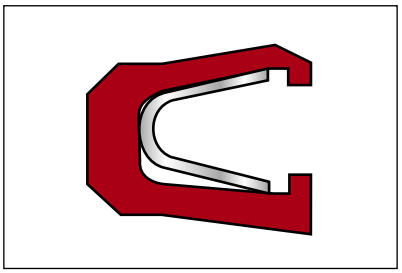
The **Tolerance Reference Table** can be found on Page E-11 of the Technical Data Section.
If specifying a diameter which is above the recommended diameter range, use the largest recommended diameter for the appropriate cross section to determine the cavity tolerances.

Part Number / Ordering

Example: To order a NLI Seal for a cavity with a 70,00 mm shaft (cavity I.D.) and a 76,15 mm bore (cavity O.D.), the part number should specify:

NLI - M007000 - 03 - 00 - 0

- 03 — EnerSeal Cross Section Code
- 007000 — Cavity I.D. (rod / shaft diameter) (to two decimal places)
- M — SI Units (millimeters)



SLI Mark IV Scraper Axial I.D. Dynamic Seal

For Mark IV Scraper Seal SLI simply specify SLI in the part number instead of NLI. All NLI cavity dimensions apply to the SLI EnerSeal.

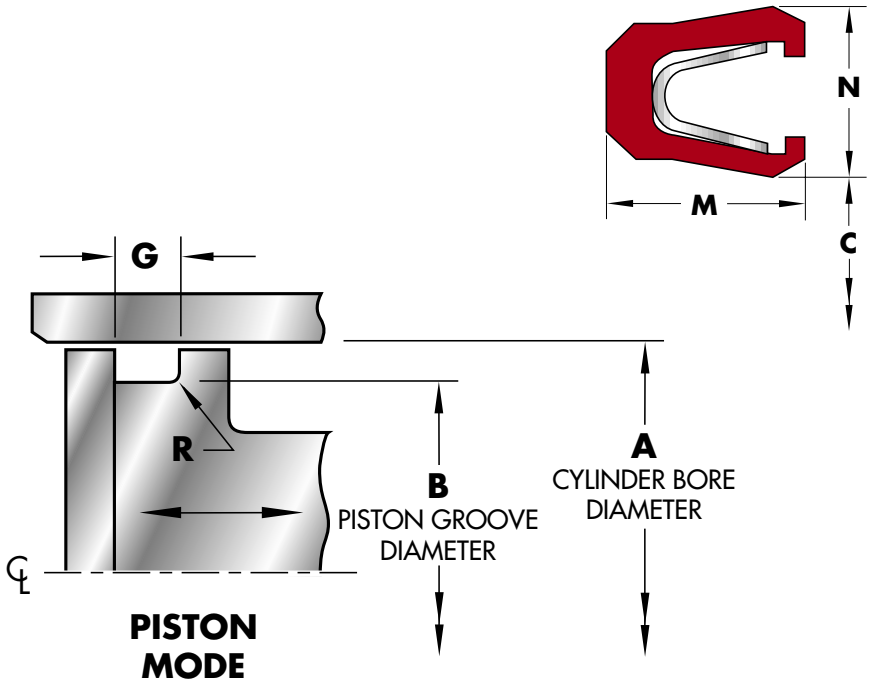
NLO Mark IV Axial O.D. Dynamic Seal

Applications:

- Ideal for sealing O.D. rotating housings.
- Used in low pressure reciprocating applications.
- Suitable for pressures to 3000 psi, 21 MPa (subject to PV guidelines – see page E-2).

Features:

- Heavy O.D. seal-lip ensures longest life.
- Available with scraper lip option (SLO) for abrasive media.
- Dual retained spring-energizer for maximum security.
- Low load high-compliance spring energizer.
- Many high-resilience spring-energizer-options, including choice of light, medium and heavy loads (for friction control) and 'NACE' corrosion resistance for oil field use.
- Available with silicone-filled cavity for food and drug applications.



NLO Cavity Dimensioning

NOMINAL CROSS SECTION	CROSS SECTION CODE	CAVITY				REFERENCE SEAL DIMENSIONS		
		A	B	G	R	C	N	M
		O.D. RANGE tolerance H8	I.D. tolerance h8	WIDTH	MAXIMUM RADIUS	I.D.	FREE HEIGHT	WIDTH
1/16 in (1,6 mm)	01	6,00 – 75,00	A – 2,84	2,39 – 2,64	0,38	B – 0,5	1,8	2,1
3/32 in (2,4 mm)	02	9,50 – 180,00	A – 4,52	3,58 – 3,84	0,64	B – 0,6	2,8	3,3
1/8 in (3,2 mm)	03	19,00 – 250,00	A – 6,15	4,78 – 5,03	0,76	B – 0,7	3,8	4,3
3/16 in (4,7 mm)	04	31,50 – 300,00	A – 9,45	7,14 – 7,39	0,76	B – 1,0	5,7	6,7
1/4 in (6,4 mm)	05	63,00 – 685,00	A – 12,12	9,53 – 9,78	0,76	B – 1,3	7,4	8,4

Cross Section

Where space permits, use of the largest cross section seal is preferred.

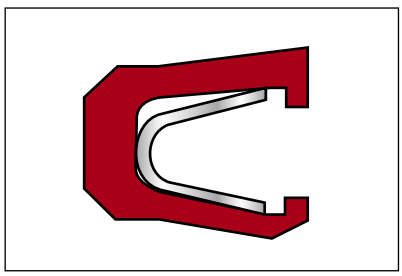
The **Tolerance Reference Table** can be found on Page E-11 of the Technical Data Section.
If specifying a diameter which is above the recommended diameter range, use the largest recommended diameter for the appropriate cross section to determine the cavity tolerances.

Part Number / Ordering

Example: To order a NLO Seal for a cavity with a 70,00 mm bore diameter (cavity O.D.) and a 63,85 mm piston diameter (cavity I.D.), the part number should specify:

NLO - M007000 - 03 - 00 - 0

- 03 — EnerSeal Cross Section Code
- 007000 — Cavity O.D. (cylinder bore diameter) (to two decimal places)
- M — SI Units (millimeters)



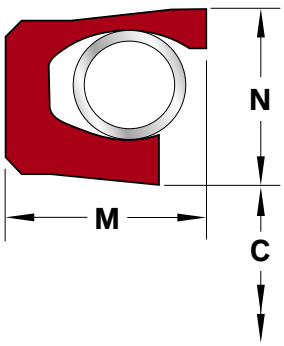
SLO Mark IV Scraper Axial O.D. Dynamic Seal

For Mark IV Scraper Seal SLO simply specify SLO in the part number instead of NLO. All NLO cavity dimensions apply to the SLO EnerSeal.

BAI Mark X I.D. Dynamic Axial Seal

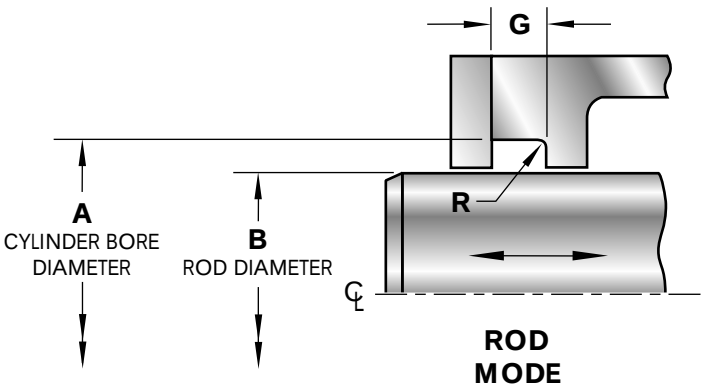
Features:

- Heavy I.D. seal-lip ensures longest life.
- Short, scraper-type I.D. lip reduces frictional losses.
- Squared, long, static leg stabilizes seal.
- Widest range of cross-sections and diameters available, including sizes for upgrading standard O-ring glands.
- Many high-resilience spring-energizer-options, including choice of light, medium and heavy loads (for friction control) and 'NACE' corrosion resistance for oil field use.
- Lowest cost elastomeric energizers available, all with excellent fatigue resistance.



Applications:

- Best choice for sealing reciprocating actuator rods.
- Suitable for pressures to 3000 psi, 21MPa.



BAI Cavity Dimensioning

NOMINAL CROSS SECTION	CROSS SECTION CODE	CAVITY				REFERENCE SEAL DIMENSIONS		
		B	A	G	R	C	N	M
		I.D. RANGE tolerance h8	O.D. tolerance H8	WIDTH	MAXIMUM RADIUS	I.D.	FREE HEIGHT	WIDTH
1/16 in (1,6 mm)	01	2,50 – 75,00	B+ 2,84	2,39 – 2,64	0,38	B – 0,3	1,7	2,0
3/32 in (2,4 mm)	02	3,00 – 180,00	B+ 4,52	3,58 – 3,84	0,64	B – 0,4	2,7	3,0
1/8 in (3,2 mm)	03	6,00 – 250,00	B+ 6,15	4,78 – 5,03	0,76	B – 0,5	3,6	4,0
3/16 in (4,7 mm)	04	12,50 – 300,00	B+ 9,45	7,14 – 7,39	0,76	B – 0,7	5,5	6,4
1/4 in (6,4 mm)	05	50,00 – 500,00	B+ 12,12	9,53 – 9,78	0,76	B – 0,8	7,0	8,8
3/8 in (9,5 mm)	06	150,00 – 1400,00	B+ 18,75	13,34 – 13,59	0,76	B – 1,0	10,7	12,6

Cross Section

Where space permits, use of the largest cross section seal is preferred.

The **Tolerance Reference Table** can be found on Page E-11 of the Technical Data Section.
If specifying a diameter which is above the recommended diameter range, use the largest recommended diameter for the appropriate cross section to determine the cavity tolerances.

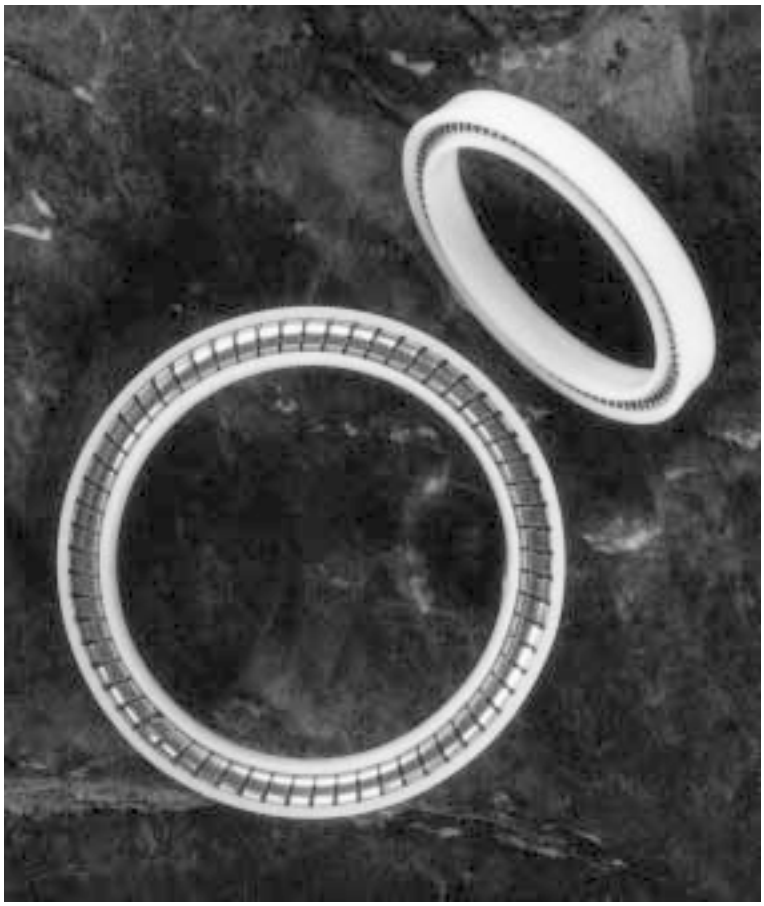
Part Number / Ordering

Example: To order a BAI Seal for a cavity with a 70,00 mm shaft (cavity I.D.) and a 76,15 mm bore (cavity O.D.), the part number should specify:

BAI - M007000 - 03 - 00 - 0

- 03 — EnerSeal Cross Section Code
- 007000 — Cavity I.D. (rod diameter) (to two decimal places)
- M — SI Units (millimeters)

BAO Mark X O.D. Dynamic Axial Seal



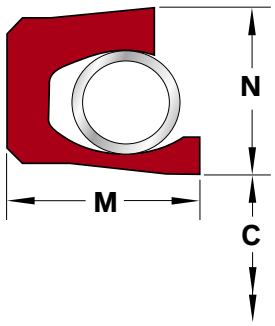
Applications:

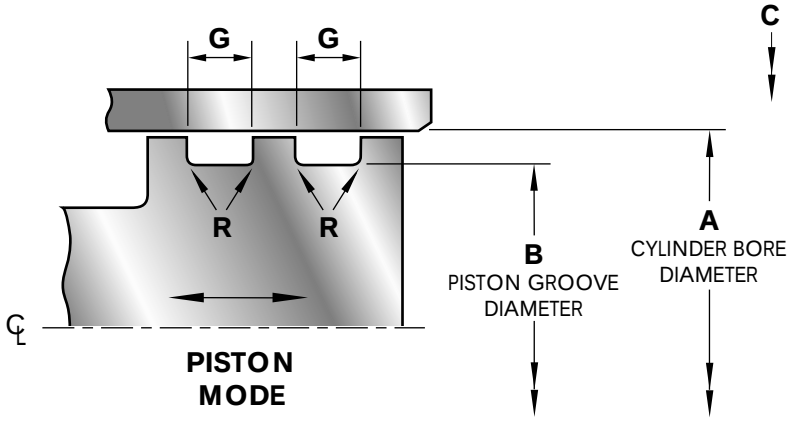
- Best choice for sealing pistons.
- Suitable for pressures to 3000 psi, 21 MPa.

Features:

- Heavy O.D. seal-lip ensures longest life.
- Short, scraper-type O.D. lip reduces frictional losses.
- Squared, long, static leg stabilizes seal.
- Widest range of cross-sections and diameters available, including sizes for upgrading standard O-ring glands.
- Many high-resilience spring-energizer-options, including choice of light, medium and heavy loads (for friction control) and 'NACE' corrosion resistance for oil field use.
- Lowest cost elastomeric energizers available, all with excellent fatigue resistance.

Reversing pressures require a double cavity piston with back-to-back seals.





BAO Cavity Dimensioning

NOMINAL CROSS SECTION	CROSS SECTION CODE	CAVITY				REFERENCE SEAL DIMENSIONS		
		A	B	G	R	C	N	M
		O.D. RANGE tolerance H8	I.D. tolerance h8	WIDTH	MAXIMUM RADIUS	I.D.	FREE HEIGHT	WIDTH
1/16 in (1,6 mm)	01	5,50 – 75,00	A – 2,84	2,39 – 2,64	0,38	B – 0,3	1,7	2,0
3/32 in (2,4 mm)	02	7,50 – 180,00	A – 4,52	3,58 – 3,84	0,64	B – 0,4	2,7	3,0
1/8 in (3,2 mm)	03	12,50 – 250,00	A – 6,15	4,78 – 5,03	0,76	B – 0,5	3,6	4,0
3/16 in (4,7 mm)	04	22,00 – 300,00	A – 9,45	7,14 – 7,39	0,76	B – 0,7	5,5	6,4
1/4 in (6,4 mm)	05	63,00 – 500,00	A – 12,12	9,53 – 9,78	0,76	B – 0,8	7,0	8,8
3/8 in (9,5 mm)	06	170,00 – 1400,00	A – 18,75	13,34 – 13,59	0,76	B – 1,0	10,7	12,6

Cross Section

Where space permits, use of the largest cross section seal is preferred.

The **Tolerance Reference Table** can be found on Page E-11 of the Technical Data Section.
If specifying a diameter which is above the recommended diameter range, use the largest recommended diameter for the appropriate cross section to determine the cavity tolerances.

Part Number / Ordering

Example: To order a BAO Seal for a cavity with a 70,00 mm bore diameter (cavity O.D.) and a 63,85 mm piston diameter (cavity I.D.), the part number should specify:

BAO - M007000 - 03 - 00 - 0

- 03 — EnerSeal Cross Section Code
- 007000 — Cavity O.D. (to two decimal places) (cylinder bore diameter)
- M — SI Units (millimeters)

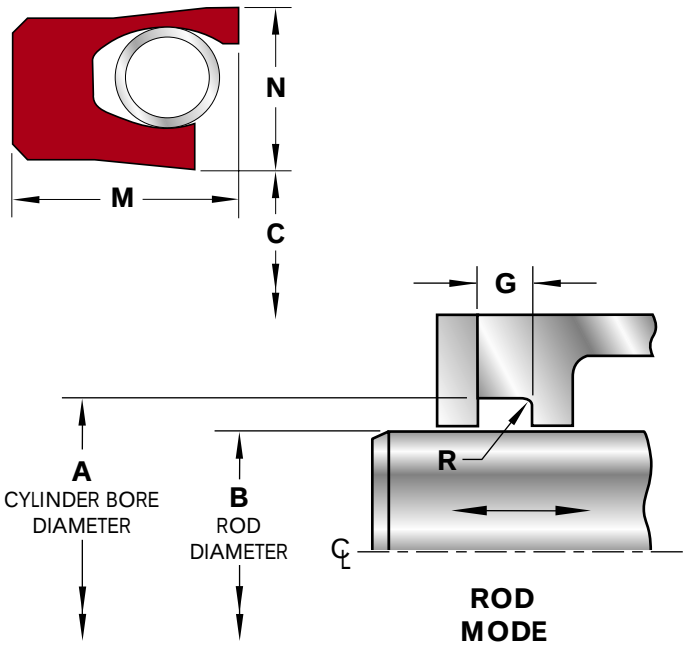
BHI Mark X-H I.D. Dynamic Axial Seal

Applications:

- Best choice for high pressure sealing of reciprocating actuator rods.
- Suitable for pressures up to 8000 psi, 55 MPa.

Features:

- Extended heel reduces the effects of extrusion.
- Heavy I.D. seal-lip ensures longest life.
- Short, scraper-type I.D. lip reduces frictional losses.
- Squared, long, static leg stabilizes seal.
- Widest range of cross-sections and diameters available, including sizes for upgrading standard O-ring glands.
- Many high-resilience spring-energizer-options, including choice of light, medium and heavy loads (for friction control) and 'NACE' corrosion resistance for oil field use.
- Lowest cost elastomeric energizers available, all with excellent fatigue resistance.



BHI Cavity Dimensioning

NOMINAL CROSS SECTION	CROSS SECTION CODE	CAVITY				REFERENCE SEAL DIMENSIONS		
		B	A	G	R	C	N	M
		I.D. RANGE tolerance h8	O.D. tolerance H8	WIDTH	MAXIMUM RADIUS	I.D.	FREE HEIGHT	WIDTH
1/16 in (1,6 mm)	01	2,50 – 75,00	B+ 2,84	3,78 – 4,04	0,38	B – 0,3	1,7	3,4
3/32 in (2,4 mm)	02	3,00 – 180,00	B+ 4,52	4,65 – 4,90	0,64	B – 0,4	2,7	4,0
1/8 in (3,2 mm)	03	6,00 – 250,00	B+ 6,15	5,97 – 6,22	0,76	B – 0,5	3,6	5,2
3/16 in (4,7 mm)	04	12,50 – 300,00	B+ 9,45	8,48 – 8,74	0,76	B – 0,7	5,5	7,7
1/4 in (6,4 mm)	05	50,00 – 500,00	B+ 12,12	12,07 – 12,32	0,76	B – 0,8	7,0	11,3
3/8 in (9,5 mm)	06	150,00 – 1400,00	B+ 18,75	15,80 – 16,05	0,76	B – 1,0	10,7	15,0

Cross Section

Where space permits, use of the largest cross section seal is preferred.

The **Tolerance Reference Table** can be found on Page E-11 of the Technical Data Section.
If specifying a diameter which is above the recommended diameter range, use the largest recommended diameter for the appropriate cross section to determine the cavity tolerances.

Part Number / Ordering

Example: To order a BHI Seal for a cavity with a 70,00 mm shaft (cavity I.D.) and a 76,15 mm bore (cavity O.D.), the part number should specify:

BHI - M007000 - 03 - 00 - 0

- 03 — EnerSeal Cross Section Code
- 007000 — Cavity I.D. (rod diameter or piston groove diameter) (to two decimal places)
- M — SI Units (millimeters)

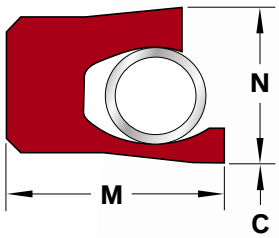
BHO Mark X O.D. Dynamic Axial Seal

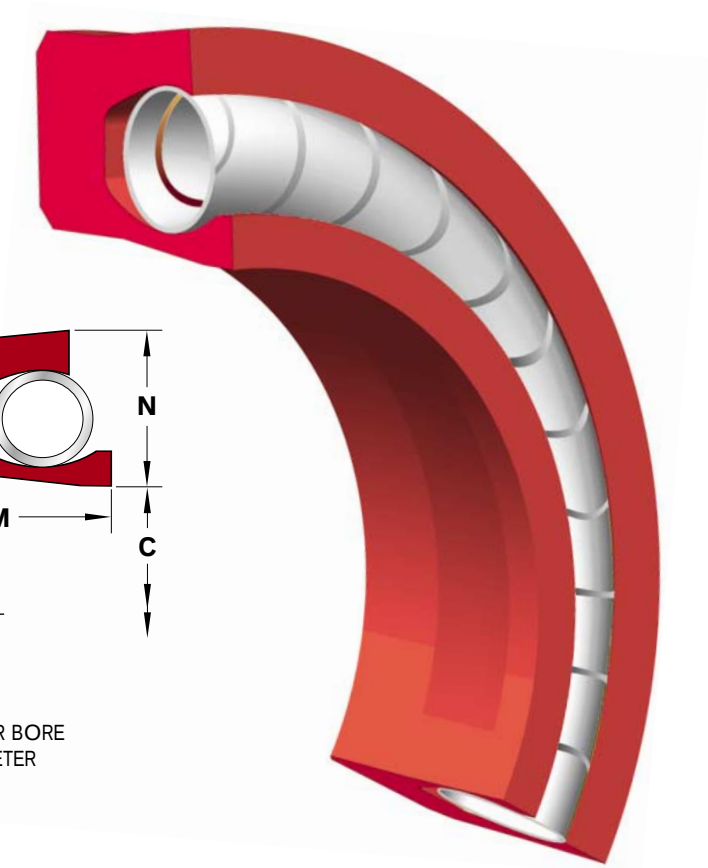
Applications:

- Best choice for high pressure sealing of pistons.
- Suitable for pressures up to 8000 psi, 55 MPa.

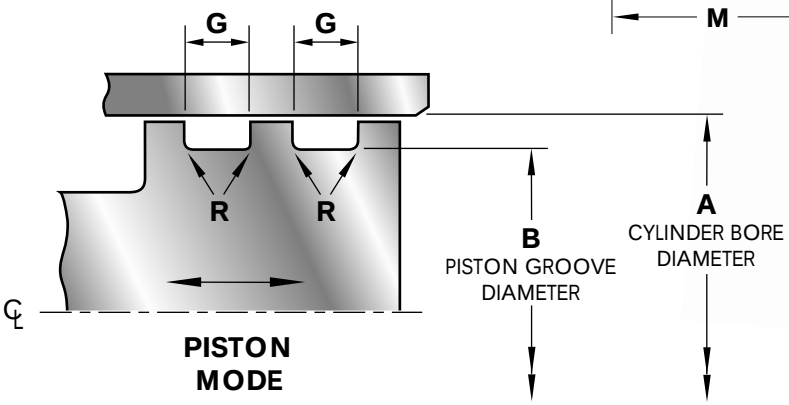
Features:

- Heavy O.D. seal-lip ensures longest life.
- Short, scraper-type O.D. lip reduces frictional losses.
- Squared, long, static leg stabilizes seal. Standard O-ring glands.
- Extended heel reduces the effects of extrusion.
- Widest range of cross-sections and diameters available, including sizes for upgrading standard O-ring glands.
- Many high-resilience spring-energizer-options, including choice of light, medium and heavy loads (for friction control) and 'NACE' corrosion resistance for oil field use.
- Lowest cost elastomeric energizers available, all with excellent fatigue resistance.





Reversing pressures require a double cavity piston with back-to-back seals.



BHO Cavity Dimensioning

NOMINAL CROSS SECTION	CROSS SECTION CODE	CAVITY				REFERENCE SEAL DIMENSIONS		
		A	B	G	R	C	N	M
		O.D. RANGE tolerance H8	I.D. tolerance h8	WIDTH	MAXIMUM RADIUS	I.D.	FREE HEIGHT	WIDTH
1/16 in (1,6 mm)	01	5,50 – 75,00	A – 2,84	3,78 – 4,04	0,38	B – 0,3	1,7	3,4
3/32 in (2,4 mm)	02	7,50 – 180,00	A – 4,52	4,65 – 4,90	0,64	B – 0,4	2,7	4,0
1/8 in (3,2 mm)	03	12,50 – 250,00	A – 6,15	5,97 – 6,22	0,76	B – 0,5	3,6	5,2
3/16 in (4,7 mm)	04	22,00 – 300,00	A – 9,45	8,48 – 8,74	0,76	B – 0,7	5,5	7,7
1/4 in (6,4 mm)	05	63,00 – 500,00	A – 12,12	12,07 – 12,32	0,76	B – 0,8	7,0	11,3
3/8 in (9,5 mm)	06	170,00 – 1400,00	A – 18,75	15,80 – 16,05	0,76	B – 1,0	10,7	15,0

Cross Section

Where space permits, use of the largest cross section seal is preferred.

The **Tolerance Reference Table** can be found on Page E-11 of the Technical Data Section.
If specifying a diameter which is above the recommended diameter range, use the largest recommended diameter for the appropriate cross section to determine the cavity tolerances.

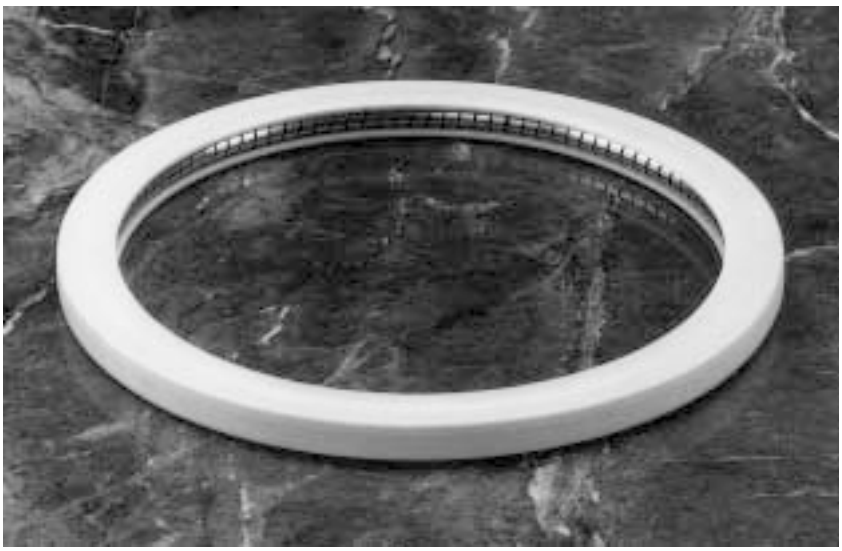
Part Number / Ordering

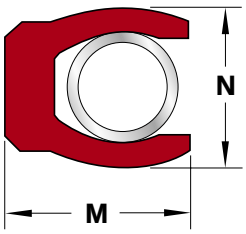
Example: To order a BHO Seal for a cavity with a 70,00 mm bore diameter (cavity O.D.) and a 63,85 mm piston diameter (cavity I.D.), the part number should specify:

BHO - M007000 - 03 - 00 - 0

- 03 — EnerSeal Cross Section Code
- 007000 — Cavity O.D. (cylinder bore diameter) (to two decimal places)
- M — SI Units (millimeters)

NAI Mark I Internal Pressure Face Seal



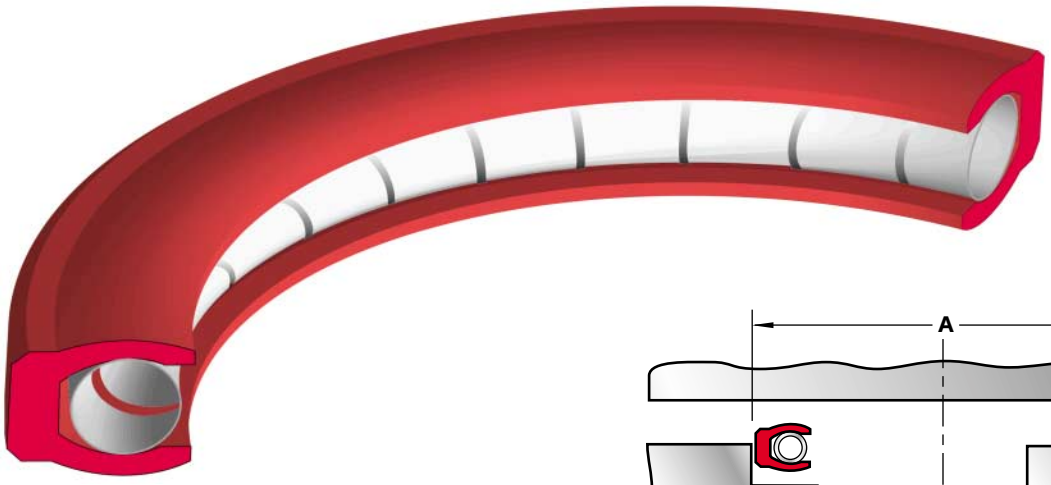


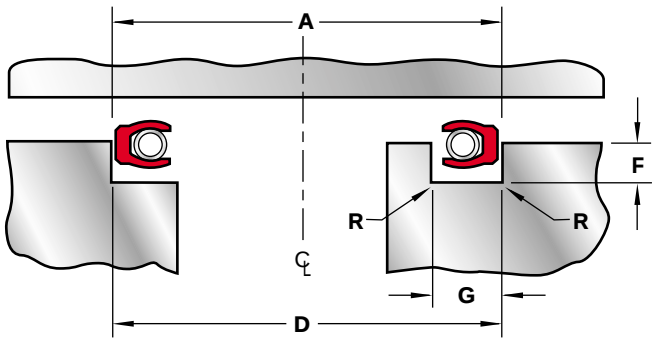
Applications:

- Excellent internally pressurized, spring energized face seal for static and intermittent dynamic use.
- Suitable for use in shallow groove or counterbores with as little as 0.056 – 0.058 inch (1,42 – 1,47 mm) depth.
- Good for pressures up to 8000 psi, 55 MPa.

Features:

- High resiliency resists permanent set and maintains long term compliance to flange separation.
- Many high-resilience spring-energizer-options, including choice of light, medium and heavy loads and 'NACE' corrosion resistance for oil field use.
- Lowest cost elastomeric energizers available, all with excellent fatigue resistance.





NAI Cavity Dimensioning

NOMINAL CROSS SECTION	CROSS SECTION CODE	CAVITY				REFERENCE SEAL DIMENSIONS		
		D	F	G	R	A	N	M
		O.D. RANGE tolerance H10	DEPTH RANGE	MINIMUM WIDTH	MAXIMUM RADIUS	O.D.	FREE HEIGHT	WIDTH
1/16 in (1,6 mm)	01	8,15 – 65,00	1,42 – 1,47	2,39	0,38	D	1,8	2,0
3/32 in (2,4 mm)	02	14,00 – 100,00	2,26 – 2,31	3,58	0,38	D	2,7	3,0
1/8 in (3,2 mm)	03	25,00 – 200,00	3,07 – 3,12	4,78	0,64	D	3,6	3,9
3/16 in (4,7 mm)	04	48,00 – 350,00	4,72 – 4,78	7,14	0,76	D	5,5	5,9
1/4 in (6,4 mm)	05	115,00 – 400,00	6,05 – 6,12	9,53	0,76	D	7,0	8,0
3/8 in (9,5 mm)	06	200,00 – 1000,00	9,47 – 9,58	13,26	0,76	D	10,4	11,7

Cross Section

Where space permits, use of the largest cross section seal is preferred.

The **Tolerance Reference Table** can be found on Page E-11 of the Technical Data Section.
If specifying a diameter which is above the recommended diameter range, use the largest recommended diameter for the appropriate cross section to determine the cavity tolerances.

Part Number / Ordering

Example: To order a NAI Seal for a cavity with a 70,00 mm O.D. and a depth of 3,10 mm, the part number should specify:

NAI - M007000 - 03 - 00 - 0

- 03 — EnerSeal Cross Section Code
- 007000 — Cavity O.D. (to two decimal places)
- M — SI Units (millimeters)

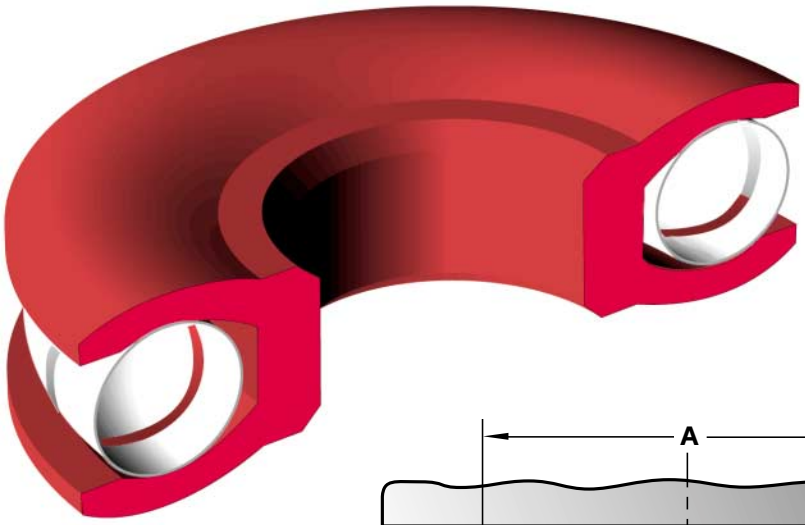
NAE Mark I External Pressure Face Seal

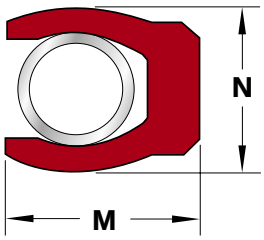
Applications:

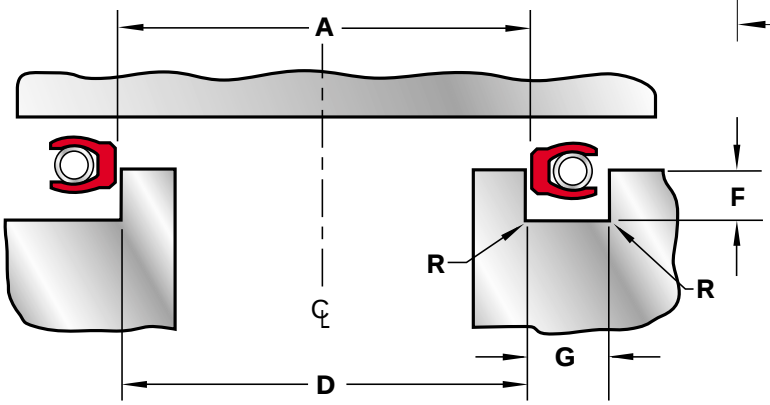
- Excellent externally pressurized, spring energized face seal for static and intermittent dynamic use.
- Suitable for use in shallow groove or counterbores with as little as 0.056 – 0.058 inch (1,42 – 1,47 mm) depth.
- Good for pressures up to 8000 psi, 55 MPa.

Features:

- High resiliency resists permanent set and maintains long term compliance to flange separation.
- Many high-resilience spring-energizer-options, including choice of light, medium and heavy loads and 'NACE' corrosion resistance for oil field use.
- Lowest cost elastomeric energizers available, all with excellent fatigue resistance.







OPEN GROOVE MODE

GROOVE MODE

NAE Cavity Dimensioning

NOMINAL CROSS SECTION	CROSS SECTION CODE	CAVITY				REFERENCE SEAL DIMENSIONS		
		D	F	G	R	A	N	M
		I.D. RANGE tolerance h10	DEPTH RANGE	MINIMUM WIDTH	MAXIMUM RADIUS	I.D.	FREE HEIGHT	WIDTH
1/16 in (1,6 mm)	01	4,75 – 65,00	1,42 – 1,47	2,39	0,38	D	1,8	2,0
3/32 in (2,4 mm)	02	10,00 – 100,00	2,26 – 2,31	3,58	0,38	D	2,7	3,0
1/8 in (3,2 mm)	03	20,00 – 200,00	3,07 – 3,12	4,78	0,64	D	3,6	3,9
3/16 in (4,7 mm)	04	40,00 – 300,00	4,72 – 4,78	7,14	0,76	D	5,5	5,9
1/4 in (6,4 mm)	05	90,00 – 400,00	6,05 – 6,12	9,53	0,76	D	7,0	8,0
3/8 in (9,5 mm)	06	200,00 – 1000,00	9,47 – 9,58	13,26	0,76	D	10,4	11,7

Cross Section

Where space permits, use of the largest cross section seal is preferred.

The **Tolerance Reference Table** can be found on Page E-11 of the Technical Data Section.
If specifying a diameter which is above the recommended diameter range, use the largest recommended diameter for the appropriate cross section to determine the cavity tolerances.

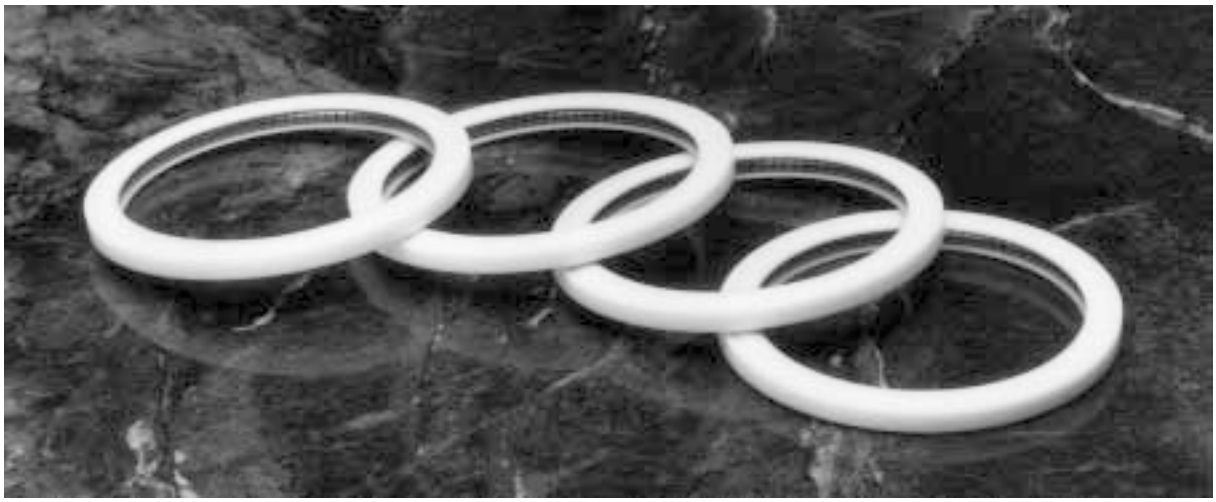
Part Number / Ordering

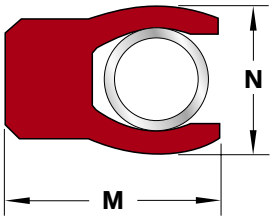
Example: To order a NAE Seal for a cavity with a 70,00 mm I.D. and a depth of 3,10 mm, the part number should specify:

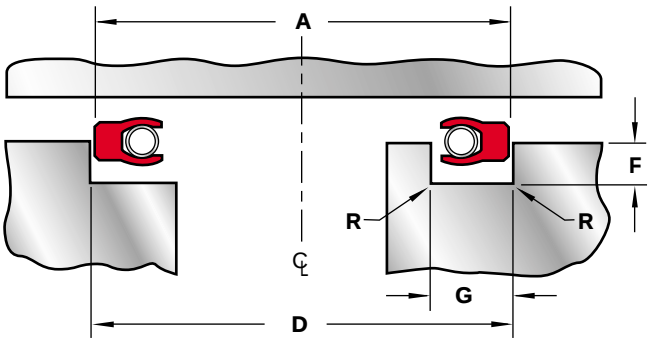
NAE - M007000 - 03 - 00 - 0

- 03 — EnerSeal Cross Section Code
- 007000 — Cavity I.D. (to two decimal places)
- M — SI Units (millimeters)

NHI Mark I-H Internal Pressure Face Seal







Applications:

- Excellent internally pressurized, spring energized face seal for static and intermittent dynamic use.
- Suitable for use in shallow groove or counter-bores with as little as 0.056 – 0.058 inch (1,42 – 1,47 mm) depth.
- Good for highest pressures to 20,000 psi, 140 MPa.

Features:

- High resiliency resists permanent set and maintains long term compliance to flange separation.
- Extended heel reduces the effects of extrusion.
- Many high-resilience spring-energizer-options, including choice of light, medium and heavy loads and 'NACE' corrosion resistance for oil field use.
- Lowest cost elastomeric energizers available, all with excellent fatigue resistance.

NHI Cavity Dimensioning

NOMINAL CROSS SECTION	CROSS SECTION CODE	CAVITY				REFERENCE SEAL DIMENSIONS		
		D	F	G	R	A	N	M
		O.D. RANGE tolerance H10	DEPTH RANGE	MINIMUM WIDTH	MAXIMUM RADIUS	O.D.	FREE HEIGHT	WIDTH
1/16 in (1,6 mm)	01	8,15 – 65,00	1,42 – 1,47	3,30	0,38	D	1,8	2,9
3/32 in (2,4 mm)	02	14,00 – 100,00	2,26 – 2,31	4,50	0,38	D	2,7	3,9
1/8 in (3,2 mm)	03	25,00 – 200,00	3,07 – 3,12	6,48	0,64	D	3,6	4,9
3/16 in (4,7 mm)	04	48,00 – 350,00	4,72 – 4,78	8,05	0,76	D	5,5	6,9
1/4 in (6,4 mm)	05	115,00 – 400,00	6,05 – 6,12	11,25	0,76	D	7,0	9,3
3/8 in (9,5 mm)	06	200,00 – 1000,00	9,47 – 9,58	15,80	0,76	D	10,4	14,2

Cross Section

Where space permits, use of the largest cross section seal is preferred.

The **Tolerance Reference Table** can be found on Page E-11 of the Technical Data Section.
If specifying a diameter which is above the recommended diameter range, use the largest recommended diameter for the appropriate cross section to determine the cavity tolerances.

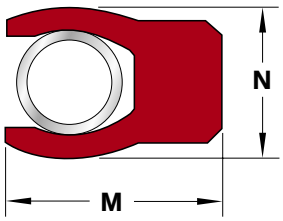
Part Number / Ordering

Example: To order a NHI Seal for a cavity with a 70,00 mm O.D. and a depth of 3,10 mm, the part number should specify:

NHI - M007000 - 03 - 00 - 0

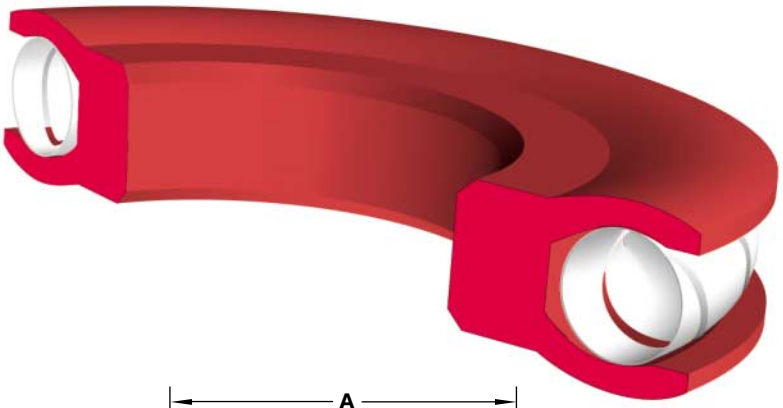
- 03 — EnerSeal Cross Section Code
- 007000 — Cavity O.D. (to two decimal places)
- M — SI Units (millimeters)

NHE Mark I-H External Pressure Face Seal



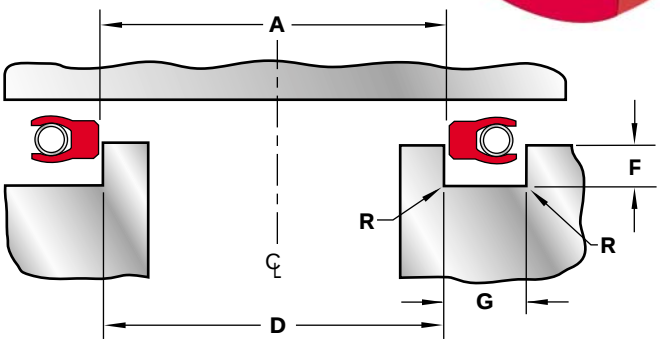
Applications:

- Excellent externally pressurized, spring energized face seal for static and intermittent dynamic use.
- Suitable for use in shallow groove or counterbores with as little as 0.056 – 0.058 inch (1,42 – 1,47 mm) depth.
- Good for highest pressures beyond 20,000 psi, 140 MPa.



Features:

- High resiliency resists permanent set and maintains long term compliance to flange separation.
- Extended heel reduces the effects of extrusion.
- Many high-resilience spring-energizer-options, including choice of light, medium and heavy loads and 'NACE' corrosion resistance for oil field use.
- Lowest cost elastomeric energizers available, all with excellent fatigue resistance.



NHE Cavity Dimensioning

NOMINAL CROSS SECTION	CROSS SECTION CODE	CAVITY				REFERENCE SEAL DIMENSIONS		
		D	F	G	R	A	N	M
		I.D. RANGE tolerance h10	DEPTH RANGE	MINIMUM WIDTH	MAXIMUM RADIUS	I.D.	FREE HEIGHT	WIDTH
1/16 in (1,6 mm)	01	4,75 – 65,00	1,42 – 1,47	3,30	0,38	D	1,8	2,9
3/32 in (2,4 mm)	02	10,00 – 100,00	2,26 – 2,31	4,50	0,38	D	2,7	3,9
1/8 in (3,2 mm)	03	20,00 – 200,00	3,07 – 3,12	6,48	0,64	D	3,6	4,9
3/16 in (4,7 mm)	04	40,00 – 300,00	4,72 – 4,78	8,05	0,76	D	5,5	6,9
1/4 in (6,4 mm)	05	90,00 – 400,00	6,05 – 6,12	11,25	0,76	D	7,0	9,3
3/8 in (9,5 mm)	06	200,00 – 1000,00	9,47 – 9,58	15,80	0,76	D	10,4	14,2

Cross Section

Where space permits, use of the largest cross section seal is preferred.

The **Tolerance Reference Table** can be found on Page E-11 of the Technical Data Section.
If specifying a diameter which is above the recommended diameter range, use the largest recommended diameter for the appropriate cross section to determine the cavity tolerances.

Part Number / Ordering

Example: To order a NHE Seal for a cavity with a 70,00 mm I.D. and a depth of 3,10 mm, the part number should specify:

NHE - M007000 - 03 - 00 - 0

- 03 — EnerSeal Cross Section Code
- 007000 — Cavity I.D. (to two decimal places)
- M — SI Units (millimeters)

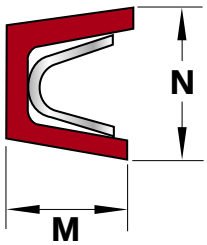
NRI Mark V Internal Pressure Face Seal

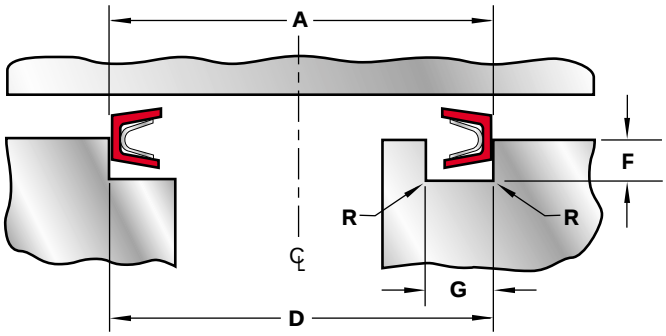
Applications:

- High force internally pressurized, spring energized face seal for static cryogenic applications.
- Good for pressures up to 5000 psi, 35 MPa.

Features:

- High resiliency resists permanent set and maintains long term compliance to flange separation.
- Spring energizer acts as control band to resist shrinkage.
- Many high-resilience spring-energizer-options, including 'NACE' approved materials.





COUNTERBORE MODE

GROOVE MODE

NRI Cavity Dimensioning

NOMINAL CROSS SECTION	CROSS SECTION CODE	CAVITY				REFERENCE SEAL DIMENSIONS		
		D	F	G	R	A	N	M
		O.D. RANGE tolerance H10	DEPTH RANGE	MINIMUM WIDTH	MAXIMUM RADIUS	O.D.	FREE HEIGHT	WIDTH
3/16 in (4,7 mm)	04	50,00 – 300,00	4,72 – 4,78	9,00	0,75	D	7,0	8,1
1/4 in (6,4 mm)	05	80,00 – 1000,00	6,05 – 6,12	10,00	0,75	D	8,1	9,1
3/8 in (9,5 mm)	06	150,00 – 1200,00	9,47 – 9,58	13,50	0,75	D	12,6	11,8
1/2 in (12,7 mm)	07	200,00 – 1200,00	12,70 – 12,80	18,50	0,75	D	16,0	16,4

Cross Section

Where space permits, use of the largest cross section seal is preferred.

The **Tolerance Reference Table** can be found on Page E-11 of the Technical Data Section.
If specifying a diameter which is above the recommended diameter range, use the largest recommended diameter for the appropriate cross section to determine the cavity tolerances.

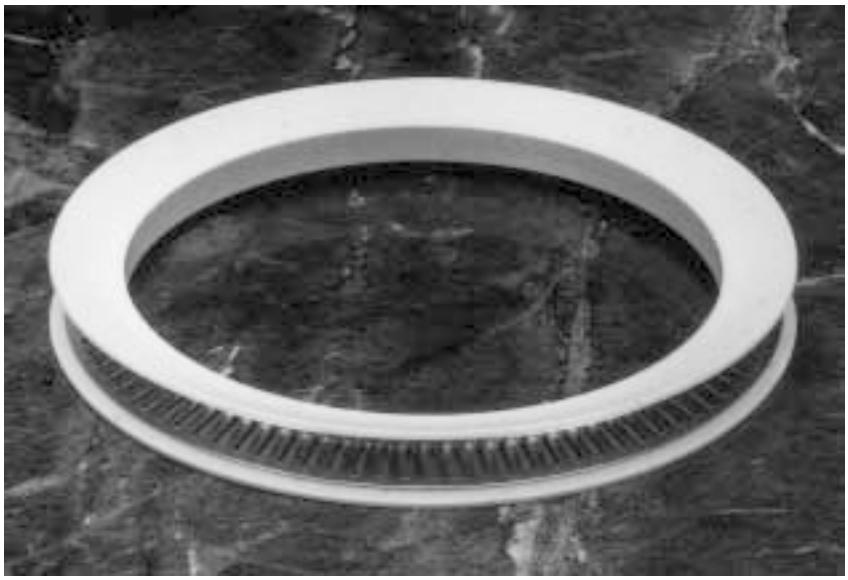
Part Number/Ordering

Example: To order a NRI Seal for a cavity with a 70,00 mm O.D. and a depth of 6,10 mm, the part number should specify:

NRI - M007000 - 05 - 00 - 0

- 05 — EnerSeal Cross Section Code
- 007000 — Cavity O.D. (to two decimal places)
- M — SI Units (millimeters)

NRE Mark V External Pressure Face Seal

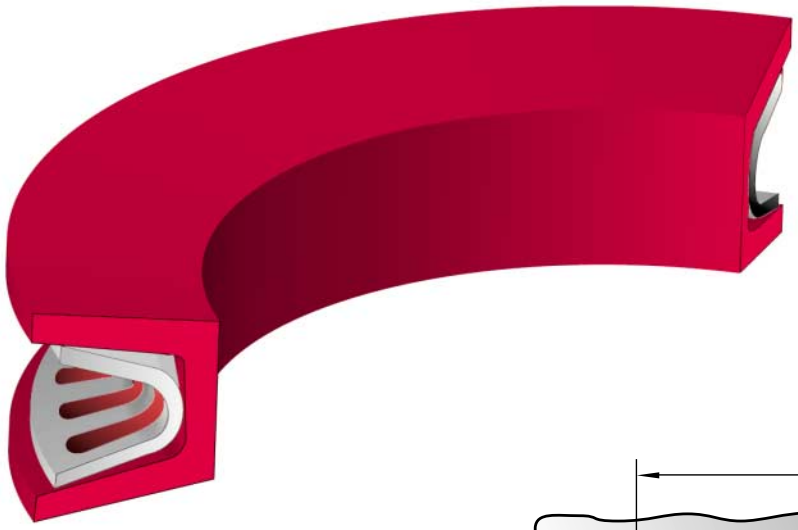


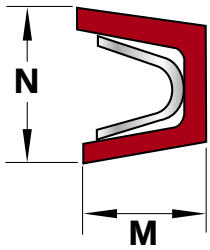
Applications:

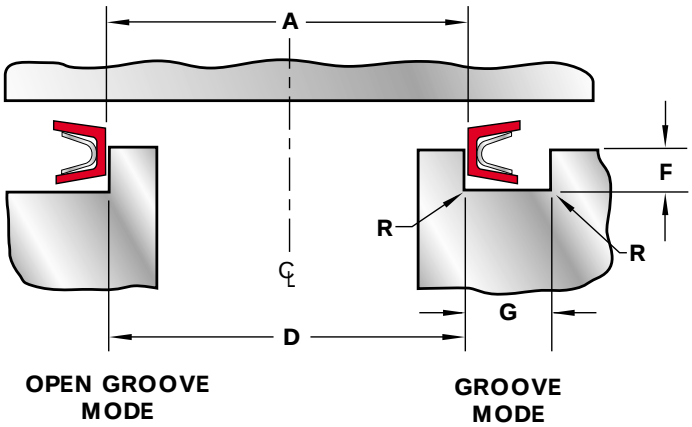
- High force externally pressurized, spring energized face seal for static cryogenic applications.
- Good for pressures up to 5000 psi, 35 MPa.

Features:

- High resiliency resists permanent set and maintains long term compliance to flange separation.
- Many high-resilience spring-energizer-options, including 'NACE' approved materials.







NRE Cavity Dimensioning

NOMINAL CROSS SECTION	CROSS SECTION CODE	CAVITY				REFERENCE SEAL DIMENSIONS		
		D	F	G	R	A	N	M
		I.D. RANGE tolerance h10	DEPTH RANGE	MINIMUM WIDTH	MAXIMUM RADIUS	I.D.	FREE HEIGHT	WIDTH
3/16 in (4,7 mm)	04	50,00 – 300,00	4,72 – 4,78	9,00	0,75	D	7,0	8,1
1/4 in (6,4 mm)	05	80,00 – 1000,00	6,05 – 6,12	10,00	0,75	D	8,1	9,1
3/8 in (9,5 mm)	06	150,00 – 1200,00	9,47 – 9,58	13,50	0,75	D	12,6	11,8
1/2 in (12,7 mm)	07	200,00 – 1200,00	12,70 – 12,80	18,50	0,75	D	16,0	16,4

Cross Section

Where space permits, use of the largest cross section seal is preferred.

The **Tolerance Reference Table** can be found on Page E-11 of the Technical Data Section.
If specifying a diameter which is above the recommended diameter range, use the largest recommended diameter for the appropriate cross section to determine the cavity tolerances.

Part Number/Ordering

Example: To order a NRE Seal for a cavity with a 70,00 mm I.D. and a depth of 6,10 mm, the part number should specify:

NRE - M007000 - 05 - 00 - 0

- 05 — EnerSeal Cross Section Code
- 007000 — Cavity I.D. (to two decimal places)
- M — SI Units (millimeters)

EnerSeal Size for MIL-G-5514 Standard Glands

EnerSeals are produced in a complete range of sizes conforming to MIL-G-5514 O-Ring gland specifications. Elastomeric O-Rings used in glands with dash numbers 013 through 028, 117 through 149, and 223 through 247 are intended for static applications only due to the possibility of spiral failure occurring in these larger diameter sizes of the smaller cross section O-Rings. As a result, Advanced Products EnerSeals are an excellent choice for use in dynamic applications with these dash numbers.

To select the EnerSeal Size refer to the list of the MS28775 Dash numbers in the adjacent table. The EnerSeal is designed for use in all three gland width configurations; no backup ring, one backup ring, and two backup rings. When one and two backup ring glands are used a long heel EnerSeal (NHA, BHI etc.) is preferred.

MIL-G-5514 Glands
1/16 inch Nominal Cross Section

MS28775 Dash Number	EnerSeal Size for I.D. Dynamic Rod Seals & Static Seals	EnerSeal Size for O.D. Dynamic Piston Seals
005	E000108 – 01	E000221 – 01
006	E000123 – 01	E000235 – 01
007	E000154 – 01	E000266 – 01
008	E000185 – 01	E000297 – 01
009	E000217 – 01	E000329 – 01
010	E000248 – 01	E000360 – 01
011	E000310 – 01	E000422 – 01
012	E000373 – 01	E000485 – 01
013	E000435 – 01	E000550 – 01
014	E000498 – 01	E000613 – 01
015	E000560 – 01	E000675 – 01
016	E000623 – 01	E000738 – 01
017	E000685 – 01	E000800 – 01
018	E000748 – 01	E000863 – 01
019	E000810 – 01	E000925 – 01
020	E000873 – 01	E000991 – 01
021	E000935 – 01	E001053 – 01
022	E000998 – 01	E001116 – 01
023	E001060 – 01	E001178 – 01
024	E001123 – 01	E001241 – 01
025	E001185 – 01	E001303 – 01
026	E001248 – 01	E001366 – 01
027	E001310 – 01	E001428 – 01
028	E001373 – 01	E001491 – 01

MIL-G-5514 Glands
3/32 inch Nominal Cross Section

MS28775 Dash Number	EnerSeal Size for I.D. Dynamic Rod Seals & Static Seals	EnerSeal Size for O.D. Dynamic Piston Seals
110	E000373 – 02	E000550 – 02
111	E000435 – 02	E000613 – 02
112	E000498 – 02	E000675 – 02
113	E000560 – 02	E000738 – 02
114	E000623 – 02	E000800 – 02
115	E000685 – 02	E000863 – 02
116	E000748 – 02	E000925 – 02
117	E000810 – 02	E000991 – 02
118	E000873 – 02	E001053 – 02
119	E000935 – 02	E001116 – 02
120	E000998 – 02	E001178 – 02
121	E001060 – 02	E001241 – 02
122	E001123 – 02	E001303 – 02
123	E001185 – 02	E001366 – 02
124	E001248 – 02	E001428 – 02
125	E001310 – 02	E001491 – 02
126	E001373 – 02	E001553 – 02
127	E001435 – 02	E001616 – 02
128	E001498 – 02	E001678 – 02
129	E001560 – 02	E001741 – 02
130	E001623 – 02	E001805 – 02
131	E001685 – 02	E001867 – 02
132	E001748 – 02	E001930 – 02
133	E001810 – 02	E001992 – 02
134	E001873 – 02	E002055 – 02
135	E001936 – 02	E002118 – 02
136	E001998 – 02	E002180 – 02
137	E002061 – 02	E002243 – 02
138	E002123 – 02	E002305 – 02
139	E002186 – 02	E002368 – 02
140	E002248 – 02	E002430 – 02
141	E002311 – 02	E002493 – 02
142	E002373 – 02	E002555 – 02
143	E002436 – 02	E002618 – 02
144	E002498 – 02	E002680 – 02
145	E002561 – 02	E002743 – 02
146	E002623 – 02	E002805 – 02
147	E002686 – 02	E002868 – 02
148	E002748 – 02	E002930 – 02
149	E002811 – 02	E002993 – 02

Part Number Example:

XXX - E000000 - 00 - 00 - 0

EnerSeal Size

MIL-G-5514 Glands
1/8 inch Nominal Cross Section

MS28775 Dash Number	EnerSeal Size for I.D. Dynamic Rod Seals & Static Seals	EnerSeal Size for O.D. Dynamic Piston Seals
210	E000748 – 03	E000991 – 03
211	E000810 – 03	E001053 – 03
212	E000873 – 03	E001116 – 03
213	E000935 – 03	E001178 – 03
214	E000998 – 03	E001241 – 03
215	E001060 – 03	E001303 – 03
216	E001123 – 03	E001366 – 03
217	E001185 – 03	E001428 – 03
218	E001248 – 03	E001491 – 03
219	E001310 – 03	E001553 – 03
220	E001373 – 03	E001616 – 03
221	E001435 – 03	E001678 – 03
222	E001498 – 03	E001741 – 03
223	E001623 – 03	E001867 – 03
224	E001748 – 03	E001992 – 03
225	E001873 – 03	E002118 – 03
226	E001998 – 03	E002243 – 03
227	E002123 – 03	E002368 – 03
228	E002248 – 03	E002493 – 03
229	E002373 – 03	E002618 – 03
230	E002498 – 03	E002743 – 03
231	E002623 – 03	E002868 – 03
232	E002748 – 03	E002993 – 03
233	E002873 – 03	E003118 – 03
234	E002997 – 03	E003243 – 03
235	E003122 – 03	E003368 – 03
236	E003247 – 03	E003493 – 03
237	E003372 – 03	E003618 – 03
238	E003497 – 03	E003743 – 03
239	E003622 – 03	E003868 – 03
240	E003747 – 03	E003993 – 03
241	E003872 – 03	E004118 – 03
242	E003997 – 03	E004243 – 03
243	E004122 – 03	E004368 – 03
244	E004247 – 03	E004493 – 03
245	E004372 – 03	E004618 – 03
246	E004497 – 03	E004743 – 03
247	E004622 – 03	E004868 – 03

MIL-G-5514 Glands
3/16 inch Nominal Cross Section

MS28775 Dash Number	EnerSeal Size for I.D. Dynamic Rod Seals & Static Seals	EnerSeal Size for O.D. Dynamic Piston Seals
325	E001498 – 04	E001867 – 04
326	E001623 – 04	E001992 – 04
327	E001748 – 04	E002118 – 04
328	E001873 – 04	E002243 – 04
329	E001998 – 04	E002368 – 04
330	E002123 – 04	E002493 – 04
331	E002248 – 04	E002618 – 04
332	E002373 – 04	E002743 – 04
333	E002498 – 04	E002868 – 04
334	E002623 – 04	E002993 – 04
335	E002748 – 04	E003118 – 04
336	E002873 – 04	E003243 – 04
337	E002997 – 04	E003368 – 04
338	E003122 – 04	E003493 – 04
339	E003247 – 04	E003618 – 04
340	E003372 – 04	E003743 – 04
341	E003497 – 04	E003868 – 04
342	E003622 – 04	E003993 – 04
343	E003747 – 04	E004118 – 04
344	E003872 – 04	E004243 – 04
345	E003997 – 04	E004368 – 04
346	E004122 – 04	E004493 – 04
347	E004247 – 04	E004618 – 04
348	E004372 – 04	E004743 – 04
349	E004497 – 04	E004868 – 04

MIL-G-5514 Glands
1/4 inch Nominal Cross Section

MS28775 Dash Number	EnerSeal Size for I.D. Dynamic Rod Seals & Static Seals	EnerSeal Size for O.D. Dynamic Piston Seals
425	E004497 – 05	E004974 – 05
426	E004622 – 05	E005099 – 05
427	E004747 – 05	E005224 – 05
428	E004872 – 05	E005349 – 05
429	E004997 – 05	E005474 – 05
430	E005122 – 05	E005599 – 05
431	E005247 – 05	E005724 – 05
432	E005372 – 05	E005849 – 05
433	E005497 – 05	E005974 – 05
434	E005622 – 05	E006099 – 05
435	E005747 – 05	E006224 – 05
436	E005872 – 05	E006349 – 05
437	E005997 – 05	E006474 – 05
438	E006247 – 05	E006724 – 05
439	E006497 – 05	E006974 – 05
440	E006747 – 05	E007224 – 05
441	E006997 – 05	E007474 – 05
442	E007247 – 05	E007724 – 05
443	E007497 – 05	E007974 – 05
444	E007747 – 05	E008224 – 05
445	E007997 – 05	E008474 – 05
446	E008497 – 05	E008974 – 05
447	E008997 – 05	E009474 – 05
448	E009497 – 05	E009974 – 05
449	E009997 – 05	E010474 – 05
450	E010497 – 05	E010974 – 05
451	E010997 – 05	E011474 – 05
452	E011497 – 05	E011974 – 05
453	E011997 – 05	E012474 – 05
454	E012497 – 05	E012974 – 05
455	E012997 – 05	E013474 – 05
456	E013497 – 05	E013974 – 05
457	E013997 – 05	E014474 – 05
458	E014497 – 05	E014974 – 05
459	E014997 – 05	E015474 – 05
460	E015497 – 05	E015974 – 05

EnerSeal Size for Standard Industrial (Fractional) Glands

EnerSeals are available to fit all Standard Industrial Glands which are specified in fractions of inches. This Series is designated with a cross section code –11 through –15. Per this standard, the nominal cross section size reflects the true gland cross section.

To select the EnerSeal Size for these Standard Industrial Glands, refer to the list of the Size Dash Numbers in the adjacent table. The EnerSeal is designed for use in all three gland width configurations: no backup ring, one backup ring, and two backup rings. When one and two backup ring glands are used a long heel EnerSeal (NHA, BHI etc.) is preferred.

Standard Industrial (Fractional) Glands 1/16 inch Nominal Cross Section

Size Dash Number	EnerSeal Size for I.D. Dynamic Rod Seals & Static Seals	EnerSeal Size for O.D. Dynamic Piston Seals
005	E000109 – 11	E000234 – 11
006	E000125 – 11	E000250 – 11
007	E000156 – 11	E000281 – 11
008	E000187 – 11	E000312 – 11
009	E000218 – 11	E000343 – 11
010	E000250 – 11	E000375 – 11
011	E000312 – 11	E000437 – 11
012	E000375 – 11	E000500 – 11
013	E000437 – 11	E000562 – 11
014	E000500 – 11	E000625 – 11
015	E000562 – 11	E000687 – 11
016	E000625 – 11	E000750 – 11
017	E000687 – 11	E000812 – 11
018	E000750 – 11	E000875 – 11
019	E000812 – 11	E000937 – 11
020	E000875 – 11	E001000 – 11
021	E000937 – 11	E001062 – 11
022	E001000 – 11	E001125 – 11
023	E001062 – 11	E001187 – 11
024	E001125 – 11	E001250 – 11
025	E001187 – 11	E001312 – 11
026	E001250 – 11	E001375 – 11
027	E001312 – 11	E001437 – 11
028	E001375 – 11	E001500 – 11
029	E001500 – 11	E001625 – 11
030	E001625 – 11	E001750 – 11
031	E001750 – 11	E001875 – 11
032	E001875 – 11	E002000 – 11
033	E002000 – 11	E002125 – 11
034	E002125 – 11	E002250 – 11
035	E002250 – 11	E002375 – 11
036	E002375 – 11	E002500 – 11
037	E002500 – 11	E002625 – 11
038	E002625 – 11	E002750 – 11
039	E002750 – 11	E002875 – 11
040	E002875 – 11	E003000 – 11
041	E003000 – 11	E003125 – 11
042	E003250 – 11	E003375 – 11
043	E003500 – 11	E003625 – 11
044	E003750 – 11	E003875 – 11
045	E004000 – 11	E004125 – 11
046	E004250 – 11	E004375 – 11

Standard Industrial (Fractional) Glands 3/32 inch Nominal Cross Section

Size Dash Number	EnerSeal Size for I.D. Dynamic Rod Seals & Static Seals	EnerSeal Size for O.D. Dynamic Piston Seals
106	E000187 – 12	E000375 – 12
107	E000219 – 12	E000406 – 12
108	E000250 – 12	E000437 – 12
109	E000312 – 12	E000500 – 12
110	E000375 – 12	E000562 – 12
111	E000437 – 12	E000625 – 12
112	E000500 – 12	E000687 – 12
113	E000562 – 12	E000750 – 12
114	E000625 – 12	E000812 – 12
115	E000687 – 12	E000875 – 12
116	E000750 – 12	E000937 – 12
117	E000812 – 12	E001000 – 12
118	E000875 – 12	E001062 – 12
119	E000937 – 12	E001125 – 12
120	E001000 – 12	E001187 – 12
121	E001062 – 12	E001250 – 12
122	E001125 – 12	E001312 – 12
123	E001187 – 12	E001375 – 12
124	E001250 – 12	E001437 – 12
125	E001312 – 12	E001500 – 12
126	E001375 – 12	E001562 – 12
127	E001437 – 12	E001625 – 12
128	E001500 – 12	E001687 – 12
129	E001562 – 12	E001750 – 12
130	E001625 – 12	E001812 – 12
131	E001687 – 12	E001875 – 12
132	E001750 – 12	E001937 – 12
133	E001812 – 12	E002000 – 12
134	E001875 – 12	E002062 – 12
135	E001937 – 12	E002125 – 12
136	E002000 – 12	E002187 – 12
137	E002062 – 12	E002250 – 12
138	E002125 – 12	E002312 – 12
139	E002187 – 12	E002375 – 12
140	E002250 – 12	E002437 – 12
141	E002312 – 12	E002500 – 12
142	E002375 – 12	E002562 – 12
143	E002437 – 12	E002625 – 12
144	E002500 – 12	E002687 – 12
145	E002562 – 12	E002750 – 12
146	E002625 – 12	E002812 – 12
147	E002687 – 12	E002875 – 12
148	E002750 – 12	E002937 – 12
149	E002812 – 12	E003000 – 12
150	E002875 – 12	E003062 – 12
151	E003000 – 12	E003187 – 12
152	E003250 – 12	E003437 – 12
153	E003500 – 12	E003687 – 12
154	E003750 – 12	E003937 – 12
155	E004000 – 12	E004187 – 12
156	E004250 – 12	E004437 – 12
157	E004500 – 12	E004687 – 12
158	E004750 – 12	E004937 – 12
159	E005000 – 12	E005187 – 12
160	E005250 – 12	E005437 – 12
161	E005500 – 12	E005687 – 12

Part Number Example:

XXX - E000000 - 00 - 00 - 0

EnerSeal Size

Standard Industrial (Fractional) Glands 1/8 inch Nominal Cross Section

Size Dash Number	EnerSeal Size for I.D. Dynamic Rod Seals & Static Seals	EnerSeal Size for O.D. Dynamic Piston Seals
202	E000250 – 13	E000500 – 13
203	E000312 – 13	E000562 – 13
204	E000375 – 13	E000625 – 13
205	E000437 – 13	E000687 – 13
206	E000500 – 13	E000750 – 13
207	E000562 – 13	E000812 – 13
208	E000625 – 13	E000875 – 13
209	E000687 – 13	E000937 – 13
210	E000750 – 13	E001000 – 13
211	E000812 – 13	E001062 – 13
212	E000875 – 13	E001125 – 13
213	E000937 – 13	E001187 – 13
214	E001000 – 13	E001250 – 13
215	E001062 – 13	E001312 – 13
216	E001125 – 13	E001375 – 13
217	E001187 – 13	E001437 – 13
218	E001250 – 13	E001500 – 13
219	E001312 – 13	E001562 – 13
220	E001375 – 13	E001625 – 13
221	E001437 – 13	E001687 – 13
222	E001500 – 13	E001750 – 13
223	E001625 – 13	E001875 – 13
224	E001750 – 13	E002000 – 13
225	E001875 – 13	E002125 – 13
226	E002000 – 13	E002250 – 13
227	E002125 – 13	E002375 – 13
228	E002250 – 13	E002500 – 13
229	E002375 – 13	E002625 – 13
230	E002500 – 13	E002750 – 13
231	E002625 – 13	E002875 – 13
232	E002750 – 13	E003000 – 13
233	E002875 – 13	E003125 – 13
234	E003000 – 13	E003250 – 13
235	E003125 – 13	E003375 – 13
236	E003250 – 13	E003500 – 13
237	E003375 – 13	E003625 – 13
238	E003500 – 13	E003750 – 13
239	E003625 – 13	E003875 – 13
240	E003750 – 13	E004000 – 13
241	E003875 – 13	E004125 – 13
242	E004000 – 13	E004250 – 13
243	E004125 – 13	E004375 – 13
244	E004250 – 13	E004500 – 13
245	E004375 – 13	E004625 – 13
246	E004500 – 13	E004750 – 13
247	E004625 – 13	E004875 – 13
248	E004750 – 13	E005000 – 13
249	E004875 – 13	E005125 – 13
250	E005000 – 13	E005250 – 13
251	E005125 – 13	E005375 – 13
252	E005250 – 13	E005500 – 13
253	E005375 – 13	E005625 – 13
254	E005500 – 13	E005750 – 13
255	E005625 – 13	E005875 – 13
256	E005750 – 13	E006000 – 13
257	E005875 – 13	E006125 – 13
258	E006000 – 13	E006250 – 13
259	E006250 – 13	E006500 – 13
260	E006500 – 13	E006750 – 13
261	E006750 – 13	E007000 – 13
262	E007000 – 13	E007250 – 13
263	E007250 – 13	E007500 – 13
264	E007500 – 13	E007750 – 13
265	E007750 – 13	E008000 – 13
266	E008000 – 13	E008250 – 13
267	E008250 – 13	E008500 – 13
268	E008500 – 13	E008750 – 13
269	E008750 – 13	E009000 – 13
270	E009000 – 13	E009250 – 13

Standard Industrial (Fractional) Glands 3/16 inch Nominal Cross Section

Size Dash Number	EnerSeal Size for I.D. Dynamic Rod Seals & Static Seals	EnerSeal Size for O.D. Dynamic Piston Seals
313	E000500 – 14	E000875 – 14
314	E000562 – 14	E000937 – 14
315	E000625 – 14	E001000 – 14
316	E000687 – 14	E001062 – 14
317	E000750 – 14	E001125 – 14
318	E000812 – 14	E001187 – 14
319	E000875 – 14	E001250 – 14
320	E000937 – 14	E001312 – 14
321	E001000 – 14	E001375 – 14
322	E001125 – 14	E001500 – 14
323	E001250 – 14	E001625 – 14
324	E001375 – 14	E001750 – 14
325	E001500 – 14	E001875 – 14
326	E001625 – 14	E002000 – 14
327	E001750 – 14	E002125 – 14
328	E001875 – 14	E002250 – 14
329	E002000 – 14	E002375 – 14
330	E002125 – 14	E002500 – 14
331	E002250 – 14	E002625 – 14
332	E002375 – 14	E002750 – 14
333	E002500 – 14	E002875 – 14
334	E002625 – 14	E003000 – 14
335	E002750 – 14	E003125 – 14
336	E002875 – 14	E003250 – 14
337	E003000 – 14	E003375 – 14
338	E003125 – 14	E003500 – 14
339	E003250 – 14	E003625 – 14
340	E003375 – 14	E003750 – 14
341	E003500 – 14	E003875 – 14
342	E003625 – 14	E004000 – 14
343	E003750 – 14	E004125 – 14
344	E003875 – 14	E004250 – 14
345	E004000 – 14	E004375 – 14
346	E004125 – 14	E004500 – 14
347	E004250 – 14	E004625 – 14
348	E004375 – 14	E004750 – 14
349	E004500 – 14	E004875 – 14
350	E004625 – 14	E005000 – 14
351	E004750 – 14	E005125 – 14
352	E004875 – 14	E005250 – 14
353	E005000 – 14	E005375 – 14
354	E005125 – 14	E005500 – 14
355	E005250 – 14	E005625 – 14
356	E005375 – 14	E005750 – 14
357	E005500 – 14	E005875 – 14
358	E005625 – 14	E006000 – 14
359	E005750 – 14	E006125 – 14
360	E005875 – 14	E006250 – 14
361	E006000 – 14	E006375 – 14
362	E006250 – 14	E006625 – 14
363	E006500 – 14	E006875 – 14
364	E006750 – 14	E007125 – 14
365	E007000 – 14	E007375 – 14
366	E007250 – 14	E007625 – 14
367	E007500 – 14	E007875 – 14
368	E007750 – 14	E008125 – 14
369	E008000 – 14	E008375 – 14
370	E008250 – 14	E008625 – 14
371	E008500 – 14	E008875 – 14
372	E008750 – 14	E009125 – 14
373	E009000 – 14	E009375 – 14
374	E009250 – 14	E009625 – 14
375	E009500 – 14	E009875 – 14
376	E009750 – 14	E010125 – 14
377	E010000 – 14	E010375 – 14
378	E010500 – 14	E010875 – 14

Standard Industrial (Fractional) Glands 1/4 inch Nominal Cross Section

Size Dash Number	EnerSeal Size for I.D. Dynamic Rod Seals & Static Seals	EnerSeal Size for O.D. Dynamic Piston Seals
401	E001500 – 15	E002000 – 15
402	E001625 – 15	E002125 – 15
403	E001750 – 15	E002250 – 15
404	E001875 – 15	E002375 – 15
405	E002000 – 15	E002500 – 15
406	E002125 – 15	E002625 – 15
407	E002250 – 15	E002750 – 15
408	E002375 – 15	E002875 – 15
409	E002500 – 15	E003000 – 15
410	E002625 – 15	E003125 – 15
411	E002750 – 15	E003250 – 15
412	E002875 – 15	E003375 – 15
413	E003000 – 15	E003500 – 15
414	E003125 – 15	E003625 – 15
415	E003250 – 15	E003750 – 15
416	E003375 – 15	E003875 – 15
417	E003500 – 15	E004000 – 15
418	E003625 – 15	E004125 – 15
419	E003750 – 15	E004250 – 15
420	E003875 – 15	E004375 – 15
421	E004000 – 15	E004500 – 15
422	E004125 – 15	E004625 – 15
423	E004250 – 15	E004750 – 15
424	E004375 – 15	E004875 – 15
425	E004500 – 15	E005000 – 15
426	E004625 – 15	E005125 – 15
427	E004750 – 15	E005250 – 15
428	E004875 – 15	E005375 – 15
429	E005000 – 15	E005500 – 15
430	E005125 – 15	E005625 – 15
431	E005250 – 15	E005750 – 15
432	E005375 – 15	E005875 – 15
433	E005500 – 15	E006000 – 15
434	E005625 – 15	E006125 – 15
435	E005750 – 15	E006250 – 15
436	E005875 – 15	E006375 – 15
437	E006000 – 15	E006500 – 15
438	E006250 – 15	E006750 – 15
439	E006500 – 15	E007000 – 15
440	E006750 – 15	E007250 – 15
441	E007000 – 15	E007500 – 15
442	E007250 – 15	E007750 – 15
443	E007500 – 15	E008000 – 15
444	E007750 – 15	E008250 – 15
445	E008000 – 15	E008500 – 15
446	E008500 – 15	E009000 – 15
447	E009000 – 15	E009500 – 15
448	E009500 – 15	E010000 – 15
449	E010000 – 15	E010500 – 15
450	E010500 – 15	E011000 – 15
451	E011000 – 15	E011500 – 15
452	E011500 – 15	E012000 – 15
453	E012000 – 15	E012500 – 15
454	E012500 – 15	E013000 – 15
455	E013000 – 15	E013500 – 15
456	E013500 – 15	E014000 – 15
457	E014000 – 15	E014500 – 15
458	E014500 – 15	E015000 – 15
459	E015000 – 15	E015500 – 15
460	E015500 – 15	E016000 – 15

EnerSeal Size for Aerospace Standard AS4716 Glands

Advanced Products offers a complete line on standard EnerSeals conforming to the standard gland sizes defined by Aerospace Standard AS4716 for AS568 O-Rings. This Series is designated with a cross section code –21 through –25. While specifically designed for standard elastomeric O-Rings, these standard glands are also to be used with other seals, including EnerSeals, when the operating conditions are demanding. AS4716 prohibits the use of elastomeric O-Rings for dash numbers 013 through 028, 117 through 149, and 223 through 247 for dynamic applications due to the possibility of spiral failure occurring in these larger diameter sizes of the smaller cross section O-Rings. For dynamic applications with these dash numbers, EnerSeals are recommended.

AS4716 is similar to MIL-G-5514, however, changes have been made to increase seal squeeze in certain smaller cross section glands. The larger AS4716 cross section sizes (–24 and –25 EnerSeal cross sections) are identical to the MIL-G-5514 sizes (–04 and –05 EnerSeal cross sections).

To select the EnerSeal Size refer to the list of the Gland and AS568 Dash Numbers in the adjacent table. The EnerSeal is designed for use in all three gland width configurations: no backup ring, one backup ring, and two backup rings. When one and two backup ring glands are used a long heel EnerSeal (NHA, BHI etc.) is preferred.

AS4716 Glands
1/16 inch Nominal Cross Section

Gland & AS568 Dash Number	EnerSeal Size for I.D. Dynamic Rod Seals	EnerSeal Size for O.D. Dynamic Piston Seals
005	E000108 – 21	E000221 – 21
006	E000123 – 21	E000235 – 21
007	E000154 – 21	E000266 – 21
008	E000185 – 21	E000297 – 21
009	E000217 – 21	E000329 – 21
010	E000248 – 21	E000360 – 21
011	E000310 – 21	E000422 – 21
012	E000373 – 21	E000485 – 21
013	E000435 – 21	E000550 – 21
014	E000498 – 21	E000613 – 21
015	E000560 – 21	E000675 – 21
016	E000623 – 21	E000738 – 21
017	E000685 – 21	E000800 – 21
018	E000748 – 21	E000863 – 21
019	E000810 – 21	E000925 – 21
020	E000873 – 21	E000991 – 21
021	E000935 – 21	E001053 – 21
022	E000998 – 21	E001116 – 21
023	E001060 – 21	E001178 – 21
024	E001123 – 21	E001241 – 21
025	E001185 – 21	E001303 – 21
026	E001248 – 21	E001366 – 21
027	E001310 – 21	E001428 – 21
028	E001373 – 21	E001491 – 21

AS4716 Glands
3/32 inch Nominal Cross Section

Gland & AS568 Dash Number	EnerSeal Size for I.D. Dynamic Rod Seals	EnerSeal Size for O.D. Dynamic Piston Seals
110	E000373 – 22	E000550 – 22
111	E000435 – 22	E000613 – 22
112	E000498 – 22	E000675 – 22
113	E000560 – 22	E000738 – 22
114	E000623 – 22	E000800 – 22
115	E000685 – 22	E000863 – 22
116	E000748 – 22	E000925 – 22
117	E000810 – 22	E000991 – 22
118	E000873 – 22	E001053 – 22
119	E000935 – 22	E001116 – 22
120	E000998 – 22	E001178 – 22
121	E001060 – 22	E001241 – 22
122	E001123 – 22	E001303 – 22
123	E001185 – 22	E001366 – 22
124	E001248 – 22	E001428 – 22
125	E001310 – 22	E001491 – 22
126	E001373 – 22	E001553 – 22
127	E001435 – 22	E001616 – 22
128	E001498 – 22	E001678 – 22
129	E001560 – 22	E001741 – 22
130	E001623 – 22	E001805 – 22
131	E001685 – 22	E001867 – 22
132	E001748 – 22	E001930 – 22
133	E001810 – 22	E001992 – 22
134	E001873 – 22	E002055 – 22
135	E001936 – 22	E002118 – 22
136	E001998 – 22	E002180 – 22
137	E002061 – 22	E002243 – 22
138	E002123 – 22	E002305 – 22
139	E002186 – 22	E002368 – 22
140	E002248 – 22	E002430 – 22
141	E002311 – 22	E002493 – 22
142	E002373 – 22	E002555 – 22
143	E002436 – 22	E002618 – 22
144	E002498 – 22	E002680 – 22
145	E002561 – 22	E002743 – 22
146	E002623 – 22	E002805 – 22
147	E002686 – 22	E002868 – 22
148	E002748 – 22	E002930 – 22
149	E002811 – 22	E002993 – 22

Part Number Example:

XXX - E000000 - 00 - 00 - 0

EnerSeal Size

AS4716 Glands
1/8 inch Nominal Cross Section

Gland & AS568 Dash Number	EnerSeal Size for I.D. Dynamic Rod Seals	EnerSeal Size for O.D. Dynamic Piston Seals
210	E000748 – 23	E000991 – 23
211	E000810 – 23	E001053 – 23
212	E000873 – 23	E001116 – 23
213	E000935 – 23	E001178 – 23
214	E000998 – 23	E001241 – 23
215	E001060 – 23	E001303 – 23
216	E001123 – 23	E001366 – 23
217	E001185 – 23	E001428 – 23
218	E001248 – 23	E001491 – 23
219	E001310 – 23	E001553 – 23
220	E001373 – 23	E001616 – 23
221	E001435 – 23	E001678 – 23
222	E001498 – 23	E001741 – 23
223	E001623 – 23	E001867 – 23
224	E001748 – 23	E001992 – 23
225	E001873 – 23	E002118 – 23
226	E001998 – 23	E002243 – 23
227	E002123 – 23	E002368 – 23
228	E002248 – 23	E002493 – 23
229	E002373 – 23	E002618 – 23
230	E002498 – 23	E002743 – 23
231	E002623 – 23	E002868 – 23
232	E002748 – 23	E002993 – 23
233	E002873 – 23	E003118 – 23
234	E002997 – 23	E003243 – 23
235	E003122 – 23	E003368 – 23
236	E003247 – 23	E003493 – 23
237	E003372 – 23	E003618 – 23
238	E003497 – 23	E003743 – 23
239	E003622 – 23	E003868 – 23
240	E003747 – 23	E003993 – 23
241	E003872 – 23	E004118 – 23
242	E003997 – 23	E004243 – 23
243	E004122 – 23	E004368 – 23
244	E004247 – 23	E004493 – 23
245	E004372 – 23	E004618 – 23
246	E004497 – 23	E004743 – 23
247	E004622 – 23	E004868 – 23

AS4716 Glands
3/16 inch Nominal Cross Section

Gland & AS568 Dash Number	EnerSeal Size for I.D. Dynamic Rod Seals	EnerSeal Size for O.D. Dynamic Piston Seals
325	E001498 – 24	E001867 – 24
326	E001623 – 24	E001992 – 24
327	E001748 – 24	E002118 – 24
328	E001873 – 24	E002243 – 24
329	E001998 – 24	E002368 – 24
330	E002123 – 24	E002493 – 24
331	E002248 – 24	E002618 – 24
332	E002373 – 24	E002743 – 24
333	E002498 – 24	E002868 – 24
334	E002623 – 24	E002993 – 24
335	E002748 – 24	E003118 – 24
336	E002873 – 24	E003243 – 24
337	E002997 – 24	E003368 – 24
338	E003122 – 24	E003493 – 24
339	E003247 – 24	E003618 – 24
340	E003372 – 24	E003743 – 24
341	E003497 – 24	E003868 – 24
342	E003622 – 24	E003993 – 24
343	E003747 – 24	E004118 – 24
344	E003872 – 24	E004243 – 24
345	E003997 – 24	E004368 – 24
346	E004122 – 24	E004493 – 24
347	E004247 – 24	E004618 – 24
348	E004372 – 24	E004743 – 24
349	E004497 – 24	E004868 – 24

AS4716 Glands
1/4 inch Nominal Cross Section

Gland & AS568 Dash Number	EnerSeal Size for I.D. Dynamic Rod Seals	EnerSeal Size for O.D. Dynamic Piston Seals
425	E004497 – 25	E004974 – 25
426	E004622 – 25	E005099 – 25
427	E004747 – 25	E005224 – 25
428	E004872 – 25	E005349 – 25
429	E004997 – 25	E005474 – 25
430	E005122 – 25	E005599 – 25
431	E005247 – 25	E005724 – 25
432	E005372 – 25	E005849 – 25
433	E005497 – 25	E005974 – 25
434	E005622 – 25	E006099 – 25
435	E005747 – 25	E006224 – 25
436	E005872 – 25	E006349 – 25
437	E005997 – 25	E006474 – 25
438	E006247 – 25	E006724 – 25
439	E006497 – 25	E006974 – 25
440	E006747 – 25	E007224 – 25
441	E006997 – 25	E007474 – 25
442	E007247 – 25	E007724 – 25
443	E007497 – 25	E007974 – 25
444	E007747 – 25	E008224 – 25
445	E007997 – 25	E008474 – 25
446	E008497 – 25	E008974 – 25
447	E008997 – 25	E009474 – 25
448	E009497 – 25	E009974 – 25
449	E009997 – 25	E010474 – 25
450	E010497 – 25	E010974 – 25
451	E010997 – 25	E011474 – 25
452	E011497 – 25	E011974 – 25
453	E011997 – 25	E012474 – 25
454	E012497 – 25	E012974 – 25
455	E012997 – 25	E013474 – 25
456	E013497 – 25	E013974 – 25
457	E013997 – 25	E014474 – 25
458	E014497 – 25	E014974 – 25
459	E014997 – 25	E015474 – 25
460	E015497 – 25	E015974 – 25

EnerSeal Size for Japanese Industrial Standard Glands (JIS B-2406)

EnerSeals are available in a complete range of sizes for JIS B-2406 standard O-Ring glands. This Series is designated with a cross section code –31 through –35. There are two size classifications defined in this standard. The P- sizes are for both static and dynamic applications and the G- sizes are intended only for static use.

To select the EnerSeal Size refer to the list of JIS B-2406 Nominal Numbers in the adjacent table. If a seal is required for a static face seal groove in accordance with JIS B-2406, please contact one of our Application Engineers at any of our worldwide offices for the appropriate EnerSeal size.

The EnerSeal is designed for use in all three gland width configurations: no backup ring, one backup ring, and two backup rings. When one and two backup ring glands are used a long heel EnerSeal (NHA, BHI etc.) is preferred.

Japanese Industrial Standard Glands (JIS B-2406)

Number of O-Ring	EnerSeal Size for I.D. Dynamic Rod Seals and Static Seals	EnerSeal Size for O.D. Dynamic Piston Seals
P 3	M000300-31	M000600-31
P 4	M000400-31	M000700-31
P 5	M000500-31	M000800-31
P 6	M000600-31	M000900-31
P 7	M000700-31	M001000-31
P 8	M000800-31	M001100-31
P 9	M000900-31	M001200-31
P 10	M001000-31	M001300-31
P 10A	M001000-32	M001400-32
P 11	M001100-32	M001500-32
P 11.2	M001120-32	M001520-32
P 12	M001200-32	M001600-32
P 12.5	M001250-32	M001650-32
P 14	M001400-32	M001800-32
P 15	M001500-32	M001900-32
P 16	M001600-32	M002000-32
P 18	M001800-32	M002200-32
P 20	M002000-32	M002400-32
P 21	M002100-32	M002500-32
P 22	M002200-32	M002600-32
P 22A	M002200-34	M002800-34
P 22.4	M002240-34	M002840-34
P 24	M002400-34	M003000-34
P 25	M002500-34	M003100-34
P 25.5	M002550-34	M003150-34
P 26	M002600-34	M003200-34
P 28	M002800-34	M003400-34
P 29	M002900-34	M003500-34
P 29.5	M002950-34	M003550-34
P 30	M003000-34	M003600-34
P 31	M003100-34	M003700-34
P 31.5	M003150-34	M003750-34
P 32	M003200-34	M003800-34
P 34	M003400-34	M004000-34
P 35	M003500-34	M004100-34
P 35.5	M003550-34	M004150-34
P 36	M003600-34	M004200-34
P 38	M003800-34	M004400-34
P 39	M003900-34	M004500-34
P 40	M004000-34	M004600-34
P 41	M004100-34	M004700-34
P 42	M004200-34	M004800-34
P 44	M004400-34	M005000-34
P 45	M004500-34	M005100-34
P 46	M004600-34	M005200-34

Part Number Example:

XXX - M000000-00 - 00 - 0

EnerSeal Size

Japanese Industrial Standard Glands (JIS B-2406)

Number of O-Ring	EnerSeal Size for I.D. Dynamic Rod Seals and Static Seals	EnerSeal Size for O.D. Dynamic Piston Seals
P 48	M004800-34	M005400-34
P 49	M004900-34	M005500-34
P 50	M005000-34	M005600-34
P 48A	M004800-35	M005800-35
P 50A	M005000-35	M006000-35
P 52	M005200-35	M006200-35
P 53	M005300-35	M006300-35
P 55	M005500-35	M006500-35
P 56	M005600-35	M006600-35
P 58	M005800-35	M006800-35
P 60	M006000-35	M007000-35
P 62	M006200-35	M007200-35
P 63	M006300-35	M007300-35
P 65	M006500-35	M007500-35
P 67	M006700-35	M007700-35
P 70	M007000-35	M008000-35
P 71	M007100-35	M008100-35
P 75	M007500-35	M008500-35
P 80	M008000-35	M009000-35
P 85	M008500-35	M009500-35
P 90	M009000-35	M010000-35
P 95	M009500-35	M010500-35
P 100	M010000-35	M011000-35
P 102	M010200-35	M011200-35
P 105	M010500-35	M011500-35
P 110	M011000-35	M012000-35
P 112	M011200-35	M012200-35
P 115	M011500-35	M012500-35
P 120	M012000-35	M013000-35
P 125	M012500-35	M013500-35
P 130	M013000-35	M014000-35
P 132	M013200-35	M014200-35
P 135	M013500-35	M014500-35
P 140	M014000-35	M015000-35
P 145	M014500-35	M015500-35
P 150	M015000-35	M016000-35
P 150A	M015000-36	M016500-36
P 155	M015500-36	M017000-36
P 160	M016000-36	M017500-36
P 165	M016500-36	M018000-36
P 170	M017000-36	M018500-36
P 175	M017500-36	M019000-36
P 180	M018000-36	M019500-36
P 185	M018500-36	M020000-36
P 190	M019000-36	M020500-36

Japanese Industrial Standard Glands (JIS B-2406)

Number of O-Ring	EnerSeal Size for I.D. Dynamic Rod Seals and Static Seals	EnerSeal Size for O.D. Dynamic Piston Seals
P 195	M019500-36	M021000-36
P 200	M020000-36	M021500-36
P 205	M020500-36	M022000-36
P 209	M020900-36	M022400-36
P 210	M021000-36	M022500-36
P 215	M021500-36	M023000-36
P 220	M022000-36	M023500-36
P 225	M022500-36	M024000-36
P 230	M023000-36	M024500-36
P 235	M023500-36	M025000-36
P 240	M024000-36	M025500-36
P 245	M024500-36	M026000-36
P 250	M025000-36	M026500-36
P 255	M025500-36	M027000-36
P 260	M026000-36	M027500-36
P 265	M026500-36	M028000-36
P 270	M027000-36	M028500-36
P 275	M027500-36	M029000-36
P 280	M028000-36	M029500-36
P 285	M028500-36	M030000-36
P 290	M029000-36	M030500-36
P 295	M029500-36	M031000-36
P 300	M030000-36	M031500-36
P 315	M031500-36	M033000-36
P 320	M032000-36	M033500-36
P 335	M033500-36	M035000-36
P 340	M034000-36	M035500-36
P 355	M035500-36	M037000-36
P 360	M036000-36	M037500-36
P 375	M037500-36	M039000-36
P 385	M038500-36	M040000-36
P 400	M040000-36	M041500-36
G 25	M002500-33	M003000-33
G 30	M003000-33	M003500-33
G 35	M003500-33	M004000-33
G 40	M004000-33	M004500-33
G 45	M004500-33	M005000-33
G 50	M005000-33	M005500-33
G 55	M005500-33	M006000-33
G 60	M006000-33	M006500-33
G 65	M006500-33	M007000-33
G 70	M007000-33	M007500-33
G 75	M007500-33	M008000-33
G 80	M008000-33	M008500-33
G 85	M008500-33	M009000-33
G 90	M009000-33	M009500-33

Japanese Industrial Standard Glands (JIS B-2406)

Number of O-Ring	EnerSeal Size for I.D. Dynamic Rod Seals and Static Seals	EnerSeal Size for O.D. Dynamic Piston Seals
G 95	M009500-33	M010000-33
G 100	M010000-33	M010500-33
G 105	M010500-33	M011000-33
G 110	M011000-33	M015000-33
G 115	M011500-33	M012000-33
G 120	M012000-33	M012500-33
G 125	M012500-33	M013000-33
G 130	M013000-33	M013500-33
G 135	M013500-33	M014000-33
G 140	M014000-33	M014500-33
G 145	M014500-33	M015000-33
G 150	M015000-35	M016000-35
G 155	M015500-35	M016500-35
G 160	M016000-35	M017000-35
G 165	M016500-35	M017500-35
G 170	M017000-35	M018000-35
G 175	M017500-35	M018500-35
G 180	M018000-35	M019000-35
G 185	M018500-35	M019500-35
G 190	M019000-35	M020000-35
G 195	M019500-35	M020500-35
G 200	M020000-35	M021000-35
G 210	M021000-35	M022000-35
G 220	M022000-35	M023000-35
G 230	M023000-35	M024000-35
G 240	M024000-35	M025000-35
G 250	M025000-35	M026000-35
G 260	M026000-35	M027000-35
G 270	M027000-35	M028000-35
G 280	M028000-35	M029000-35
G 290	M029000-35	M030000-35
G 300	M030000-35	M031000-35


ES0498

Introduction to the Material Selection Process

Many designers favor EnerSeal jacket and energizer materials which they know, by experience, offer excellent service with the highest performance and longest life in their application.

JACKET MATERIALS

The table on the following pages (D-2 and D-3) offers an "expert system" developed jointly by our engineers and our customers. It gives straightforward jacket selection criteria for seventeen state of the art materials.

The first eight selections (material codes 01 to 09), are highlighted as being widely used popular materials. We keep these in inventory in a wide range of billet sizes for the fastest manufacturing response time. The remaining materials (materials codes 10 to 45), are all specialist materials chosen particularly for their unique properties in very demanding service.

From page D-2 make an initial, possibly multiple, selection of all materials with appropriate Application Descriptions and Service Temperature Ranges. The final selection may then be made using the performance rating table on page D-3, to choose a material with the best combination of characteristics for the intended service.

ENERGIZERS

Full details of standard and optional energizers are shown on page D-4.

EnerSeal Jacket Materials

STANDARD MATERIALS

Material Code	Material	Application / Description	Service Temperature Range °F	Service Temperature Range °C
01	Virgin P.T.F.E. unfilled	Excellent for cryogenic applications. Good for Gases.	- 420 to 400	- 250 to 200
02	P.T.F.E. + 15% Graphite	Excellent for Corrosive Service, also for steam and water. Low abrasion. Good in unlubricated service.	- 250 to 450	- 150 to 230
03	P.T.F.E. + 15% Glass / 5% MoS_2	Highly wear resistant. Only for use on very hard metals due to its abrasiveness.	- 250 to 500	- 150 to 260
04	P.T.F.E. + 60% Bronze	Excellent wear, temperature, and pressure resistance. Has limitation due to electrical conductivity. Not suitable for oil sealing. Excellent for high speeds.	- 250 to 550	- 150 to 290
05	P.T.F.E. + 10% Ekonol®	Excellent high temperature resistance. Does not abrade soft metals in dynamic applications. Excellent for sealing gases.	- 250 to 600	- 150 to 315
06	U.H.M.W. Polyethylene	One of our toughest, most wear resistant materials. Excellent for cryogenic applications. Best material for reciprocating movement.	- 420 to 210	- 250 to 100
07	P.T.F.E. + 25% Carbon / Graphite	Widely used in water and steam applications.	- 250 to 520	- 150 to 270
09	Modified P.T.F.E.	Excellent for static applications. Similar to 01 with low porosity. Excellent for gases.	- 450 to 450	- 270 to 230
10	P.T.F.E. + 10% Carbon / Graphite	Similar to 07. Has higher wear rate but is less abrasive.	- 250 to 520	- 150 to 270
12	P.T.F.E. + 15% Glass	Used for backup rings in food contact applications. Used on hard metals due to its abrasiveness.	- 330 to 520	- 200 to 270
15	PEEK	Used for backup rings, high pressure, temperature, and Radiation resistance to 10^9 rads.	- 180 to 570	- 120 to 300
20	P.C.T.F.E.	Good for cryogenic gas applications.	- 450 to 300	- 270 to 150
21	Tefzel®	Good radiation resistance 10^8 rads.	- 100 to 300	- 75 to 150
22	FEP	Good for cryogenic gas applications.	- 450 to 400	- 270 to 200
30	Celazole®	Very high strength material used for high temperature applications.	60 to 750	15 to 400
31	Modified P.T.F.E. + 25% Glass	Used for large diameter seals. Resists deformation.	- 420 to 520	- 250 to 270
45	P.T.F.E. + Carbon Fiber	Good for strong alkali and hydrofluoric acid. Good in water service.	- 250 to 520	- 150 to 270
60	AP-60 (proprietary blend)	Very high temperature and pressure applications.	- 200 to 675	- 130 to 350
63	P.T.F.E. + proprietary carbon fiber	Good for dynamic applications, good wear resistance, does not abrade dynamic surfaces.	- 250 to 520	- 150 to 270

Ekonol is a registered trademark of the Carborundum Company. Tefzel is a registered trademark of the E.I. DuPont de Nemours Company. Celazole is a registered trademark of Hoechst Celanese Corporation.

	Coefficient Of Friction	FDA Approved for Food Contact	Chemical Resistance 5 = Excellent 1 = Fair	Reciprocating Wear Resistance 5 = Excellent 1 = Fair	Rotating Wear Resistance 5 = Excellent 1 = Fair	Pressure/Extrusion Resistance 5 = Excellent 1 = Fair	Color	Relative Cost 5 = higher 1 = lower
	0.07	Yes	5	1	1	1	White	2
	0.07	No	4	2	2	3	Black	2
	0.07	No	4	5	5	4	Gray	2
	0.15	No	2	3	5	5	Bronze	4
	0.11	No	3	3	4	4	Cream	4
	0.2	Yes	1	5	1	5	Translucent	1
	0.1	No	4	4	5	4	Black	2
	0.07	Yes	5	1	1	3	White	2
	0.1	No	4	3	4	4	Black	2
	0.09	No	4	4	3	5	White	2
	0.2	No	4	3	1	5	Lt. Brown	5
	0.35	No	4	1	1	3	Translucent	5
	0.4	Yes	4	1	1	3	Translucent	5
	0.3	Yes	4	1	1	3	Translucent	5
	0.2	No	4	1	1	5	Black	4
	0.09	No	4	4	5	5	White	4
	0.1	No	4	5	4	5	Black	3
	0.2	No	4	3	3	5	Dark Grey	5
	0.1	No	3	5	5	4	Red/Gray	3

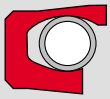
Selecting the EnerSeal Energizer

The EnerSeal energizer is designated by a single digit code in the part number as shown below.

XXX - X000000 - 00 - 00 - 0

Energizer Code

Refer to the following chart to select the spring energizer code for your seal type and application.

Code	Material	Mark I 	Mark IV 	Mark V 	Mark X 	Relative Cost 5=higher 1=lower	NACE Approved *see Note (a)*	Available with light or heavy spring *see Note (b)*
1	17-7PH Stainless Steel	Standard			Standard	1		•
2	Cobalt Chrome Alloy	Standard	Standard		Standard	4	•	•
3	316 Stainless Steel		Optional	Optional		4		•
3S	316 Stainless Steel with Silicone Filling		Optional			5		
4	304 Stainless Steel		Standard	Standard		1		•
4S	304 Stainless Steel with Silicone Filling		Optional			4		
5	Buna N [see note (d)]	Optional			Optional	1		
7	Viton® [see note (d)]	Optional			Optional	2		
8	Silicone Filling only		Optional			3		
10	Alloy X-750	Optional	Optional	Optional	Optional	3	•	

NOTES:

a) Approved for use in corrosive service per NACE MR-01-075 Specification.

b) To specify a light spring for reduce seal friction, add Y to the Spring Code (1Y, 2Y, etc.)
To specify a heavy spring to increase the sealing force in gas or cryogenic applications, add X to the Spring Code (1X, 2X, etc.) Contact one of our applications engineers for assistance.

c) Silicone filling prevents the sealing media from contacting the metal spring in applications such as food processing. This is only available with axial pressure seals or internal pressure face seals and is temperature limited to approximately 400°F or 200°C.

d) Temperature limit for Buna N is 200°F or 100°C. Temperature limit for Viton is 400°F or 200°C.

Viton is a registered trademark of E.I. DuPont de Nemours Company.

Technical Information

This section provides additional information about EnerSeal performance and capabilities. This allows you to perform a more detailed evaluation of the application and to fine tune the seal and cavity design.

This section includes:

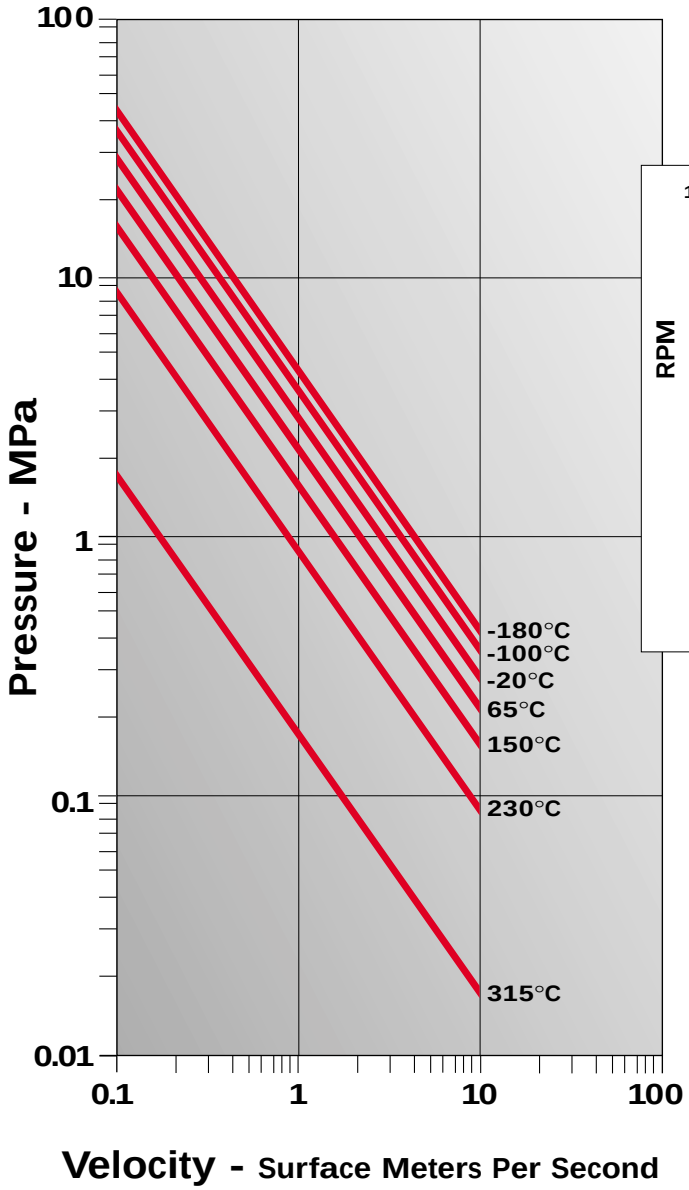
Pressure-Velocity-Temperature Guidelines

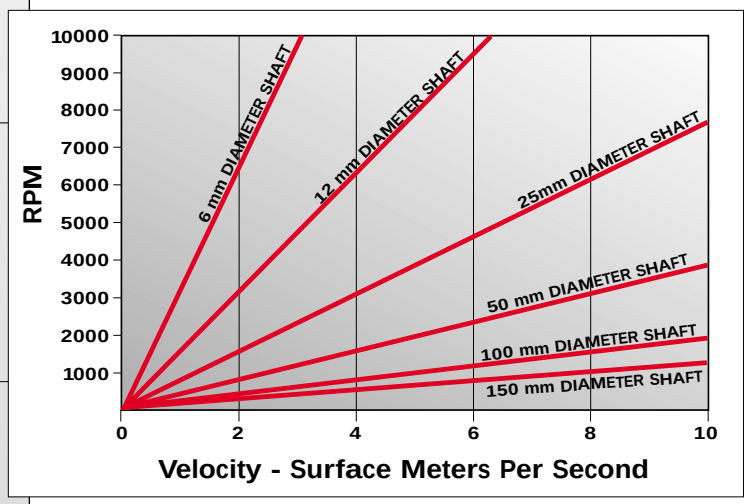
The Mark IV family of EnerSeals is primarily designed for rotating applications. Temperature and wear resistant jacket materials are recommended in order to withstand the temperature rise due to friction at the sealing surface which is additive to the local ambient temperature. The relationship between operating pressure, surface speed, and temperature is used to pre-qualify the Mark IV EnerSeal for rotating applications.

The Pressure-Velocity (PV) graph below applies to unlubricated rotating applications using Mark IV EnerSeals having a Jacket Material with a 4 or 5 Rotating Wear Resistance Rating (Refer to Page D-3). If the point corresponding to the operating pressure and surface velocity falls on or below the appropriate temperature line, the Mark IV is an appropriate seal for your application.

If Your Application Is Beyond The PV Limits

This information is intended to be used only as a guideline since there are many other factors, such as sealing media, cavity hardware material, and surface finish, which affect the amount of heat generated and the performance of the seal. In cases where the media being sealed is a lubricant, continuous operation at PV levels 20 times these guidelines has been achieved.





Advanced Products also offers a complete line of high speed lip seals, high pressure rotary seals, and custom designed seals for extreme operation. See Section F, "Other EnerSeals". Please consult one of our Application Engineers for assistance in selecting the seal for your extreme environment.

Friction Information

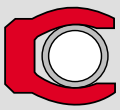
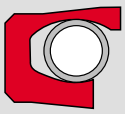
Friction is the resistance to motion of one surface relative to another. In dynamic seal applications it is the resistance to rotation or reciprocation between the EnerSeal and the hardware sealing surface. Frictional Linear Force which resists reciprocating motion and Frictional Torque which resists rotating motion are based on the diameter of the dynamic surface, the coefficient of friction of the EnerSeal jacket material, the system pressure, the load of the spring in the EnerSeal, and the geometry of the EnerSeal jacket. The approximate frictional force or torque between the EnerSeal and mating surfaces for your application can be calculated using the following equations:

$$\text{Frictional Linear Force (N)} = \pi D \mu \, (PJ + S)$$

$$\text{Frictional Torque (N} \cdot \text{mm)} = \frac{\pi D^2 \mu}{2} \, (PJ + S)$$

Where:

- P = System pressure (MPa)
- D = Diameter of dynamic surface (mm)
- μ = Coefficient of friction for EnerSeal jacket material (Refer to page D-3)
- S = Spring factor (N/mm) (for standard spring thickness refer to the table below)
- J = EnerSeal jacket geometry factor (mm) (Refer to table below)

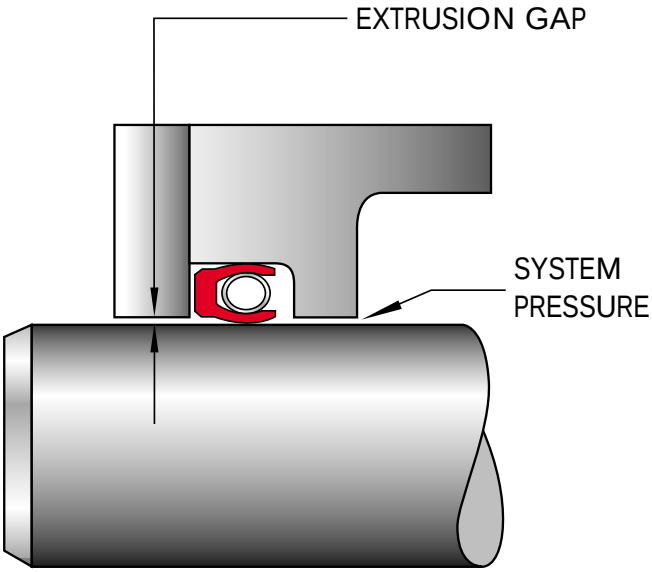
Nominal Cross Section	Code Section Code	Mark I 		Mark IV 		Mark X 	
		Spring Factor S	Geometry Factor J	Spring Factor S	Geometry Factor J	Spring Factor S	Geometry Factor J
1/16 (1,6 mm)	01	6,1	0,5	2,1	0,8	6,1	0,5
3/32 (2,4 mm)	02	5,3	0,8	1,8	1,3	5,3	0,8
1/8 (3,2 mm)	03	5,3	1,3	1,4	1,8	5,3	1,3
3/16 (4,7 mm)	04	5,3	2,0	1,1	2,8	5,3	2,0
1/4 (6,4 mm)	05	5,3	2,5	1,6	3,6	5,3	2,5
3/8 (9,5 mm)	06	5,3	3,3	—	—	5,3	3,3

Extrusion Gap Recommendations

An extrusion gap in a fluid system is the operational or manufacturing clearance between adjacent pressure containing parts, and is located on the low pressure side of a seal.

Any seal under the action of hydrostatic loads will tend to be forced, or extruded, into such a gap. This effect (which can be very severe with elastomeric seals) is well controlled and greatly reduced with the higher strength polymeric seals.

Some jacket materials are more resistant to high pressures than others and are, therefore, less susceptible to extrusion and can tolerate larger gaps. Additionally, larger cross section seals are more tolerant of larger extrusion gaps.



TO DETERMINE THE MAXIMUM RECOMMENDED EXTRUSION GAP refer to the following graph and table.

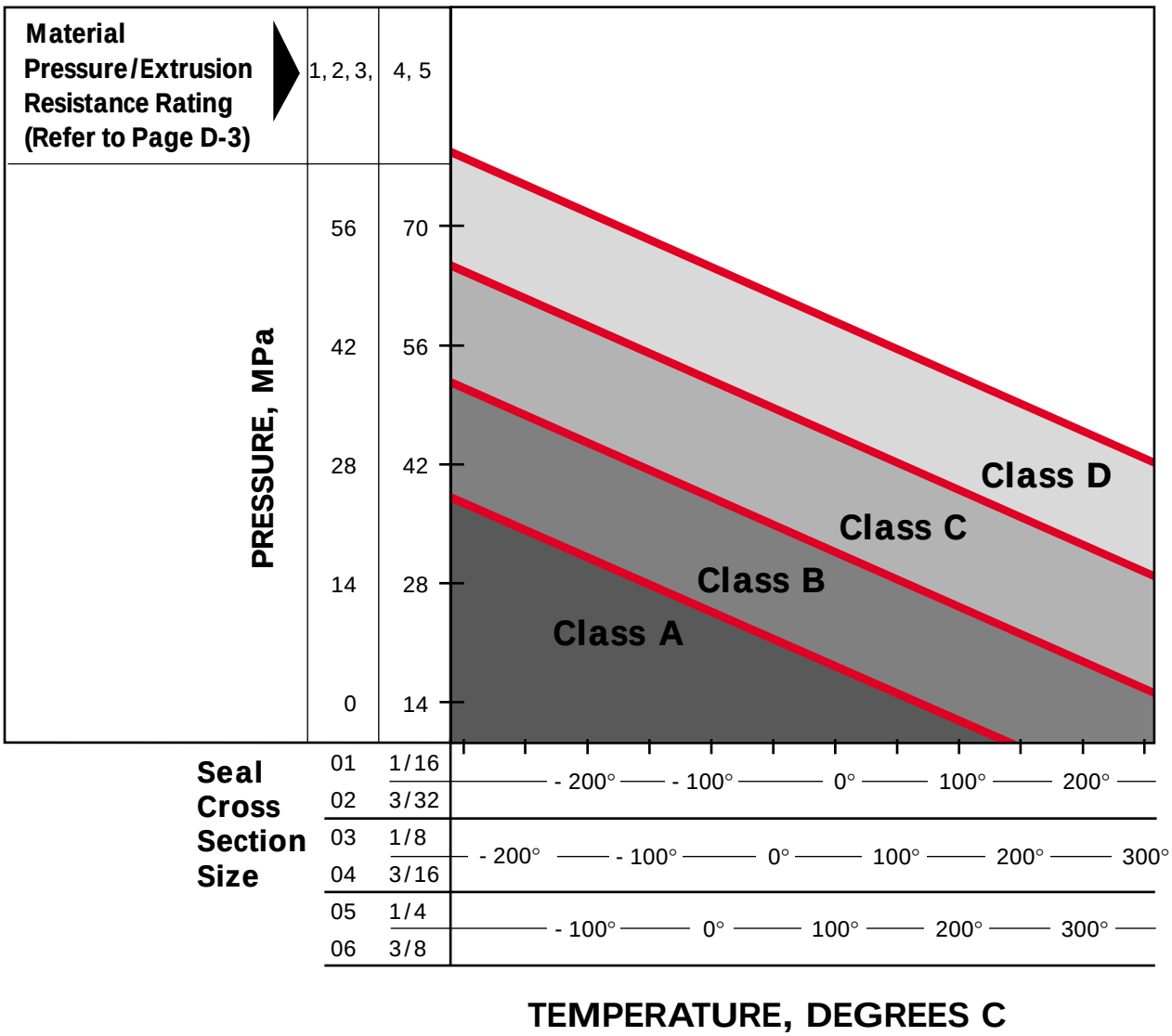
1. Note material pressure / extrusion rating from page D-3.
2. Locate maximum pressure on the graph.
3. Locate maximum temperature for appropriate seal cross section.
4. Determine applicable extrusion gap class from graph.
5. From the table, determine the maximum recommended extrusion gap for the various EnerSeal styles.

Also note that eccentricity and shaft runout, discussed on page E-7, affect extrusion gap and should be considered in the cavity design.

Anti-Extrusion Rings

Advanced Products offers a variety of Anti-Extrusion Rings which are recommended for use with the EnerSeal when it is not possible to maintain an extrusion gap below the Maximum Recommended Guidelines. Refer to page E-6 for Anti-Extrusion Ring information.

Extrusion Gap Class

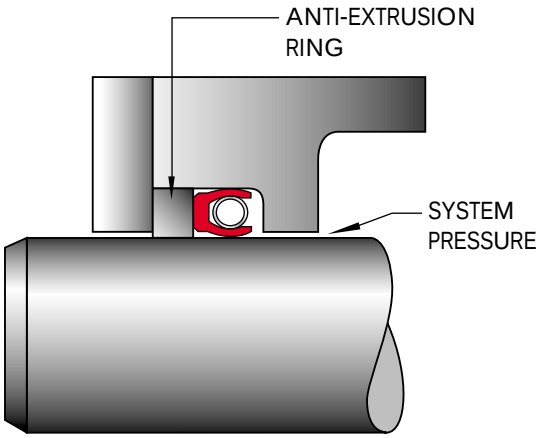


Maximum Extrusion Gap

Cross Section		Class A	Class B	Class C	Class D
NAA	Mark I	0,15	0,10	0,08	0,05
NHA	Mark I-H	0,25	0,20	0,10	0,08
FLO	Mark IV	0,15	0,08	0,05	—
BAI	Mark X	0,25	0,20	0,10	0,08
BHI	Mark X-H	0,30	0,25	0,15	0,10

Anti-Extrusion Rings

If it is not possible to maintain an extrusion gap below the maximum recommended guidelines use of anti-extrusion rings is advised. The anti-extrusion rings are made of hard materials that are resistant to high pressures. They are installed behind the seal, providing a smaller extrusion gap and allowing the seal to operate properly. There are a variety of anti-extrusion rings available for use in various cavity configurations and extrusion gap sizes. Refer to the part numbering guidelines below for selecting the appropriate anti-extrusion ring for your application.



I X X - X000000 - 00 - 00

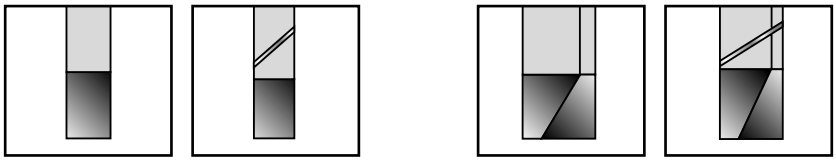
Anti-extrusion ring material
- 12 – P.T.F.E. + 15% Glass
- 15 – PEEK

Size (Same as EnerSeal size for this cavity)

Indicate either A, O, or I (Same as EnerSeal for this cavity)

Up to 50% over maximum recommended extrusion gaps
- A – Plain ring
- B – Plain scarf cut ring*

Up to 100% over maximum recommended extrusion gaps
- C – 2 piece ring
- D – 2 piece, scarf cut ring*



*Scarf cut rings are required for installation into partially or fully closed cavities.

Use of anti-extrusion rings require an increase to the standard cavity width, G, which is provided in Section C. To allow for proper installation, the standard width should be increased as follows.

Nominal Seal Cross Section	1/16	3/32	1/8	3/16	1/4	3/8
Seal Cross Section Code	01	02	03	04	05	06
Increase in cavity width (for types IAX and IBX)	0.06 inch 1,5 mm	0.08 inch 2,0 mm	0.10 inch 2,5 mm	0.12 inch 3,0 mm	0.14 inch 3,5 mm	0.20 inch 5,0 mm
Increase in cavity width (for types ICX and IDX)	0.11 inch 2,8 mm	0.13 inch 3,3 mm	0.15 inch 3,8 mm	0.19 inch 4,7 mm	0.22 inch 5,5 mm	0.29 inch 7,4 mm

Note: If anti-extrusion rings are required for a face seal application, contact one of our Application Engineers at any of our worldwide offices for assistance.

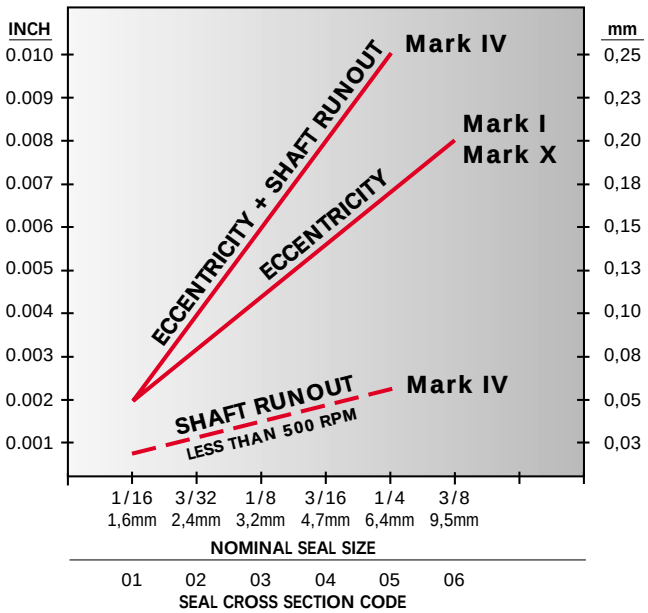
Eccentricity and Shaft Runout

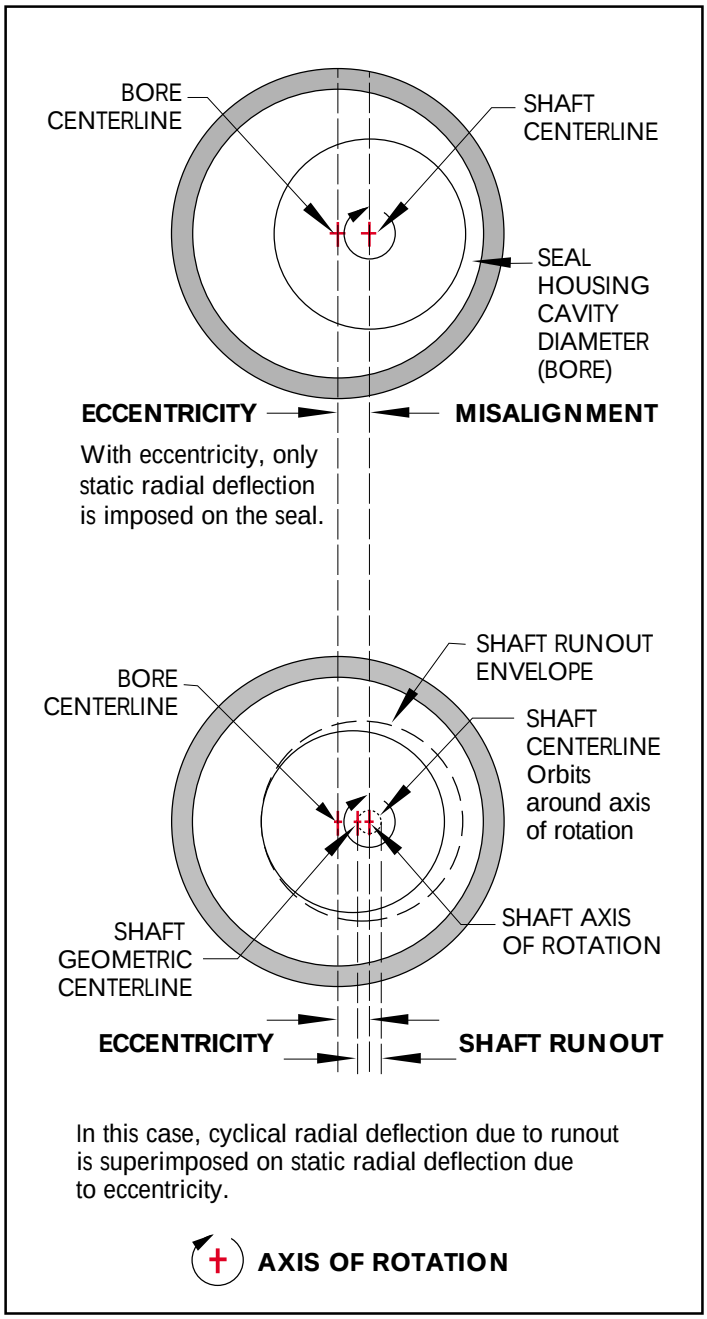
Spring energized teflon seals are frequently used to seal circular cross section shafts, plungers, rods, etc. The graph below will assist designers in ensuring reliable seal performance by avoiding excessive eccentricity and/or shaft runout.

Eccentricity of a rotating or static shaft results in an enlarged extrusion gap. Please refer to the graph below for eccentricity limits (for specific information on extrusion please refer to page E-4).

Shaft Runout, for example due to a bent shaft or whirling deflection, creates a potentially more serious problem. In this case, the seal must be sufficiently compliant to maintain proper contact with the shaft despite being compressed and extended each revolution. Excessive runout may lead to wear and leakage problems (especially during cold-starting) and eventual fatigue failures.

When using the Mark IV EnerSeal, the combination of eccentricity + shaft runout should be held below the recommended guidelines shown below. In addition, total runout alone should not exceed the shaft runout limit to ensure that seal performance and life are not sacrificed. The Mark I and Mark X EnerSeals are used in static and reciprocating applications, therefore, only eccentricity guidelines apply.



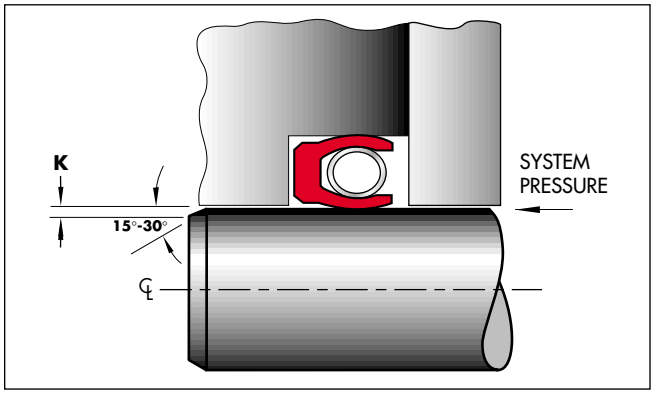


Installation Guidelines

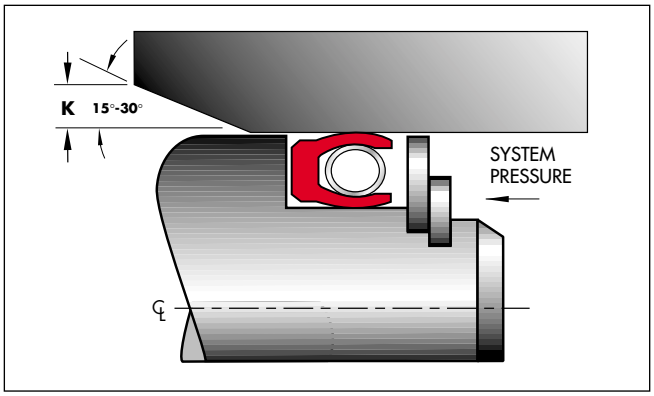
Recommended Installation Configurations

Split cavity configurations offer the simplest means of installation of EnerSeals. In this arrangement, one of the two cavity sides is separated from the mating hardware (shaft or bore, depending upon the cavity locations) which allows the seal to easily be installed without temporarily distorting or deforming it in the process.

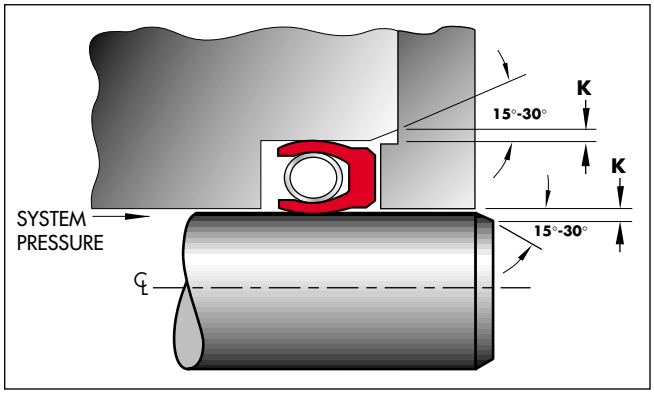
Typical split cavity configurations are illustrated in the figures below. The lead in chamfers detailed in the figures and table will facilitate seal installation. To prevent possible seal damage, it is also recommended that all corners where the seal passes be rounded.



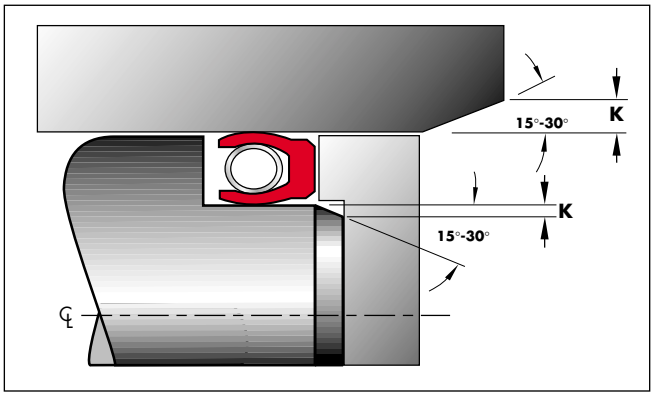
Installed heel end first into bore.



Installed heel end first into piston.

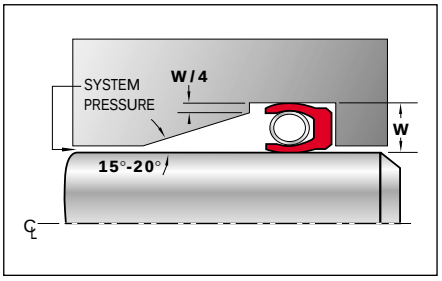


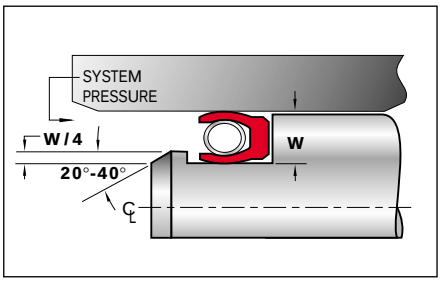
Installed open end first into bore.



Installed open end first into piston.

Nominal Seal Cross Section	1/16	3/32	1/8	3/16	1/4	3/8
Seal Cross Section Code	01	02	03	04	05	06
Chamfer Height, K min.	0.016 in.	0.024 in.	0.030 in.	0.035 in.	0.039 in.	0.059 in.
	0,40 mm	0,60 mm	0,75 mm	0,90 mm	1,00 mm	1,50 mm





Alternate Installation Configurations / Non-Split Glands

Sometimes, use of such split cavity is not practical or possible. Here, two non-split cavity geometries should be considered.

Installation in the Housing

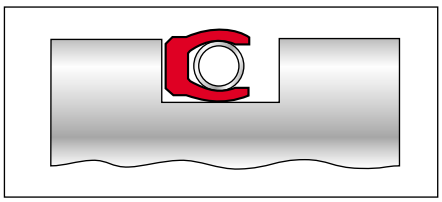
A modified cavity as shown here may be used. In installation, the circular EnerSeal is temporarily deformed to an elliptical shape, as it is inserted into the bore, until the leading edge is seated in the groove. The angled gland "ramp" makes this installation possible with minimal temporary seal distortion. This installation should not be employed unless the I.D. of the seal is at least 15 times its cross-section.

Installation in Partially-Closed Piston Cavity

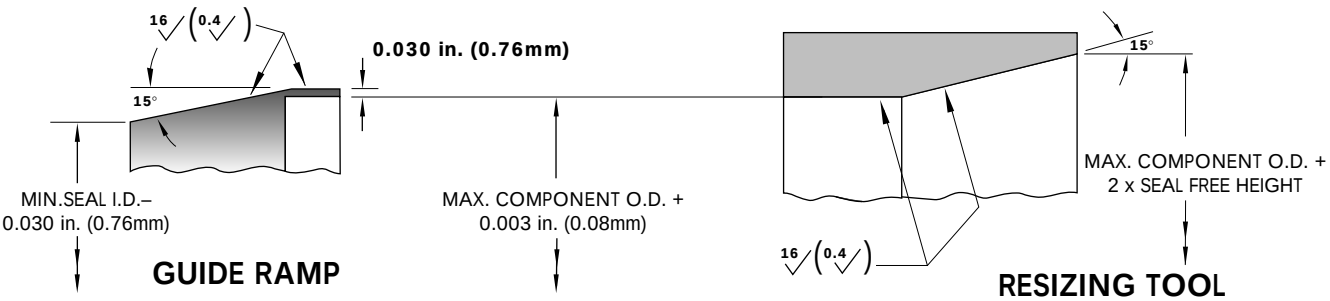
A modified cavity as shown in this figure may be used. Proper seal installation is accomplished by rapidly moving the seal over the locking lip, minimizing seal distortion. A guide rampand resizing tool as shown below may assist in installation.

Installation in Fully-Closed Cavity

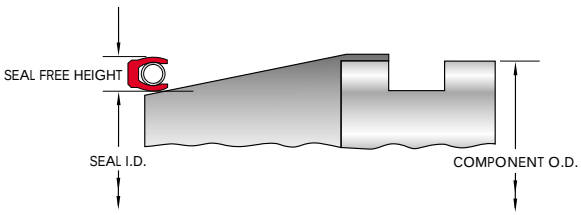
While it is possible to use the non-split cavity geometry shown in the figure to the right, installation of the EnerSeal is quite difficult – even with virgin P.T.F.E. seals – because the seal must be stretched over the full diameter of the shaft. This installation should not be employed unless the I.D. of the seal is at least 15 times its cross-section. Otherwise permanent seal deformation may occur, affecting sealing integrity.



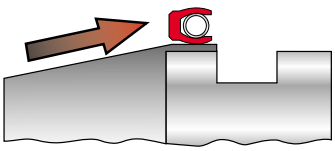
A stretching guide ramp and resizing tool may be fabricated to assist in installing the EnerSeal into a fully closed cavity. Refer to these drawings for design specifications.



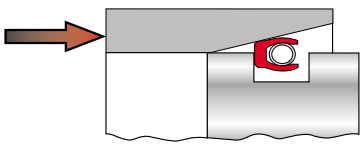
STEP 1: Place the seal on the guide ramp. Preheating the seal to approximately 300°F or 150°C in water, oil or air will soften the seal and aid in stretching and installing the seal.



STEP 2: Push the seal over the guide ramp.



STEP 3: Slide the resizing tool over the seal to compress the seal to its original diameter.



Hardware Surface Roughness and Hardness

Surface Roughness Recommendations

Due to the toughness and low coefficient of friction of P.T.F.E., EnerSeals, unlike seals made of other materials, slip over the "high points" of the mating surface and resist abrasion. To maximize seal performance the chart recommendations for surface roughness should be followed.

Dynamic surfaces with relatively rough finishes will result in higher wear rates which decrease the seal life and may compromise performance. Additionally, dynamic surfaces which have a finish smoother than recommended may also decrease the seal's effectiveness. The optimum surface roughness allows a film of the fluid being sealed to flow between the seal and the mating surface which provides effective cooling and extends the life of the seal. The optimum roughness also creates a slight wearing of the jacket material leaving a thin layer of smooth material on the dynamic surface.

Surface Roughness, R_a				
Media Being Sealed	Dynamic Surfaces		Static Surfaces	
	μ inch	μ m	μ inch	μ m
Cryogenics	4 – 8	0.1 – 0.2	4 – 8	0.1 – 0.2
Helium Gas Hydrogen Gas Freon	4 – 8	0.1 – 0.2	8 – 16	0.2 – 0.4
Air Nitrogen Gas Argon Natural Gas Fuel (Aircraft and Automotive)	8 – 16	0.2 – 0.4	16 – 32	0.4 – 0.8
Water Hydraulic Oil Crude Oil Sealants	8 – 16	0.2 – 0.4	16 – 63	0.4 – 1.6

Surface Hardness Recommendations

The hardness of the dynamic hardware surface affects the wear rate of the seal. Additionally, some seal jacket materials are abrasive and will wear softer metal shafts or dynamic components. In general, higher surface finish results in better overall seal and hardware performance. The ideal hardness of the dynamic surfaces of the mating hardware is 50 to 60 Rockwell C.

Tolerance Reference Tables

Advanced Products EnerSeals are designed for use in cavities that are produced using typical machining processes. The tolerance tables below are consistent with the American National Standard Tolerances (ANSI B4.1) and the British Standard for Metric ISO Limits and Fits (BS 4500).

ANSI B4.1	Axial Seals		Face Seals		Flange Cavity Only
Nominal Cavity Diameter (inches) Over – To	TOLERANCE GRADE				
	h8 Cavity I.D.	H8 Cavity O.D.	h10 Cavity I.D.	H10 Cavity O.D.	H11 Cavity O.D.
	(Dimensions are in 0.001 inches)				
0 – 0.12	+ 0.0 / – 0.6	– 0.0 / + 0.6	+ 0.0 / – 1.6	– 0.0 / + 1.6	– 0.0 / + 2.5
0.12 – 0.24	+ 0.0 / – 0.7	– 0.0 / + 0.7	+ 0.0 / – 1.8	– 0.0 / + 1.8	– 0.0 / + 3.0
0.24 – 0.40	+ 0.0 / – 0.9	– 0.0 / + 0.9	+ 0.0 / – 2.2	– 0.0 / + 2.2	– 0.0 / + 3.5
0.40 – 0.71	+ 0.0 / – 1.0	– 0.0 / + 1.0	+ 0.0 / – 2.8	– 0.0 / + 2.8	– 0.0 / + 4.0
0.71 – 1.19	+ 0.0 / – 1.2	– 0.0 / + 1.2	+ 0.0 / – 3.5	– 0.0 / + 3.5	– 0.0 / + 5.0
1.19 – 1.97	+ 0.0 / – 1.6	– 0.0 / + 1.6	+ 0.0 / – 4.0	– 0.0 / + 4.0	– 0.0 / + 6.0
1.97 – 3.15	+ 0.0 / – 1.8	– 0.0 / + 1.8	+ 0.0 / – 4.5	– 0.0 / + 4.5	– 0.0 / + 7.0
3.15 – 4.73	+ 0.0 / – 2.2	– 0.0 / + 2.2	+ 0.0 / – 5.0	– 0.0 / + 5.0	– 0.0 / + 9.0
4.73 – 7.09	+ 0.0 / – 2.5	– 0.0 / + 2.5	+ 0.0 / – 6.0	– 0.0 / + 6.0	– 0.0 / + 10.0
7.09 – 9.85	+ 0.0 / – 2.8	– 0.0 / + 2.8	+ 0.0 / – 7.0	– 0.0 / + 7.0	– 0.0 / + 12.0
9.85 – 12.41	+ 0.0 / – 3.0	– 0.0 / + 3.0	+ 0.0 / – 8.0	– 0.0 / + 8.0	– 0.0 / + 12.0
12.41 – 15.75	+ 0.0 / – 3.5	– 0.0 / + 3.5	+ 0.0 / – 9.0	– 0.0 / + 9.0	– 0.0 / + 14.0
15.75 – 19.69	+ 0.0 / – 4.0	– 0.0 / + 4.0	+ 0.0 / – 10.0	– 0.0 / + 10.0	– 0.0 / + 16.0
19.69 – 30.09	+ 0.0 / – 5.0	– 0.0 / + 5.0	+ 0.0 / – 12.0	– 0.0 / + 12.0	– 0.0 / + 20.0
30.09 – 41.49	+ 0.0 / – 6.0	– 0.0 / + 6.0	+ 0.0 / – 16.0	– 0.0 / + 16.0	– 0.0 / + 25.0
41.49 – 56.19	+ 0.0 / – 8.0	– 0.0 / + 8.0	+ 0.0 / – 20.0	– 0.0 / + 20.0	– 0.0 / + 30.0
56.19 – 76.39	+ 0.0 / – 10.0	– 0.0 / + 10.0	+ 0.0 / – 25.0	– 0.0 / + 25.0	– 0.0 / + 40.0

BS 4500	Axial Seals		Face Seals		Flange Cavity Only
Nominal Cavity Diameter (mm) Over – To	TOLERANCE GRADE				
	h8 Cavity I.D.	H8 Cavity O.D.	h10 Cavity I.D.	H10 Cavity O.D.	H11 Cavity O.D.
	(Dimensions are in 0.001 millimeters)				
0 – 3	+ 0.0 / – 14	– 0.0 / + 14	+ 0.0 / – 40	– 0.0 / + 40	– 0.0 / + 60
3 – 6	+ 0.0 / – 18	– 0.0 / + 18	+ 0.0 / – 48	– 0.0 / + 48	– 0.0 / + 75
6 – 10	+ 0.0 / – 22	– 0.0 / + 22	+ 0.0 / – 58	– 0.0 / + 58	– 0.0 / + 90
10 – 18	+ 0.0 / – 27	– 0.0 / + 27	+ 0.0 / – 70	– 0.0 / + 70	– 0.0 / + 110
18 – 30	+ 0.0 / – 33	– 0.0 / + 33	+ 0.0 / – 84	– 0.0 / + 84	– 0.0 / + 130
30 – 50	+ 0.0 / – 39	– 0.0 / + 39	+ 0.0 / – 100	– 0.0 / + 100	– 0.0 / + 160
50 – 80	+ 0.0 / – 46	– 0.0 / + 46	+ 0.0 / – 120	– 0.0 / + 120	– 0.0 / + 190
80 – 120	+ 0.0 / – 54	– 0.0 / + 54	+ 0.0 / – 140	– 0.0 / + 140	– 0.0 / + 220
120 – 180	+ 0.0 / – 63	– 0.0 / + 63	+ 0.0 / – 160	– 0.0 / + 160	– 0.0 / + 250
180 – 250	+ 0.0 / – 72	– 0.0 / + 72	+ 0.0 / – 185	– 0.0 / + 185	– 0.0 / + 290
250 – 315	+ 0.0 / – 81	– 0.0 / + 81	+ 0.0 / – 210	– 0.0 / + 210	– 0.0 / + 320
315 – 400	+ 0.0 / – 89	– 0.0 / + 89	+ 0.0 / – 230	– 0.0 / + 230	– 0.0 / + 360
400 – 500	+ 0.0 / – 97	– 0.0 / + 97	+ 0.0 / – 250	– 0.0 / + 250	– 0.0 / + 400
500 – 760	+ 0.0 / – 127	– 0.0 / + 127	+ 0.0 / – 300	– 0.0 / + 300	– 0.0 / + 500
760 – 1050	+ 0.0 / – 152	– 0.0 / + 152	+ 0.0 / – 400	– 0.0 / + 400	– 0.0 / + 630
1050 – 1425	+ 0.0 / – 203	– 0.0 / + 203	+ 0.0 / – 500	– 0.0 / + 500	– 0.0 / + 760
1425 – 1940	+ 0.0 / – 254	– 0.0 / + 254	+ 0.0 / – 630	– 0.0 / + 630	– 0.0 / + 1000

All tolerances above heavy line are in accordance with American-British-Canadian (ABC) Agreements.

Warranty Statement

Advanced Products is experienced in the manufacture of safety-critical seals for manned space flight and nuclear reactors as well as a vast range of industrial and commercial applications. Advanced Products' seals are manufactured from high grade materials with full lot-control, traceability and inspection procedures being applied at all stages. All such procedures are controlled by our Q.A. Manual. Where applicable, we cite appropriate International, Government or Industry Standards as well as our own specially developed Process Specifications.

We are confident that our seals will be delivered free of all material or manufacturing defects. We will replace, free of charge, any defective products reported to us within 12 months of their delivery date. This warranty is limited to the replacement value of the defective seals only, and does not include any additional or consequential liabilities whatsoever.

Seals are, by design, compliant, relatively soft components which may be damaged if misapplied or installed incorrectly. Equally, dynamic seals are inevitably subject to wear, especially in abrasive media. Seal performance is also highly dependent on the condition (hardness, roughness, tolerancing) of the mating surfaces against which the seal contacts. Consequently, except for the general recommendations found in this design manual, we cannot give specific warranties for life-expectancy, leak-rate or other operational parameters.

Customers are always advised to qualify seals, preferably by test, or by similarity, in the exact configuration of their intended use.

Corporate Quality Statement

- To ensure total **customer satisfaction**, Advanced Products shall maintain a unified Quality System, evolving and responsive to our customers' changing requirements.
- Our Quality System shall ensure the fulfillment of customers' needs by controlling our entire company operation. Clear, written procedures shall define each function from the initial Application Evaluation to the Proposal, Order Entry, Development and Design, Manufacturing through to final Delivery.
- Welcoming independent auditing by our customers and internationally recognized Quality Auditors, Advanced Products is committed to building and maintaining a Quality System in full compliance with ISO 9000/9001.

Corporate Mission Statement

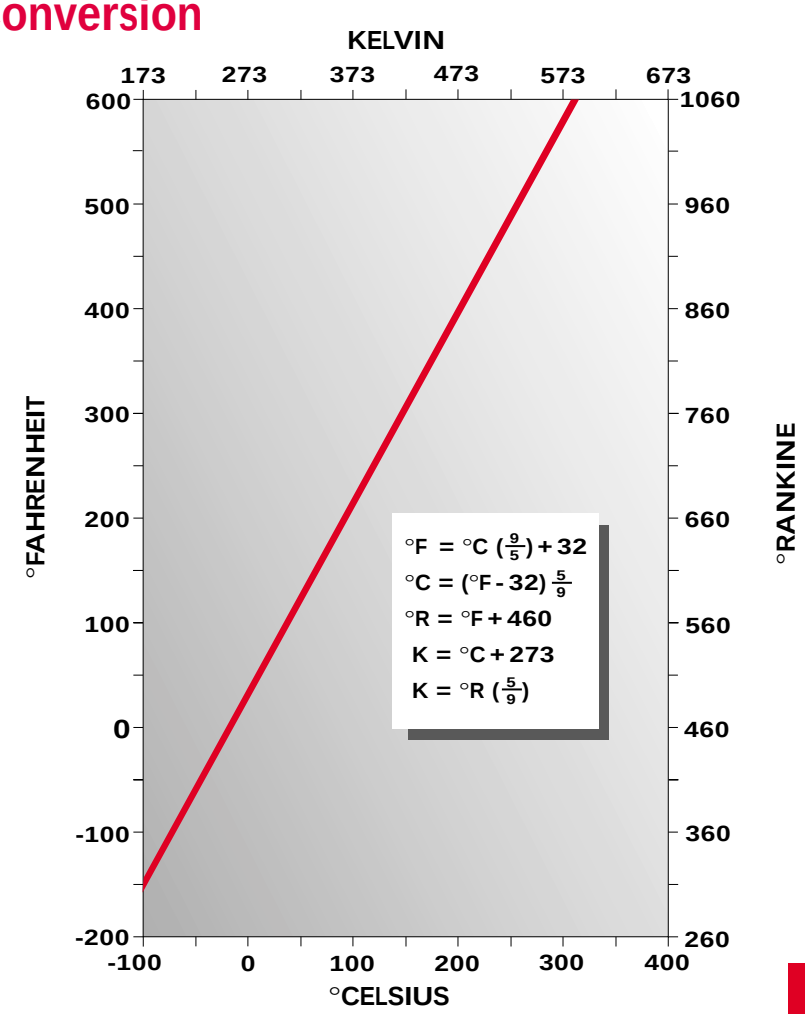
- Working in partnership with both customers and suppliers, our primary mission is **customer satisfaction**, through supplying effective, high-quality, engineered sealing solutions.
- We recognize that customer satisfaction, alone, creates new challenges and employment opportunities, and a fair return for our stockholders.
- We proudly acknowledge our continuing dedication to serving advanced technology industries worldwide including: nuclear power generation, chemical, semi-conductors, medical equipment, offshore oil and gas production, and aerospace.
- We are commited to our growing role in global environmental protection. High integrity sealing can help eliminate leakage, pollution and toxic emissions, as well as improving the efficiency and reliability of prime-movers, machinery and industrial processes.

Conversion Tables

Pressure Conversion

TO OBTAIN / MULTIPLY		atmosphere	bar	inches of mercury	inches of water	millimeters of mercury (Torr)	millimeters of water	kPa	MPa	Newtons/ m^2 (Pascal)	pounds/ square inch
atmosphere	by	1	1.0133	29.9210	4.0678×10^{2}	7.6000×10^{2}	1.0332×10^{4}	1.0133×10^{2}	1.0133×10^{-1}	1.0133×10^{5}	14.6960
bar	by	9.8692×10^{-1}	1	29.5300	4.0146×10^{2}	7.5006×10^{2}	1.0197×10^{4}	1.0000×10^{2}	1.0000×10^{-1}	1.0000×10^{5}	14.5038
inches of mercury	by	3.3421×10^{-2}	3.3864×10^{-2}	1	13.5950	25.4000	3.4532×10^{2}	3.3864	3.3864×10^{-3}	3.3864×10^{3}	4.9116×10^{-1}
inches of water	by	2.4584×10^{-3}	2.4840×10^{-3}	7.3556×10^{-2}	1	1.8685	25.4000	2.4910×10^{-1}	2.4910×10^{-4}	2.4910×10^{2}	3.6128×10^{-2}
millimeters of mercury (Torr)	by	1.3158×10^{-3}	1.3332×10^{-3}	3.9370×10^{-2}	5.3520×10^{-1}	1	13.5950	1.3332×10^{-1}	1.3332×10^{-4}	1.3332×10^{2}	1.9337×10^{-2}
millimeters of water	by	9.6787×10^{-5}	9.8068×10^{-5}	2.8959×10^{-3}	3.9370×10^{-2}	7.3556×10^{-2}	1	9.8068×10^{-3}	9.8068×10^{-6}	9.8068	1.4223×10^{-3}
kPa	by	9.8692×10^{-3}	1.0000×10^{-2}	2.9530×10^{-1}	4.0146	7.5006	1.0197×10^{2}	1	1.0000×10^{-3}	1.0000×10^{3}	1.4504×10^{-1}
MPa	by	9.8692	10.0000	2.9530×10^{2}	4.0146×10^{3}	7.5006×10^{3}	1.0197×10^{5}	1.0000×10^{3}	1	1.0000×10^{6}	1.4504×10^{2}
Newtons/ m^2 (Pascal)	by	9.8692×10^{-6}	1.0000×10^{-5}	2.9530×10^{-4}	4.0146×10^{-3}	7.5006×10^{-3}	1.0197×10^{-1}	1.0000×10^{-3}	1.0000×10^{-6}	1	1.4504×10^{-4}
pounds/ square inch	by	6.8046×10^{-2}	6.8947×10^{-2}	2.0360	27.6810	51.7144	7.0310×10^{2}	6.8948	6.8948×10^{-3}	6.8948×10^{3}	1

Temperature Conversion



Leak Rate Equivalents

cc/sec	mbar-l/sec	Torr-l/sec	Pa-m^3/sec	Approximate Equivalent	Approximate 1mm^3 Bubble Equivalent
1	1.01	$7.6x10^{-1}$	$1.01x10^{-1}$	$2x10^{-3}$ SCFM	Steady Stream
$1x10^{-1}$	$1.01x10^{-1}$	$7.6x10^{-2}$	$1.01x10^{-2}$	1 cc every 10 seconds	Steady Stream
$1x10^{-2}$	$1.01x10^{-2}$	$7.6x10^{-3}$	$1.01x10^{-3}$	1 cc every 100 seconds	10 per second
$1x10^{-3}$	$1.01x10^{-3}$	$7.6x10^{-4}$	$1.01x10^{-4}$	3 cc per hour	1 per second
$1x10^{-4}$	$1.01x10^{-4}$	$7.6x10^{-5}$	$1.01x10^{-5}$	1 cc every 3 hours	1 every 10 seconds
$1x10^{-5}$	$1.01x10^{-5}$	$7.6x10^{-6}$	$1.01x10^{-6}$	1 cc every 24 hours	1 every 100 seconds
$1x10^{-6}$	$1.01x10^{-6}$	$7.6x10^{-7}$	$1.01x10^{-7}$	1 cc every 2 weeks	3 per hour
$1x10^{-7}$	$1.01x10^{-7}$	$7.6x10^{-8}$	$1.01x10^{-8}$	3 cc per year	Bubbles too infrequent to observe
$1x10^{-8}$	$1.01x10^{-8}$	$7.6x10^{-9}$	$1.01x10^{-9}$	1 cc every 3 years	
$1x10^{-9}$	$1.01x10^{-9}$	$7.6x10^{-10}$	$1.01x10^{-10}$	1 cc every 30 years	
$1x10^{-10}$	$1.01x10^{-10}$	$7.6x10^{-11}$	$1.01x10^{-11}$	1 cc every 300 years	
$1x10^{-11}$	$1.01x10^{-11}$	$7.6x10^{-12}$	$1.01x10^{-12}$	1 cc every 3000 years	

Application Data Sheet

Please photocopy for future use!

Advanced

FACE SEAL

Sales Engineer _____

Date _____

CUSTOMER

COMPANY _____ PHONE _____

ADDRESS _____ FAX _____

CITY _____ ST. _____ ZIP _____

CONTACT _____ TITLE _____

OPERATING CONDITIONS

APPLICATION/EQUIPMENT _____

EXISTING SEAL _____ CUSTOMER PART NUMBER _____

CLAMPING LOAD AVAILABLE _____ SURFACE FINISH _____

❑ INTERNAL PRESSURE ❑ EXTERNAL PRESSURE

❑ STATIC ❑ CYCLIC (please fill in table below)

FREQUENCY _____

AMPLITUDE _____

FLUID MEDIA _____ CAVITY MATERIALS _____

MAXIMUM ALLOWABLE LEAKAGE _____

ADDITIONAL INFORMATION _____

_____

	AT ASSEMBLY	MINIMUM	MAXIMUM	OPERATING
TEMPERATURE (state units)				
PRESSURE (state units)				
CAVITY DEPTH "F" (± tol.)				
CAVITY WIDTH "G" (± tol.)				
O.D. "D" (± tol.) internal pressure				
I.D. "D" (± tol.) external pressure				

SKETCH of APPLICATION

ENG. ACTION

QUOTATION QUANTITIES _____ ANNUAL QUANTITY POTENTIAL _____

❑ NO. DRAWINGS REQUIRED ❑ SKETCH ❑ ENGINEERING DRAWING

Application Data Sheet

Please photocopy for future use!

Advanced

AXIAL SEAL

Sales Engineer _____

Date _____

CUSTOMER

COMPANY _____ PHONE _____

ADDRESS _____ FAX _____

CITY _____ ST. _____ ZIP _____

CONTACT _____ TITLE _____

OPERATING CONDITIONS

APPLICATION/EQUIPMENT _____

EXISTING SEAL _____ CUSTOMER PART NUMBER _____

INSERTION/FRICTION FORCE LIMITATIONS _____

❑ STATIC ❑ ROTATING ❑ RECIPROCATING ❑ OSCILLATORY

RPM _____ STROKE LENGTH _____ ROTATION _____

VELOCITY _____ VELOCITY _____

CYCLE RATE _____ CYCLE RATE _____

FLUID MEDIA _____ CAVITY MATERIALS _____

MAXIMUM ALLOWABLE LEAKAGE _____

ADDITIONAL INFORMATION _____

_____

_____

	AT ASSEMBLY	MINIMUM	MAXIMUM	OPERATING
TEMPERATURE (state units)				
PRESSURE (state units)				
CAVITY O.D. "A" (± tol.)				
CAVITY I.D. "B" (± tol.)				
CAVITY LENGTH "G" (± tol.)				

SKETCH of APPLICATION

ENG. ACTION

QUOTATION QUANTITIES _____ ANNUAL QUANTITY POTENTIAL _____

❑ NO. DRAWINGS REQUIRED ❑ SKETCH ❑ ENGINEERING DRAWING

Additional EnerSeal Styles

Our experience shows that eighty percent of all applications are satisfied using one of the standard EnerSeal types previously described in Section C of this design manual. This section addresses the needs of the remaining twenty percent of applications.

The VHA, RDI, and AAI seals shown on pages F-2 and F-3 are frequently used in common applications where the traditional sealing methods are inadequate and the advantages of spring energized P.T.F.E. seals make them the superior choice. This section also shows many additional seal configurations that have been developed and proven for specialized applications in many different industries and final products. Advanced Products' Engineering will frequently recommend these for applications having special requirements. Dimensional data has not been provided in Section F as many of these seal types are available customized for specific applications and cavities.

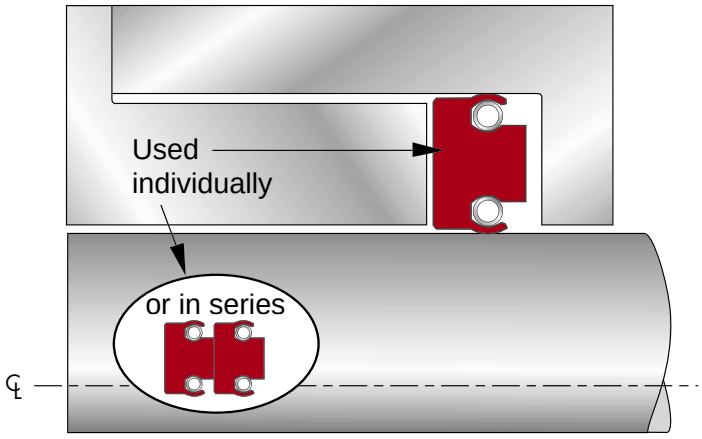
Please advise us of your requirements by filling out a copy of the "Application Data Sheet" included as page E-15 of this design manual. Please fax the completed "Application Data Sheet" to your nearest Advanced Products' Sales Office or Distributor. We will respond quickly with detailed recommendations.

The additional EnerSeal types are conveniently grouped within the following categories:

- Axial Seals for Rotary, Reciprocating and Static Sealing (page F-3)
- Axial Scraper and Wiper Seals (page F-3)
- Axial Flanged Seals for High Speed Rotary Sealing and Cryogenic Applications (page F-3)
- High Speed Rotary Seals and Lip-Seals (page F-4)
- Double Acting Axial Seals (page F-4)
- Face seals for Rotary and Static Sealing (page F-4)
- Double Cavity Seals for Large Cross Section Sizes (page F-5)
- Trapped, High Pressure Anti-Blowout Seals (page F-5)
- Conical Seals (page F-5)

The VHA Valve Stem Seal

The VHA seal is a valve stem seal which is offered as a replacement for chevron packing. Unlike the common gland packing, the VHA seal does not require disc springs, since it is self energized, and does not require gland adjustments due to wear and thermal movement. This seal is designed to fit standard pocket cross sections and can be used individually at pressures up to 10,000 psi (70 MPa) and can be stacked in series for redundant sealing at pressures up to 450 psi (3 MPa).

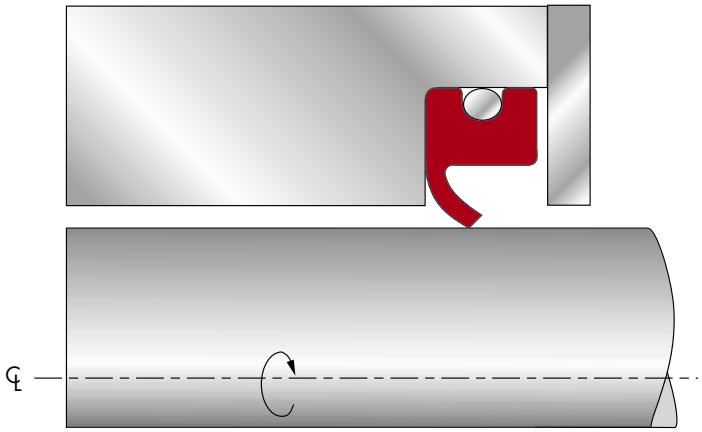


The RDI Lip Seal

The RDI lip seal is an excellent choice for high speed rotating applications and offer many advantages over the common metal cased rubber lip seals.

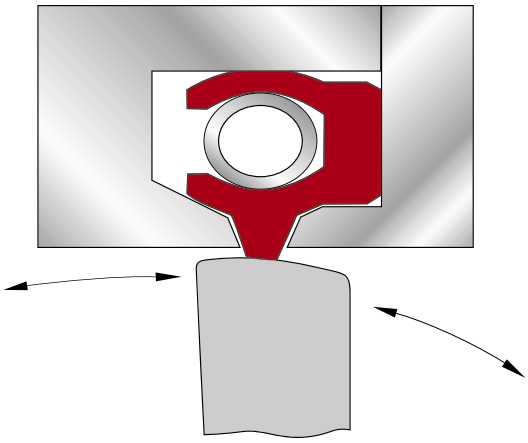
Some of the benefits over the rubber lip seals are:

- The P.T.F.E. has a much greater temperature range than rubber
- Lower frictional force
- Higher rotational speed capability
- Not susceptible to "ringing" (bonding to shaft, as is common with rubber when exposed to periods of no movement).
- Available for any cross section needed.



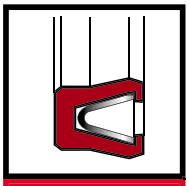
The AAI Butterfly Seat Seal

This seal is often used as a tight shutoff seal for butterfly valves. The AAI is an Anti Blow Out type remaining secure in its cavity even when exposed to high velocities when the valve is initially opened. It is available in sizes ranging from 2 inches (50 mm) to 56 inches (1420 mm) and has a wide operating temperature range of -400°F (-200°C) to 600°F (315°C).



Axial Seals for Rotary, Reciprocating and Static Sealing

These are ideal for many applications from valve stems to hydraulic cylinders to cover plates.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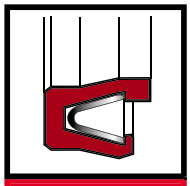
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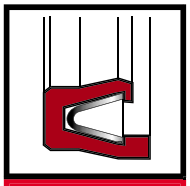
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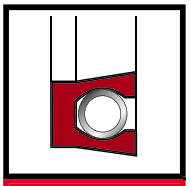
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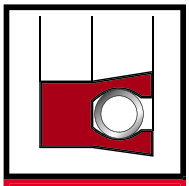
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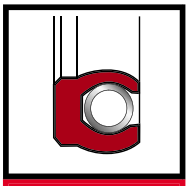
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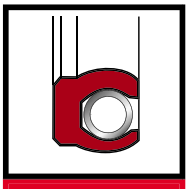
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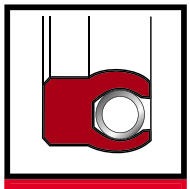
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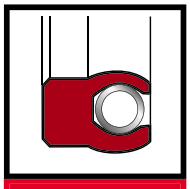
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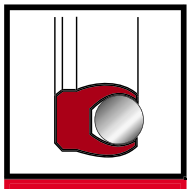
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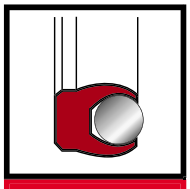
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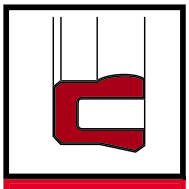
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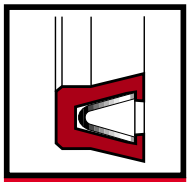
Axial Scraper and Wiper Seals

These seals prevent abrasive particles from accumulating under the seal during the reciprocating or rotating motion thus extending seal life and improving performance.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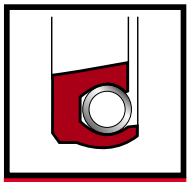
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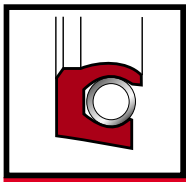
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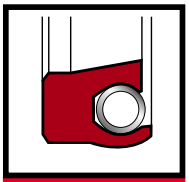
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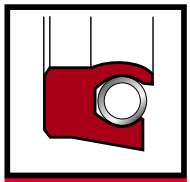
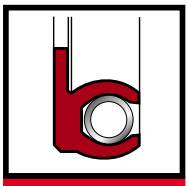

SHO

Axial Flanged Seals for High Speed Rotary Sealing and Cryogenic Applications

The flange feature prevents the seal from rotating within its gland as the high speed shaft rotates against the seal's internal surface. Under cryogenic applications the restrained flange minimizes seal shrinkage so that it maintains firm contact against the sealing surfaces.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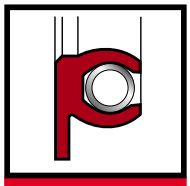
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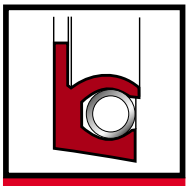
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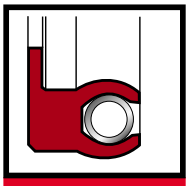
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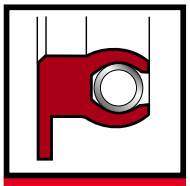
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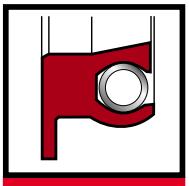
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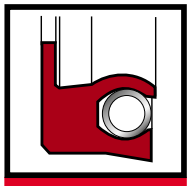
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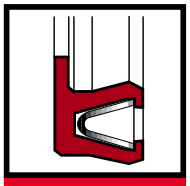
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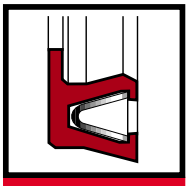
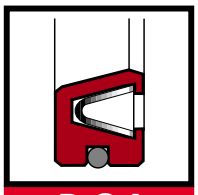

FLT

Rotary Seals and Very High Speed Seals Seal To Fit Lip Grooves and To Suit High Speeds

These special seals are designed for very high speed applications and fit into standard lip seal grooves. They are available in a wide range of sizes.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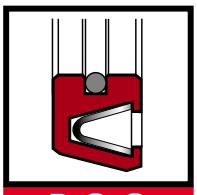
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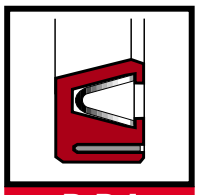
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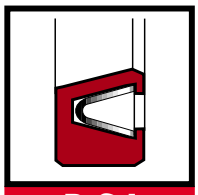
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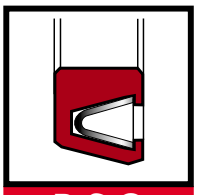
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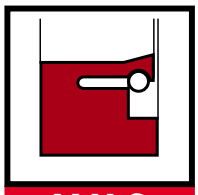
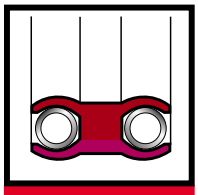

VHS

Double Acting Seals

Double acting seals are designed for exposure to reversing system pressures.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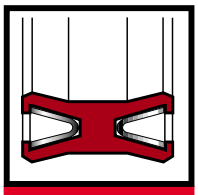
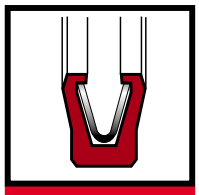

DLS

Face Seals For Internal and External Pressure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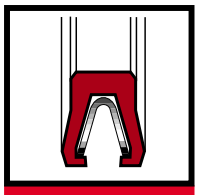
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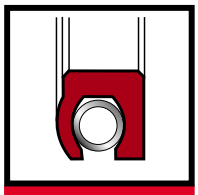
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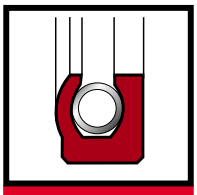
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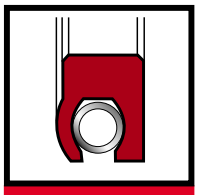
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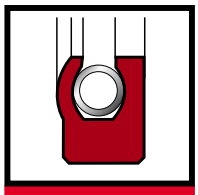
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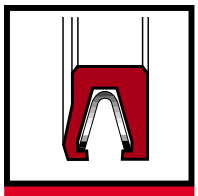
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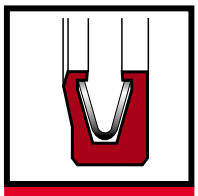
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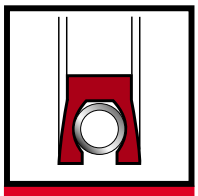
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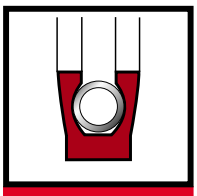
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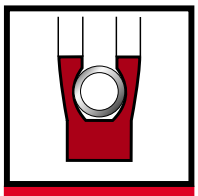
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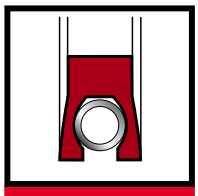
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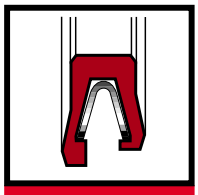
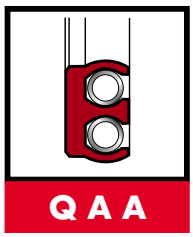

LLG

These are used as standard face seals with higher temperature capabilities than elastomeric seals and lower seating load requirements than metal seals. These high conformity seals are an excellent option when flange separation and/or non-parallelism is a concern.

Double Cross Section Seals To Suit Large Cavity Sizes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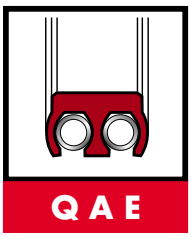
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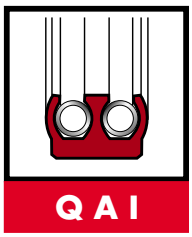
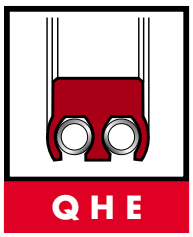

QAI


QHA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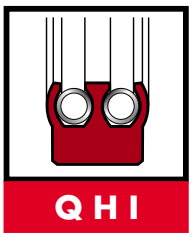
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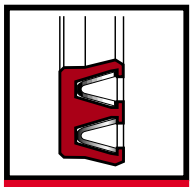
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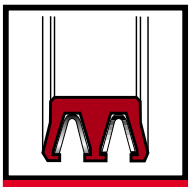
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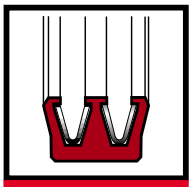
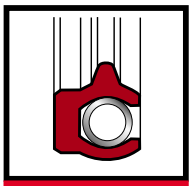

QLI

Theses seals are offered to fill large radial glands when groove length is limited.

Trapped Anti Blow Out Seals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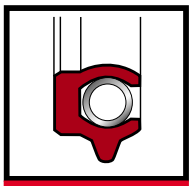
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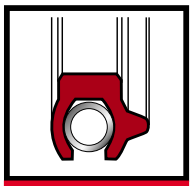
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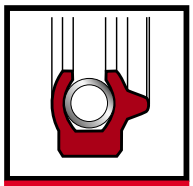
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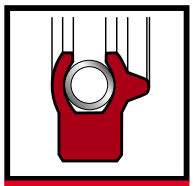
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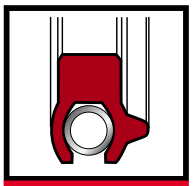
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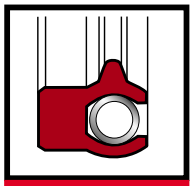
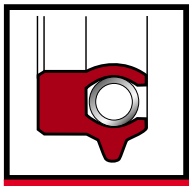
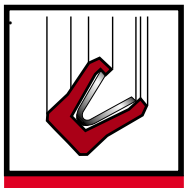

AHI


AHO

Trapped Anti Blow Out seals are used where rapid fluid flow may dislodge a non-trapped seal from its sealing cavity. Being constrained in a pocket also provides additional control over thermal movement of the seal.

Conical Seals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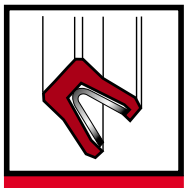
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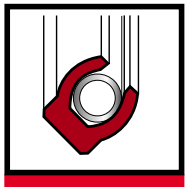
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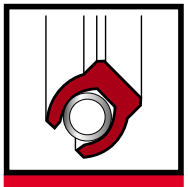
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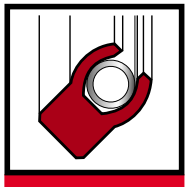
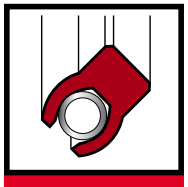

CHI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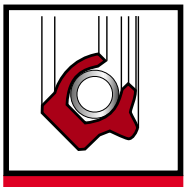
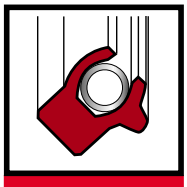

AAC


AHC

These seals suit applications such as angular ball valves and poppet valves which have conical sealing surfaces.


ES0498

The Advanced Products EnerRing

The most extreme environments demand EnerRing® sealing solutions. EnerRing resilient metallic seals meet the challenges of high temperatures or cryogenics, high pressures or hard vacuum, corrosive chemicals, and even intense levels of radiation; performing dependably year after year.

Advantages of EnerRings

- **Independent Optimization of Functional Components** means each discrete function including load, springback, and outer sealing layer ductility/hardness can be optimized to ensure highest seal performance in every situation.
- **Directly Bonded Electroplating** onto the load bearing substrate eliminates unnecessary parts and failure-modes.
- **Pressure Energization** uses internal hydrostatic pressures beneficially to supplement the self-energization forces from the tubing, jacket, or spring. This becomes particularly helpful at high pressures over 3,000 psi (21 MPa) enabling EnerRings to seal at 25,000 psi (170 MPa) and beyond, without risk of blow-by during proof or burst testing.
- **Total Metal Seal Service** covers custom and standard sized seals from 0.250" to 300" (6 mm to 7,60 m), including circular and non-circular shapes. We also offer the complete range of U.S. Military Standard (MS) metal O-Ring sizes, all Aerospace Standard AS1895 E-Ring sizes, and the fastest delivery of C-Rings from our preferred size list (page E-18).
- **Rapid Response and JIT** (Just-In-Time) deliveries are assured due to design, testing, and all manufacturing processes (including roll and die-forming, machining, welding, heat-treatment, electroplating, fluorescent penetrant and radiographic NDT) being performed within our own facilities.
- **EnerRings are the Preferred Solution** in many jet engine, space, and nuclear applications as well as oil, gas, and chemical equipment, plastic molding, diesel engines, and a growing variety of industrial equipment. With ever more stringent pollution and leakage legislation, plus the demand for greater efficiency and lifetime reliability, EnerRing seals provide the highest integrity sealing solutions for today's world *and tomorrow's.*

Visit our World Wide Web homepage at

http://www.advpro.com

for the latest news from Advanced Products, application data pages you can e-mail direct to us, and links to other useful engineering web sites.

EnerRing is a trademark of the Advanced Products Company.

How To Use The EnerRing Design Manual

The Advanced Products EnerRing line of resilient metal seals are offered in a variety of sizes, shapes, cross sections and materials to satisfy the sealing needs of your extreme environments. The EnerRing part number defines all the key design elements as indicated below:

XXX - 000000 - 00 - 00 - 0 - XXX

- XXX — EnerRing Type (Section B)
- 000000 — Seal Diameter (inches specified to three decimal places or millimeters specified to two decimal places). (Section C)
- 00 — Seal Cross Section (Section C)
- 00 — Material (Section D)
- 0 — Temper (Section D)
- XXX — Plating, Coating or Finish (Section D)

This design manual provides a rapid, unambiguous, self-selection process with all the features, applications, and limitations of each product clearly stated. The manual is organized into sections which allow you easily to determine the part number of the EnerRing that is right for your application.

Section B helps you to determine which EnerRing type is most appropriate for your application.

Section C is organized by EnerRing type. Having selected the best EnerRing type from Section B, simply turn to the page in Section C for the seal selected and you will find all the groove and EnerRing dimensions you need.

Section D lists the many available EnerRing materials and assists you in determining which combination of materials is most appropriate for your sealing environment.

Section E provides supporting technical information and recommendations.

Section F shows a number of other EnerRing designs which are available for unique applications when only a special seal will do. In these cases, please contact one of our Applications Engineers at any of our worldwide offices and we will be happy to assist you. Please fax us your Application Data Sheet (Page E-24) for a fast, complete response.

Warranty Statement

Advanced Products is experienced in the manufacture of safety-critical seals for manned space flight and nuclear reactors as well as a vast range of industrial and commercial applications. Advanced Products' seals are manufactured from high grade materials with full lot-control, traceability and inspection procedures being applied at all stages. All such procedures are controlled by our Q.A. Manual. Where applicable, we cite appropriate International, Government or Industry Standards as well as our own specially developed Process Specifications.

We are confident that our seals will be delivered free of all material or manufacturing defects. We will replace, free of charge, any defective products reported to us within 12 months of their delivery date. This warranty is limited to the replacement value of the defective seals only, and does not include any additional or consequential liabilities whatsoever.

Seals are, by design, compliant, relatively soft components which may be damaged if misapplied or installed incorrectly. Equally, dynamic seals are inevitably subject to wear, especially in abrasive media. Seal performance is also highly dependent on the condition (hardness, roughness, tolerancing) of the mating surfaces against which the seal contacts. Consequently, except for the general recommendations found in this design manual, we cannot give specific warranties for life-expectancy, leak-rate or other operational parameters.

Customers are always advised to qualify seals, preferably by test, or by similarity, in the exact configuration of their intended use.

Corporate Quality Statement

- To ensure total **customer satisfaction**, Advanced Products shall maintain a unified Quality System, evolving and responsive to our customers' changing requirements.
- Our Quality System shall ensure the fulfillment of customers' needs by controlling our entire company operation. Clear, written procedures shall define each function from the initial Application Evaluation to the Proposal, Order Entry, Development and Design, Manufacturing through to final Delivery.
- Welcoming independent auditing by our customers and internationally recognized Quality Auditors, Advanced Products is committed to building and maintaining a Quality System in full compliance with ISO 9000/9001.

Corporate Mission Statement

- Working in partnership with both customers and suppliers, our primary mission is **customer satisfaction**, through supplying effective, high-quality, engineered sealing solutions.
- We recognize that customer satisfaction, alone, creates new challenges and employment opportunities, and a fair return for our stockholders.
- We proudly acknowledge our continuing dedication to serving advanced technology industries worldwide including: nuclear power generation, chemical, semi-conductors, medical equipment, offshore oil and gas production, and aerospace.
- We are committed to our growing role in global environmental protection. High integrity sealing can help eliminate leakage, pollution and toxic emissions, as well as improving the efficiency and reliability of prime-movers, machinery and industrial processes.


ER0597

Selecting the EnerRing Type for Your Application

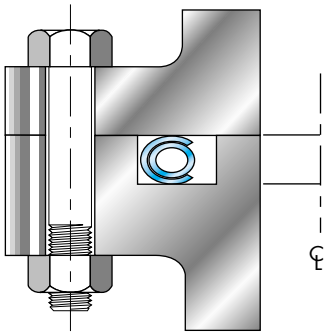
EnerRings are produced in a number of standard designs which are appropriate for use in a broad spectrum of the most commonly encountered applications. The **EnerRing Type** is designated in the part numbers as shown below.

MXX - 000000 - 00 - 00 - 0 - XXX

EnerRing Type (The first letter, M, indicates that the seal dimensions are specified in SI units (millimeters))

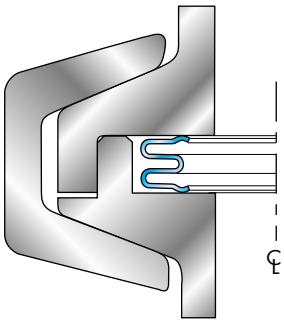
The flow diagrams on the following pages are designed to provide guidance to the appropriate EnerRing type for your application. There are two basic types of applications:

Face Seal Applications



High Load

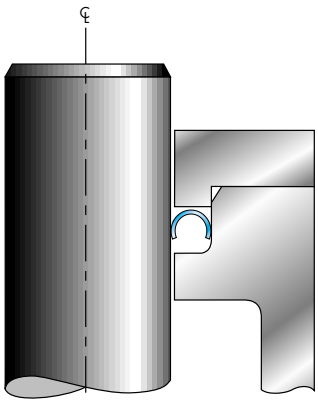
Generally, the high load seals provide greater leak tightness and are preferred when there is sufficient seating load (the load required to compress the seal) and little flange movement due to thermal excursions, vibrations, etc.
Go to page B-2.



High Elasticity

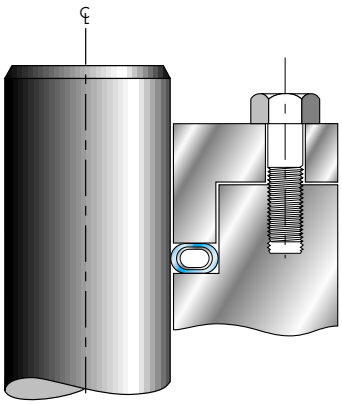
Lower load seals are frequently used when resiliency, or springback is needed to maintain effective sealing during flange separation or rotation. Additionally, low load seals are suitable for applications where seating load is limited or there is concern about yielding or damaging the mating hardware surfaces.
Go to page B-3.

Axial Seal Applications



MCA,
Axial C-Ring

can be used as either a static seal or in semi-dynamic applications such as a quarter-turn valve stem seal.
Go to page C-28.

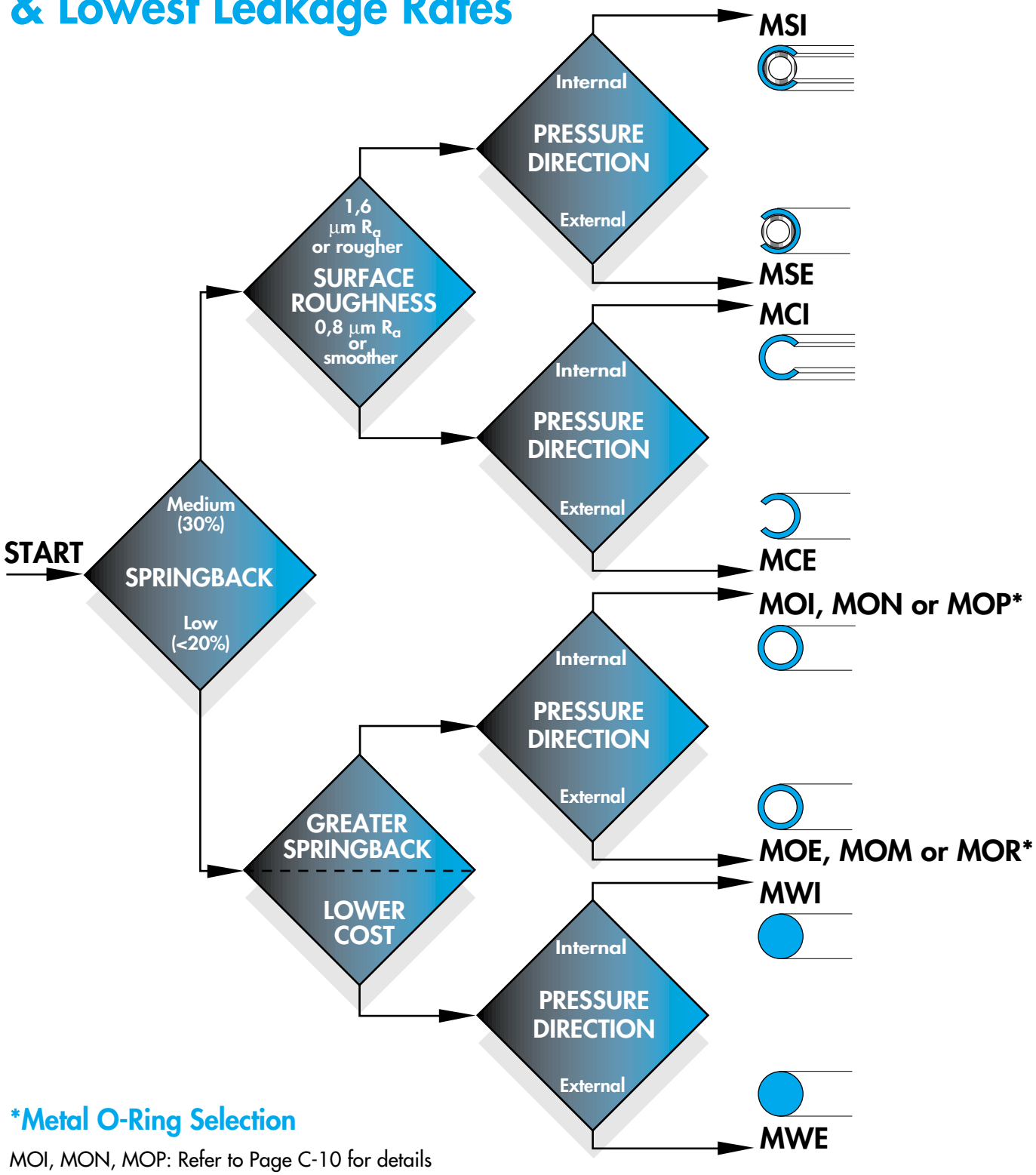


MSO,
Axial Spring Energized Metal O-Ring (SEMOR)

relies on axial compression to provide radial seal expansion resulting in high load sealing.
Go to page C-30.

Face Seals for Higher Seating Loads & Lowest Leakage Rates

(Greater than 18 N/mm circumference)



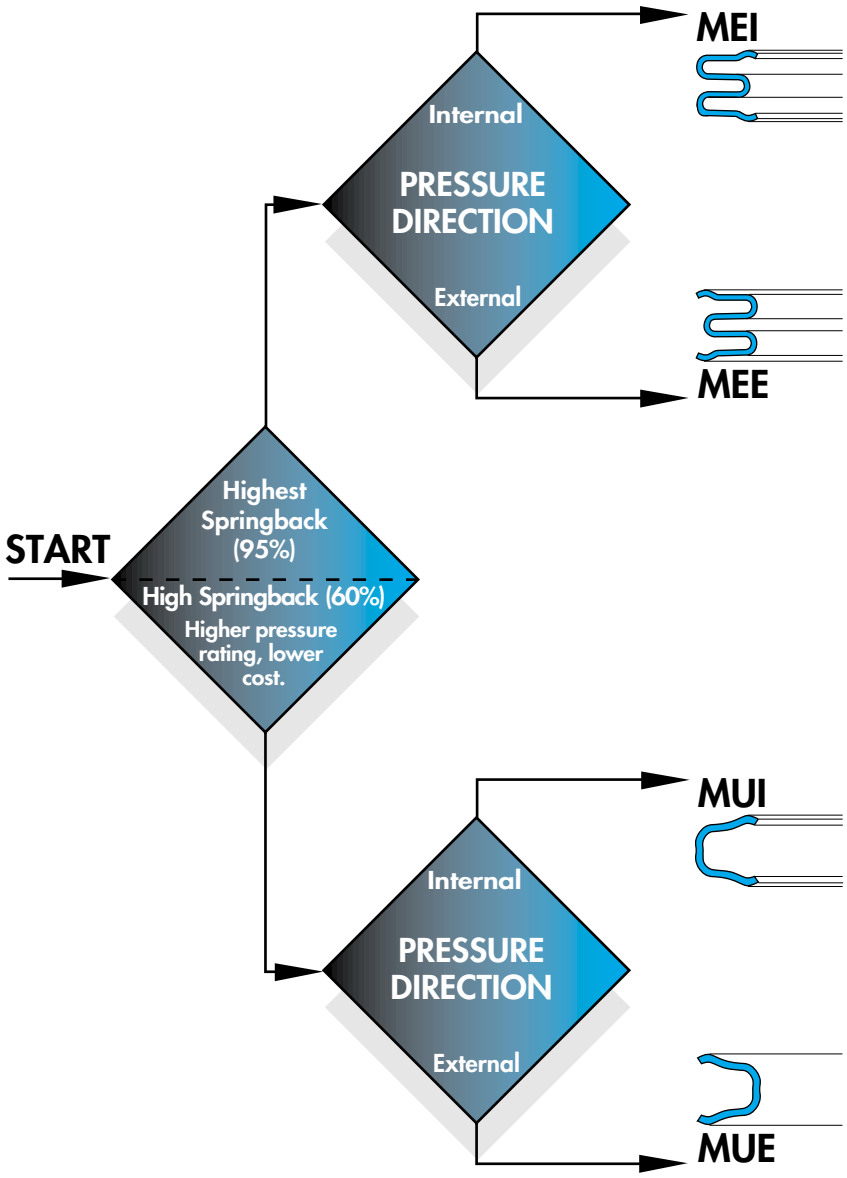
*Metal O-Ring Selection

MOI, MON, MOP: Refer to Page C-10 for details

MOE, MOM, MOR: Refer to Page C-12 for details

Face Seals for Lower Seating Loads & Higher Springback

(Less than 18 N/mm circumference)



Seal Selection at a Glance

In addition to the EnerRing selection flow diagrams on the preceding pages, the following rating table provides simple guidelines which can be used to confirm the appropriate EnerRing selection. Refer to the table below for a comparison of EnerRing types.

Ratings: ★★★★ Excellent
★★★ Very Good
★★ Good
★ Fair
NR Not Recommended

Seal Type	Sealing Requirements					
	High Springback	Low Load	High Load	Low Leak Rate	Pressure Capability	Low Cost
Metal C-Ring	★★	★★	★★	★★★	★★★★	★★★
Metal E-Ring	★★★★	★★★★	NR	★	★★	★
Metal O-Ring	★	NR	★★★	★★★	★★★★	★★★
Metal U-Ring	★★★	★★★★	NR	★	★★★	★
Metal Wire Ring	NR	NR	★★★★	★★	★★★★	★★★★
Spring Energized C-Ring	★★	NR	★★★★	★★★★	★★★★	★

Standard EnerRings for Specific and Standard Applications

The EnerRing type for these applications are listed below.

Seal Description	EnerRing Type
Nuclear Pressure Vessel Metal O-Ring Seal	MNI
Boss Seal for U.S. Military Standard MS-33649 Fluid Connection Boss and MS-33514/33656 Fitting Ends	MBI
Metal E-Ring for AS1895 Flanges	MEI
Metal O-Ring for U.S. Military Standards	EON

Selecting the EnerRing Size for your Application

EnerRings are available in any diameter from 6 mm to 7,6 m and a variety of free heights to fit the various cavity sizes you may have.

The EnerRing size is designated in the part number as shown below.

MXX - 000000 - 00 - 00 - 0 - XXX

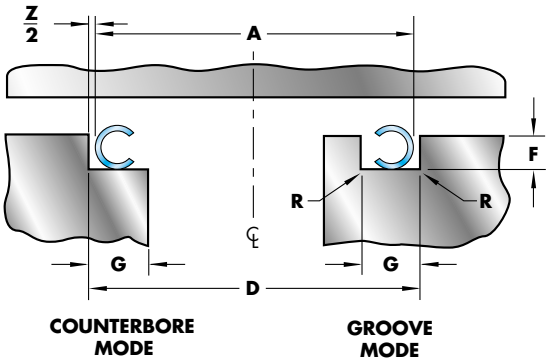
- 00 — Cross Section Code
- 000000 — Seal Diameter prior to plating (millimeters specified to two decimal places; 0000,00)

Refer to the page of the EnerRing type selected for your application to determine the appropriate seal diameter, cross section, and cavity dimensions. Cavity and Seal Dimensions and Seal Performance Data for the Standard EnerRings can be found on the following pages:

MCI Metal C-Ring, Internal Pressure Face Seal

Applications:

- Excellent internally pressurized static face seal for valve assemblies, pressure vessels, jet engines, fuel injectors, separable fittings, etc.
- Moderate load permits the use of lighter flanges and fewer bolts.
- Good springback properties to accommodate thermal cycles and joint separation.
- Temperature range from cryogenics to 870°C.
- Pressure range from vacuum to 690 MPa and above.



Features:

- Wide range of 10 standard free heights from 0,79 to 12,70 mm.
- Available in any diameter from 6 mm to 3 m, plus hundreds of preferred sizes (refer to page E-18).
- Relatively flexible for use with non-flat flanges.
- Available in 8 materials offering high temperature strength, good springback, corrosion and fatigue resistance.
- Optimized one piece construction for low cost.
- Wide range of plating options (refer to page D-6) for superior sealing.
- Uses jacket strength and hydrostatic forces additively, to increase sealing forces at higher pressures.
- Circular, race-track, and other custom shapes available. Tri-lobed or elliptical C-Rings available for snap-in/snap-out convenience.

Cavity Dimensions

C	D	F	G	R
SEAL FREE HEIGHT	O.D. RANGE tolerance H10	DEPTH RANGE	MINIMUM WIDTH	MAXIMUM RADIUS
0,79	6,00 – 25,00	0,64 – 0,69	1,02	0,25
1,19	8,00 – 50,00	0,94 – 1,02	1,40	0,30
1,57	10,00 – 200,00	1,27 – 1,37	1,91	0,38
2,39	13,00 – 400,00	1,91 – 2,01	2,67	0,51
3,18	25,00 – 600,00	2,54 – 2,67	3,43	0,76
3,96	32,00 – 750,00	3,18 – 3,30	4,32	1,27
4,78	75,00 – 900,00	3,84 – 3,99	5,08	1,27
6,35	100,00 – 1200,00	5,08 – 5,28	6,60	1,52
9,53	300,00 – 2000,00	7,62 – 8,03	9,65	1,52
12,70	600,00 – 3000,00	10,16 – 10,67	12,70	1,52

All dimensions are in millimeters.
The Tolerance Reference table can be found on page E-22.

Seal and Cavity Sizing

Seal free height is based on cavity diameter and depth alone. Seal diameter (dimension A) is derived below.

$$A = D - Z - 2P_{max}$$ (tolerance h11, see page E-22)

Where: D = Minimum cavity O.D.
Z = Diametral clearance between cavity and seal
P_{max} = Maximum plating thickness (from page D-7)

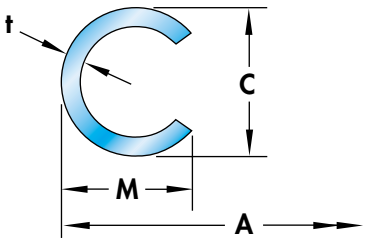
Part Numbering

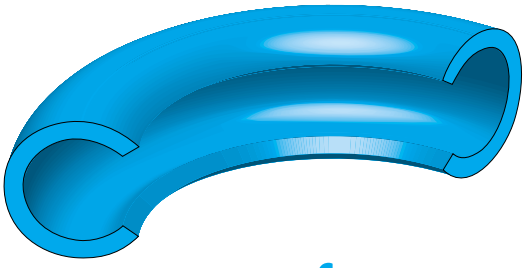
Refer to page A-2 for part numbering convention. The seal size is specified in the part number as follows:

MCI - 000000 - 00 - 00 - 0 - XXX

00 — EnerRing Cross Section Code

000000 — Seal O.D. prior to plating (dimension A) to two decimal places
(Example: A 70,00 mm seal is specified as 007000)





Seal Dimensions

C SEAL FREE HEIGHT	Z DIAMETRAL CLEARANCE	M MAXIMUM RADIAL WIDTH	t MATERIAL THICKNESS	CROSS SECTION CODE
0,79 ± 0,05	0,08	0,71	0,15	01
			0,18	02
1,19 ± 0,05	0,13	0,96	0,15	03
			0,20	04
1,57 ± 0,05	0,15	1,26	0,15	05
			0,25	06
2,39 ± 0,05	0,20	1,91	0,25	07
			0,38	08
3,18 ± 0,08	0,30	2,54	0,38	09
			0,51	10
3,96 ± 0,08	0,41	3,17	0,41	11
			0,61	12
4,78 ± 0,10	0,46	3,82	0,51	13
			0,76	14
6,35 ± 0,10	0,51	5,08	0,64	15
			0,97	16
9,53 ± 0,10	0,76	7,62	0,97	17
			1,27	18
12,70 ± 0,13	1,02	10,16	1,27	19
			1,65	20

Performance

SEATING LOAD (N per mm circumference)	SPRINGBACK (mm)	WORKING PRESSURE RATING*(MPa)
30	0,04	530
40	0,03	690
20	0,05	290
40	0,05	430
15	0,08	200
50	0,05	400
30	0,15	230
70	0,13	390
55	0,18	260
100	0,15	390
45	0,23	220
100	0,18	370
60	0,25	220
130	0,20	390
70	0,33	210
180	0,23	360
110	0,51	210
260	0,38	300
140	0,64	210
300	0,51	290

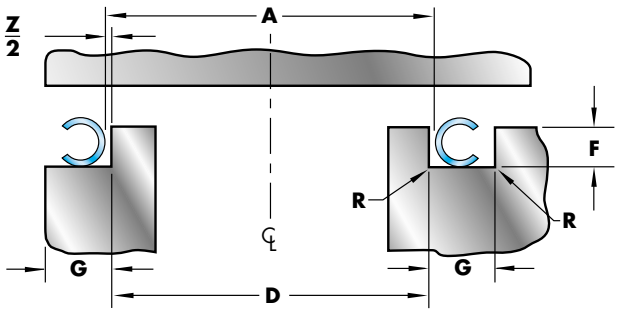
All dimensions are in millimeters and prior to plating. Shaded boxes indicate standard cross section code.
Performance data is based on Alloy 718 material with -6 treatment. Seal Performance is discussed in Section E.

* If working pressures exceed the above ratings, consult us for recommendations.

MCE Metal C-Ring, External Pressure Face Seal

Applications:

- Excellent externally pressurized static face seal.
- Moderate load permits the use of lighter flanges and fewer bolts.
- Good springback properties to accommodate thermal cycles and joint separation.
- Temperature range from cryogenics to 870°C.
- Pressure range from vacuum to 690 MPa and above.



OPEN GROOVE MODE

GROOVE MODE

Features:

- Wide range of 10 standard free heights from 0,79 to 12,70 mm.
- Available in any diameter from 6 mm to 3 m, plus hundreds of preferred sizes (refer to page E-18).
- Relatively flexible for use with non-flat flanges.
- Available in 8 materials offering high temperature strength, good springback, corrosion and fatigue resistance.
- Optimized one piece construction for low cost.
- Wide range of plating options (refer to page D-6) for superior sealing.
- Uses jacket strength and hydrostatic forces additively, to increase sealing forces at higher pressures.
- Circular, race-track, and other custom shapes available. Tri-lobed or elliptical C-Rings available for snap-in/snap-out convenience.

Cavity Dimensions

C	D	F	G	R
SEAL FREE HEIGHT	I.D. RANGE tolerance h10	DEPTH RANGE	MINIMUM WIDTH	MAXIMUM RADIUS
0,79	5,00 – 25,00	0,64 – 0,69	1,02	0,25
1,19	8,00 – 50,00	0,94 – 1,02	1,40	0,30
1,57	9,00 – 200,00	1,27 – 1,37	1,91	0,38
2,39	10,00 – 400,00	1,91 – 2,01	2,67	0,51
3,18	20,00 – 600,00	2,54 – 2,67	3,43	0,76
3,96	32,00 – 750,00	3,18 – 3,30	4,32	1,27
4,78	75,00 – 900,00	3,84 – 3,99	5,08	1,27
6,35	100,00 – 1200,00	5,08 – 5,28	6,60	1,52
9,53	300,00 – 2000,00	7,62 – 8,03	9,65	1,52
12,70	600,00 – 3000,00	10,16 – 10,67	12,70	1,52

All dimensions are in millimeters.
The Tolerance Reference table can be found on page E-22.

Seal and Cavity Sizing

Seal free height is based on cavity diameter and depth alone. Seal diameter (dimension A) is derived below.

$$A = D + Z + 2P_{max}$$ (tolerance H11, see page E-22)

Where: D = Maximum cavity I.D.
Z = Diametral clearance between cavity and seal
P_{max} = Maximum plating thickness (from page D-7)

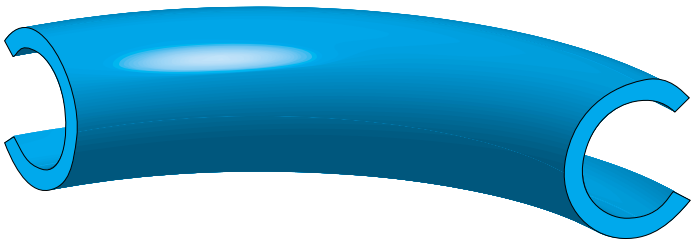
Part Numbering

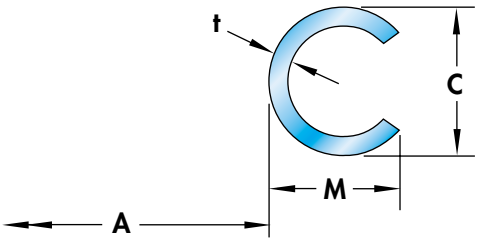
Refer to page A-2 for part numbering convention. The seal size is specified in the part number as follows:

MCE - 000000 - 00 - 00 - 0 - XXX

EnerRing Cross Section Code

Seal I.D. prior to plating (dimension A) to two decimal places
(Example: A 70,00 mm seal is specified as 007000)





Seal Dimensions

C SEAL FREE HEIGHT	Z DIAMETRAL CLEARANCE	M MAXIMUM RADIAL WIDTH	t MATERIAL THICKNESS	CROSS SECTION CODE
0,79 ± 0,05	0,08	0,71	0,15	01
			0,18	02
1,19 ± 0,05	0,13	0,96	0,15	03
			0,20	04
1,57 ± 0,05	0,15	1,26	0,15	05
			0,25	06
2,39 ± 0,05	0,20	1,91	0,25	07
			0,38	08
3,18 ± 0,08	0,30	2,54	0,38	09
			0,51	10
3,96 ± 0,08	0,41	3,17	0,41	11
			0,61	12
4,78 ± 0,10	0,46	3,82	0,51	13
			0,76	14
6,35 ± 0,10	0,51	5,08	0,64	15
			0,97	16
9,53 ± 0,10	0,76	7,62	0,97	17
			1,27	18
12,70 ± 0,13	1,02	10,16	1,27	19
			1,65	20

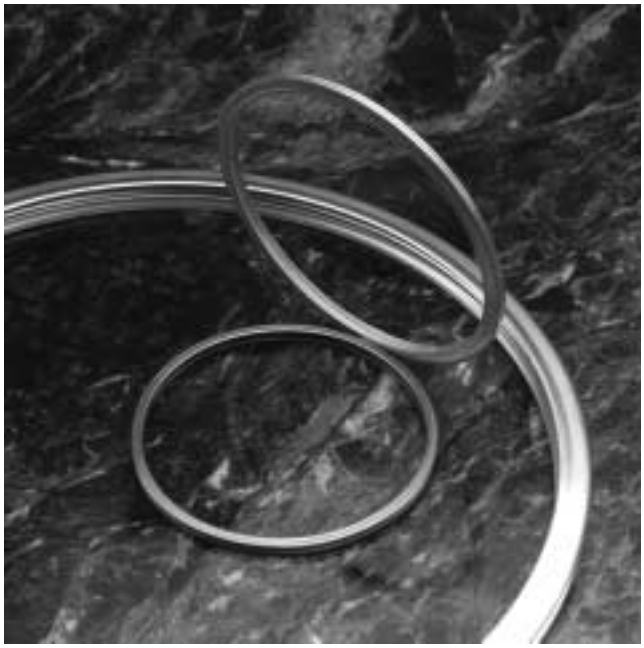
Performance

SEATING LOAD (N per mm circumference)	SPRINGBACK (mm)	WORKING PRESSURE RATING*(MPa)
30	0,04	530
40	0,03	690
20	0,05	290
40	0,05	430
15	0,08	200
50	0,05	400
30	0,15	230
70	0,13	390
55	0,18	260
100	0,15	390
45	0,23	220
100	0,18	370
60	0,25	220
130	0,20	390
70	0,33	210
180	0,23	360
110	0,51	210
260	0,38	300
140	0,64	210
300	0,51	290

All dimensions are in millimeters and prior to plating. Shaded boxes indicate standard cross section code.
Performance data is based on Alloy 718 material with -6 treatment. Seal Performance is discussed in Section E.

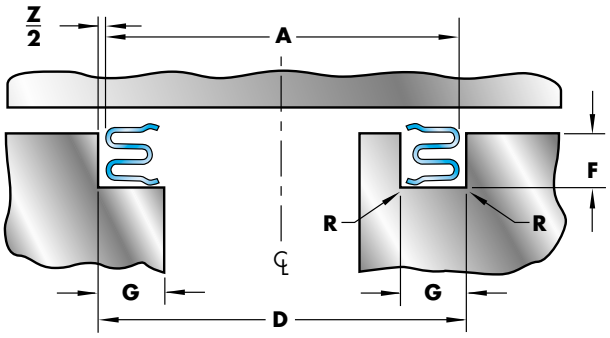
* If working pressures exceed the above ratings, consult us for recommendations.

MEI Metal E-Ring, Internal Pressure Face Seal



Applications:

- High temperature pneumatic joints, turbine engine bleed air ducting joints, turbine engine cases, very low load flanges and/or joints with considerable movement.
- Multi-convolution E-Rings available for very high deflection applications.
- Available internally pressure-energized or pressure neutral for reversing pressures.
- Resonant frequency of E-Ring may be customized to avoid destructive resonance in high vibration applications.
- Available in standard sizes to fit all Aerospace Standard AS1895 flanges (refer to page C-34).
- For temperatures up to 870°C.

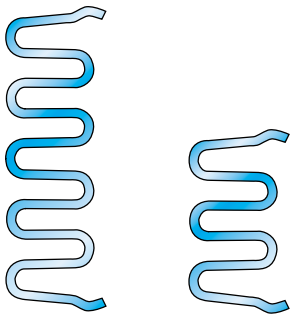


COUNTERBORE MODE

GROOVE MODE

Features:

- Optimized one piece construction for lower costs.
- Highly compliant, very low load seal. Generally used unplated.
- Five standard sections and any diameter from 45 mm to 1,2 m (larger on request).
- Radiused footprint area protects mating surfaces.
- Fully elastic working envelope for consistent performance over many compression/ extension cycles. Defined fatigue life.
- Available in a choice of high strength/ high temperature nickel alloys.
- Available with HVOF (High Velocity Oxygen Flame) anti-gall coating.



E-Rings are available with additional convolutions for even greater springback.

Cavity Dimensions

C SEAL FREE HEIGHT	D O.D. RANGE tolerance H10	F DEPTH RANGE	G MINIMUM WIDTH	R MAXIMUM RADIUS
1,88	45,00 – 200,00	1,55 – 1,60	2,29	0,38
2,59	50,00 – 300,00	2,16 – 2,26	2,92	0,51
2,74	57,00 – 300,00	2,16 – 2,26	4,32	0,51
2,74	50,00 – 300,00	2,16 – 2,26	2,92	0,51
3,35	50,00 – 600,00	2,95 – 3,05	4,19	0,76
3,57	57,00 – 600,00	2,95 – 3,05	5,84	0,76
3,57	50,00 – 600,00	2,95 – 3,05	4,19	0,76
5,54	85,00 – 900,00	4,55 – 4,65	5,84	1,02
7,49	150,00 – 1200,00	6,20 – 6,35	8,00	1,52

All dimensions are in millimeters.
The Tolerance Reference table can be found on page E-22.

Seal and Cavity Sizing

Seal free height is based on cavity diameter and depth alone. Seal diameter (dimension A) is derived below.

A = D - Z (tolerance h11, see page E-22)

Where: D = Minimum cavity O.D.
Z = Diametral clearance between cavity and seal

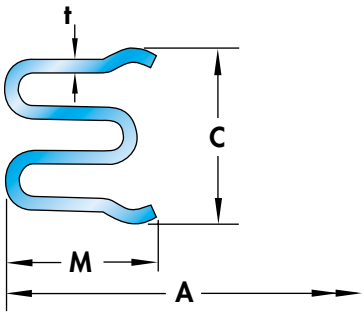
Part Numbering

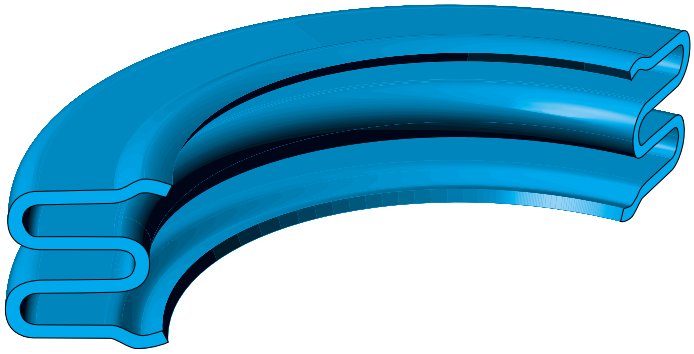
Refer to page A-2 for part numbering convention. The seal size is specified in the part number as follows:

MEI - 000000 - 00 - 00 - 0

EnerRing Cross Section Code

Seal O.D. (dimension A) to two decimal places
(Example: A 70,00 mm seal is specified as 007000)





Seal Dimensions

C SEAL FREE HEIGHT	Z DIAMETRAL CLEARANCE	t MATERIAL THICKNESS	M MAXIMUM RADIAL WIDTH	CROSS SECTION CODE
1,88 ± 0,08	0,08	0,13	1,68	05
2,59 ± 0,13	0,08	0,25	2,31	06
2,74 ± 0,13	0,08	0,25	3,68	07
2,74 ± 0,13	0,08	0,25	2,31	08
3,35 ± 0,13	0,13	0,38	3,10	11
3,57 ± 0,10	0,13	0,30	4,90	09
3,57 ± 0,10	0,13	0,30	3,10	10
5,54 ± 0,13	0,15	0,38	4,83	13
7,49 ± 0,15	0,20	0,51	6,78	15

Performance

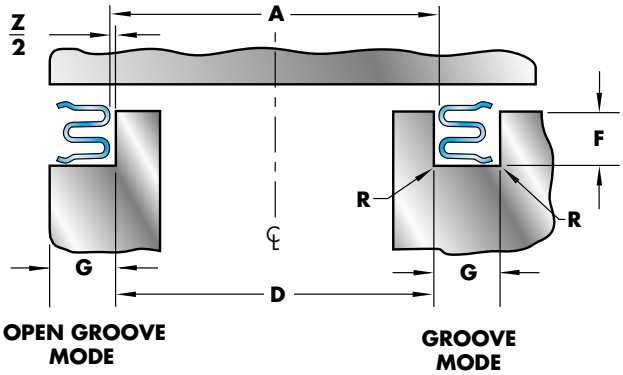
SEATING LOAD (N per mm circumference)	SPRINGBACK (mm)	WORKING PRESSURE RATING* (MPa)
5	0,30	10
5	0,38	10
7	0,53	10
16	0,45	35
13	0,35	38
8	0,57	10
11	0,57	25
9	0,94	15
14	1,21	15

All dimensions are in millimeters.
Performance data is based on Alloy 718 material with -6 treatment. Seal Performance is discussed in Section E.
* If working pressures exceed the above ratings consult us for recommendations.

MEE Metal E-Ring, External Pressure Face Seal

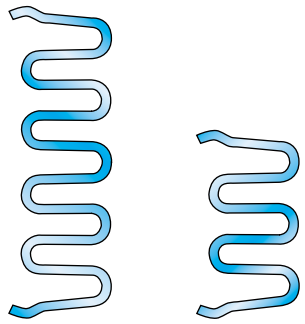
Applications:

- High temperature pneumatic joints with external pressurization and/or joints with considerable movement.
- Multi-convolution E-Rings available for very high deflection applications.
- Available externally pressure-energized or pressure-neutral for reversing pressures.
- Resonant frequency of E-Ring may be customized to avoid destructive resonance in high vibration applications.
- For temperatures up to 870°C.



Features:

- Optimized one piece construction for lower costs.
- Highly compliant, very low load seal. Generally used unplated.
- Five standard sections and any diameter from 45 mm to 1,2 m (larger on request).
- Radiused footprint area protects mating surfaces.
- Fully elastic working envelope for consistent performance over many compression/extension cycles. Defined fatigue life.
- Available in a choice of high strength/high temperature nickel alloys.
- Available with HVOF (High Velocity Oxygen Flame) anti-gall coating.



E-Rings are available with additional convolutions for even greater springback.

Cavity Dimensions

C SEAL FREE HEIGHT	D I.D. RANGE tolerance h10	F DEPTH RANGE	G MINIMUM WIDTH	R MAXIMUM RADIUS
1,88	45,00 – 200,00	1,55 – 1,60	2,29	0,38
2,59	50,00 – 300,00	2,16 – 2,26	2,92	0,51
2,74	57,00 – 300,00	2,16 – 2,26	4,32	0,51
2,74	50,00 – 300,00	2,16 – 2,26	2,92	0,51
3,35	50,00 – 600,00	2,95 – 3,05	4,19	0,76
3,57	57,00 – 600,00	2,95 – 3,05	5,84	0,76
3,57	50,00 – 600,00	2,95 – 3,05	4,19	0,76
5,54	85,00 – 900,00	4,55 – 4,65	5,84	1,02
7,49	150,00 – 1200,00	6,20 – 6,35	8,00	1,52

All dimensions are in millimeters.
The Tolerance Reference table can be found on page E-22.

Seal and Cavity Sizing

Seal free height is based on cavity diameter and depth alone. Seal diameter (dimension A) is derived below.

$$A = D + Z$$ (tolerance H11, see page E-22)

Where: D = Maximum cavity I.D.
Z = Diametral clearance between cavity and seal

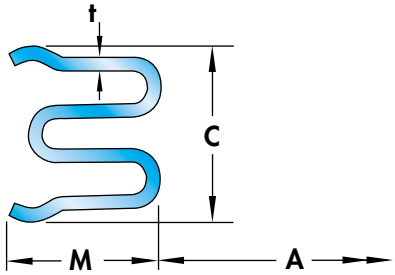
Part Numbering

Refer to page A-2 for part numbering convention. The seal size is specified in the part number as follows:

MEE - 000000 - 00 - 00 - 0

EnerRing Cross Section Code

Seal I.D. (dimension A) to two decimal places
(Example: A 70,00 mm seal is specified as 007000)



Seal Dimensions

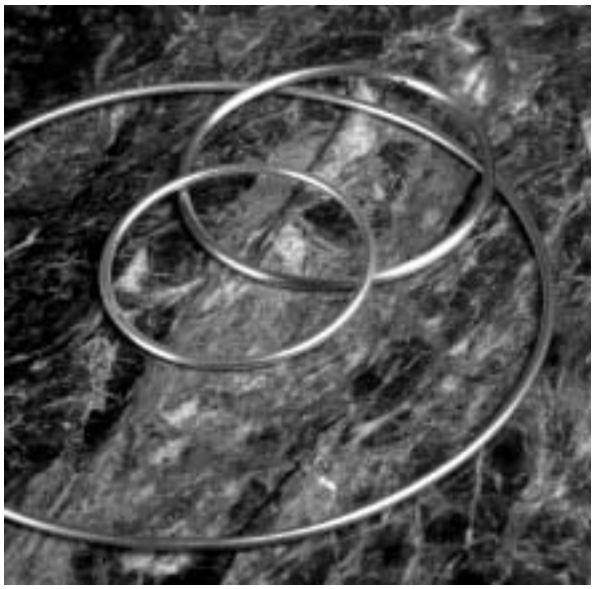
C SEAL FREE HEIGHT	Z DIAMETRAL CLEARANCE	t MATERIAL THICKNESS	M MAXIMUM RADIAL WIDTH	CROSS SECTION CODE
1,88 ± 0,08	0,08	0,13	1,68	05
2,59 ± 0,13	0,08	0,25	2,31	06
2,74 ± 0,13	0,08	0,25	3,68	07
2,74 ± 0,13	0,08	0,25	2,31	08
3,35 ± 0,13	0,13	0,38	3,10	11
3,57 ± 0,10	0,13	0,30	4,90	09
3,57 ± 0,10	0,13	0,30	3,10	10
5,54 ± 0,13	0,15	0,38	4,83	13
7,49 ± 0,15	0,20	0,51	6,78	15

Performance

SEATING LOAD (N per mm circumference)	SPRINGBACK (mm)	WORKING PRESSURE RATING* (MPa)
5	0,30	10
5	0,38	10
7	0,53	10
16	0,45	35
13	0,35	38
8	0,57	10
11	0,57	25
9	0,94	15
14	1,21	15

All dimensions are in millimeters.
Performance data is based on Alloy 718 material with -6 treatment. Seal Performance is discussed in Section E.
* If working pressures exceed the above ratings consult us for recommendations.

MOI, MON and MOP Metal O-Rings, Internal Pressure Face Seal



Applications:

- Heavy joints with minimum movement.
- Static, low leakage face sealing.
- Contiguous sealing surface permits use within triple-surface, chamfered joints and non-rectangular section grooves.

Selection of Types:

MOI: *(preferred)* internally vented and pressure-energized: recommended for high pressures. (Refer to performance table on facing page).

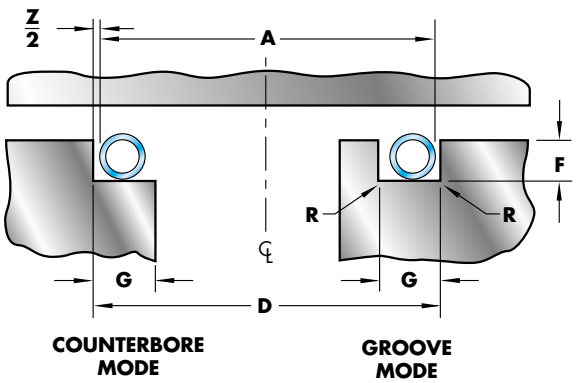
MON*: *(preferred)* non-vented, non-filled: avoids ingress of working fluid(s) into the seal, lowest cost, but pressure capability is reduced. (Refer to performance table on facing page).

MOP*: *(optional)* non-vented, gas pressure-filled. Good for bi-directional (reversing) pressures. Avoids ingress of working fluid(s) into the seal. Enhances load at high temperatures.

*Not for use in applications with a very high ambient pressure (drill string equipment, and under-sea applications).

Features:

- Many tubing material choices and plating options available for widest media compatibility.
- Standard metal O-Rings available for all 'MS' sizes and configurations (see pages C-35 to C-40).
- Over thirty years proven service in nuclear pressure vessel closure head sealing (see page C-26).
- All welds are 100% fluorescent penetrant inspected.
- Eleven standard free heights and any diameter from 6,35 mm to 7,6 m.
- High sealing load creates excellent plating compression and superior sealing.
- Robust, high integrity seal for ease of handling, even in largest sizes.



Cavity Dimensions

C SEAL FREE HEIGHT	D O.D. RANGE tolerance H10	F DEPTH RANGE	G MINIMUM WIDTH	R MAXIMUM RADIUS
0,89	6,35 – 25,00	0,64 – 0,69	1,40	0,25
1,19	10,00 – 50,00	0,94 – 1,02	1,78	0,30
1,57	13,00 – 200,00	1,14 – 1,27	2,29	0,38
2,39	25,00 – 400,00	1,88 – 2,01	3,18	0,51
3,18	38,00 – 600,00	2,54 – 2,67	4,06	0,76
3,96	75,00 – 750,00	3,18 – 3,30	5,08	1,27
4,78	100,00 – 900,00	3,84 – 3,99	6,35	1,27
6,35	200,00 – 1200,00	5,08 – 5,28	8,89	1,52
9,53	300,00 – 2000,00	8,26 – 8,51 (max. range 7,62 – 8,76)	12,70	1,52
12,70	800,00 – 7600,00	11,05 – 11,43 (max. range 10,16 – 11,68)	16,51	1,52
15,88	1500,00 – 7600,00	13,72 – 14,22 (max. range 12,70 – 14,61)	20,57	1,52

All dimensions are in millimeters.
The Tolerance Reference table can be found on page E-22.

Seal and Cavity Sizing

Seal free height is based on cavity diameter and depth alone. Seal diameter (dimension A) is derived below.

$$A = D - Z - 2P_{max}$$

Where: D = Minimum cavity O.D.
Z = Diametral clearance between cavity and seal
P_{max} = Maximum plating thickness (from page D-7)

SEAL TOLERANCE	
FREE HEIGHT	SEAL DIAMETER (A) TOLERANCE (-0,00)
0,89 - 4,78	+0,13
6,35	+0,20
9,53 - 15,88	+0,25

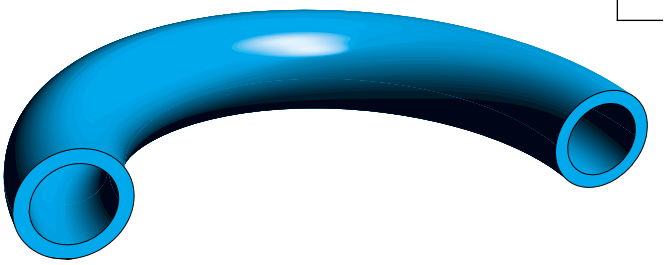
Part Numbering

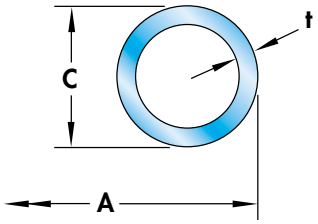
Refer to page A-2 for part numbering convention. The seal size is specified in the part number as follows:

MO [I, N or P] - 000000 - 00 - 00 - 0 - XXX

EnerRing Cross Section Code

Seal O.D. prior to plating (dimension A) to two decimal places
(Example: A 70,00 mm seal is specified as 007000)





Seal Dimensions

C SEAL FREE HEIGHT	Z DIAMETRAL CLEARANCE	t MATERIAL THICKNESS	CROSS SECTION CODE
0,89 +0,08 -0,03	0,18	0,15	01
1,19 +0,08 -0,03	0,20	0,18	29
1,57 +0,08 -0,03	0,20	0,15	02
		0,25	03
		0,30	31
		0,36	08
2,39 +0,08 -0,03	0,23	0,15	04
		0,25	05
		0,30	32
		0,46	09
3,18 +0,08 -0,03	0,28	0,20	06
		0,25	07
		0,30	25
		0,51	10
3,96 +0,10 -0,00	0,33	0,41	11
		0,51	12
4,78 +0,13 -0,00	0,36	0,51	13
		0,64	14
6,35 +0,13 -0,00	0,46	0,64	15
		0,81	16
9,53 +0,13 -0,00	0,64	0,97	17
		1,24	18
12,70 +0,15 -0,00	0,76	1,27	19
		1,65	20
15,88 +0,15 -0,00	0,76	1,60	21

Performance

SEATING LOAD (N/mm circumf)		SPRINGBACK (mm)		WORKING PRESSURE RATING† (MPa) VENTED		WORKING PRESSURE RATING† (MPa) NON-VENTED	
304SS*/ 321SS	Alloy X-750/ Alloy 718*	304SS*/ 321SS	Alloy X-750/ Alloy 718*	304SS*/ 321SS	Alloy X-750/ Alloy 718*	304SS*/ 321SS	Alloy X-750/ Alloy 718*
70	100	0,01	0,01	70	100	5	7
70	100	0,03	0,03	50	70	5	7
50	60	0,04	0,05	30	45	4	6
100	130	0,03	0,04	80	110	5	7
140	190	0,03	0,03	100	140	5	8
190	260	0,03	0,03	120	170	6	8
30	40	0,05	0,05	10	15	5	7
50	70	0,05	0,05	30	40	6	8
70	100	0,03	0,04	40	70	6	8
210	280	0,03	0,04	110	170	6	9
20	20	0,10	0,13	15	30	3	5
30	40	0,08	0,10	30	40	3	6
50	70	0,05	0,08	40	70	4	6
160	210	0,05	0,05	110	170	5	7
70 *	100	0,10 *	0,13	30 *	40	5 *	7
130 *	180	0,08 *	0,10	90 *	140	5 *	8
80 *	110	0,10 *	0,13	30 *	40	5 *	7
120 *	170	0,08 *	0,10	100 *	150	5 *	8
80 *	110	0,13 *	0,15	30 *	40	5 *	7
170 *	230	0,10 *	0,13	90 *	140	5 *	8
110 *	180 *	0,15 *	0,23 *	30 *	60 *	8 *	11 *
190 *	300 *	0,13 *	0,18 *	50 *	100 *	9 *	14 *
180 *	420 *	0,23 *	0,43 *	30 *	60 *	8 *	11 *
300 *	670 *	0,18 *	0,30 *	50 *	100 *	9 *	14 *
250 *	580 *	0,28 *	0,51 *	30 *	60 *	8 *	11 *

All dimensions are in millimeters and prior to plating. Shaded boxes indicate standard cross section code.
† If working pressures exceed the above ratings consult us for recommendations. Seal Performance is discussed in Section E.

MOE, MOM and MOR Metal O-Rings, External Pressure Face Seal

Selection of Types:

MOE: *(preferred)* externally vented and pressure-energized: recommended for high pressures. (Refer to performance table on facing page).

MOM*: *(preferred)* non-vented, non-filled: avoids ingress of working fluid(s) into the seal, lowest costs, but reduces pressure capability. (Refer to performance table on facing page).

MOR*: *(optional)* non-vented, gas pressure-filled. Good for bi-directional (reversing) pressures. Avoids ingress of working fluid(s) into the seal. Enhances load at high temperatures.

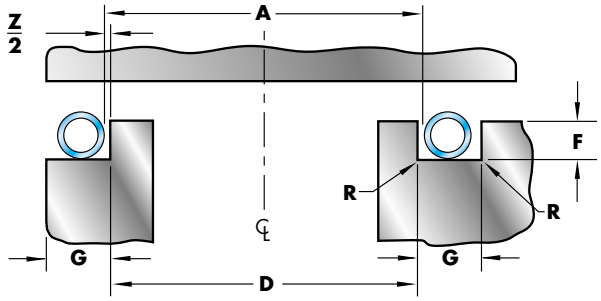
*Not for use in applications with a very high ambient pressure (drill string equipment, and under-sea applications).

Applications:

- Heavy joints with minimum movement.
- Static, low leakage face sealing.
- Contiguous sealing surface permits use within triple-surface, chamfered joints and non-rectangular section grooves.

Features:

- Many tubing material choices and plating options available for widest media compatibility.
- All welds are 100% fluorescent penetrant inspected.
- Eleven standard free heights and any diameter from 5 mm to 7,6 m.
- High sealing load creates excellent plating compression and superior sealing.
- Robust, high integrity seal for ease of handling, even in largest sizes.



Cavity Dimensions

C SEAL FREE HEIGHT	D I.D. RANGE tolerance h10	F DEPTH RANGE	G MINIMUM WIDTH	R MAXIMUM RADIUS
0,89	5,00 – 25,00	0,64 – 0,69	1,40	0,25
1,19	8,00 – 50,00	0,94 – 1,02	1,78	0,30
1,57	10,00 – 200,00	1,14 – 1,27	2,29	0,38
2,39	20,00 – 400,00	1,88 – 2,01	3,18	0,51
3,18	32,00 – 600,00	2,54 – 2,67	4,06	0,76
3,96	70,00 – 750,00	3,18 – 3,30	5,08	1,27
4,78	95,00 – 900,00	3,84 – 3,99	6,35	1,27
6,35	190,00 – 1200,00	5,08 – 5,28	8,89	1,52
9,53	300,00 – 2000,00	8,26 – 8,51 (max. range 7,62 – 8,76)	12,70	1,52
12,70	800,00 – 7600,00	11,05 – 11,43 (max. range 10,16 – 11,68)	16,51	1,52
15,88	1500,00 – 7600,00	13,72 – 14,22 (max. range 12,70 – 14,61)	20,57	1,52

All dimensions are in millimeters.
The Tolerance Reference table can be found on page E-22.

Seal and Cavity Sizing

Seal free height is based on cavity diameter and depth alone. Seal diameter (dimension A) is derived below.

$$A = D + Z + 2P_{max}$$

Where:
- D = Maximum cavity I.D.
- Z = Diametral clearance between cavity and seal
- P_{max} = Maximum plating thickness (from page D-7)

SEAL TOLERANCE	
FREE HEIGHT	SEAL DIAMETER (A) TOLERANCE (-0,00)
0,89 - 4,78	+0,13
6,35	+0,20
9,53 - 15,88	+0,25

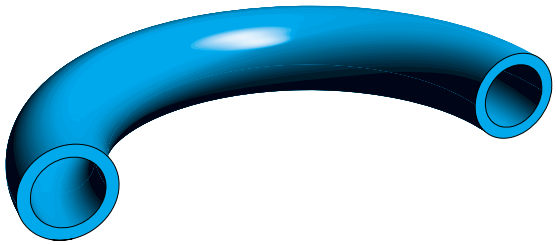
Part Numbering

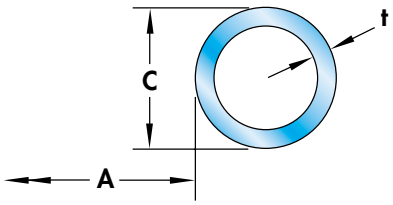
Refer to page A-2 for part numbering convention. The seal size is specified in the part number as follows:

MO [E, M or R] - 000000 - 00 - 00 - 0 - XXX

EnerRing Cross Section Code

Seal I.D. prior to plating (dimension A) to two decimal places
(Example: A 70,00 mm seal is specified as 007000)





Seal Dimensions

C SEAL FREE HEIGHT	Z DIAMETRAL CLEARANCE	t MATERIAL THICKNESS	CROSS SECTION CODE
0,89 $^{+0,08}_{-0,03}$	0,18	0,15	01
1,19 $^{+0,08}_{-0,03}$	0,20	0,18	29
1,57 $^{+0,08}_{-0,03}$	0,20	0,15	02
		0,25	03
		0,30	31
		0,36	08
2,39 $^{+0,08}_{-0,03}$	0,23	0,15	04
		0,25	05
		0,30	32
		0,46	09
3,18 $^{+0,08}_{-0,03}$	0,28	0,20	06
		0,25	07
		0,30	25
		0,51	10
3,96 $^{+0,10}_{-0,00}$	0,33	0,41	11
		0,51	12
4,78 $^{+0,13}_{-0,00}$	0,36	0,51	13
		0,64	14
6,35 $^{+0,13}_{-0,00}$	0,46	0,64	15
		0,81	16
9,53 $^{+0,13}_{-0,00}$	0,64	0,97	17
		1,24	18
12,70 $^{+0,15}_{-0,00}$	0,76	1,27	19
		1,65	20
15,88 $^{+0,15}_{-0,00}$	0,76	1,60	21

Performance

SEATING LOAD (N/mm circumf)		SPRINGBACK (mm)		WORKING PRESSURE RATING† (MPa)			
				VENTED		NON-VENTED	
304SS*/ 321SS	Alloy X-750/ Alloy 718*	304SS*/ 321SS	Alloy X-750/ Alloy 718*	304SS*/ 321SS	Alloy X-750/ Alloy 718*	304SS*/ 321SS	Alloy X-750/ Alloy 718*
70	100	0,01	0,01	70	100	5	7
70	100	0,03	0,03	50	70	5	7
50	60	0,04	0,05	30	45	4	6
100	130	0,03	0,04	80	110	5	7
140	190	0,03	0,03	100	140	5	8
190	260	0,03	0,03	120	170	6	8
30	40	0,05	0,05	10	15	5	7
50	70	0,05	0,05	30	40	6	8
70	100	0,03	0,04	40	70	6	8
210	280	0,03	0,04	110	170	6	9
20	20	0,10	0,13	15	30	3	5
30	40	0,08	0,10	30	40	3	6
50	70	0,05	0,08	40	70	4	6
160	210	0,05	0,05	110	170	5	7
70 *	100	0,10 *	0,13	30 *	40	5 *	7
130 *	180	0,08 *	0,10	90 *	140	5 *	8
80 *	110	0,10 *	0,13	30 *	40	5 *	7
120 *	170	0,08 *	0,10	100 *	150	5 *	8
80 *	110	0,13 *	0,15	30 *	40	5 *	7
170 *	230	0,10 *	0,13	90 *	140	5 *	8
110 *	180 *	0,15 *	0,23 *	30 *	60 *	8 *	11 *
190 *	300 *	0,13 *	0,18 *	50 *	100 *	9 *	14 *
180 *	420 *	0,23 *	0,43 *	30 *	60 *	8 *	11 *
300 *	670 *	0,18 *	0,30 *	50 *	100 *	9 *	14 *
250 *	580 *	0,28 *	0,51 *	30 *	60 *	8 *	11 *

All dimensions are in millimeters and prior to plating. Shaded boxes indicate standard cross section code.
† If working pressures exceed the above ratings consult us for recommendations. Seal Performance is discussed in Section E.

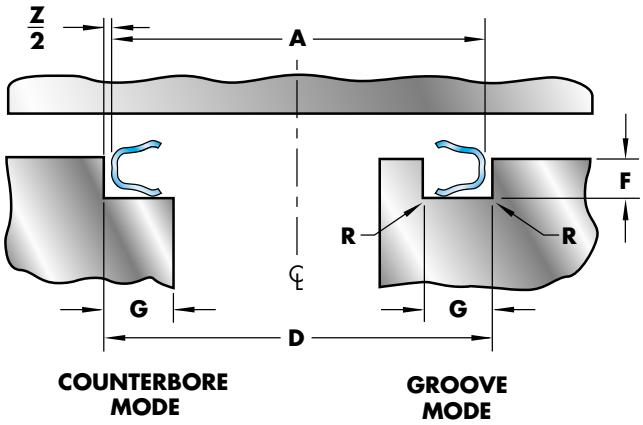
MUI Metal U-Ring, Internal Pressure Face Seal

Applications:

- High temperature joints with significant movement.
- Up to 28 MPa working pressure.
- Up to 870°C.
- Retrofittable in (2,36 mm seal free height and larger) metal O-Ring grooves for lower load and greater springback.

Features:

- Compliant low load seal, generally used unplated.
- Five standard free heights and any diameter from 45 mm to 1,2 m.
- Radiused footprint area protects mating surfaces.
- Good all round performance, economically priced.



Cavity Dimensions

C	D	F	G	R
SEAL FREE HEIGHT	O.D. RANGE tolerance H10	DEPTH RANGE	MINIMUM WIDTH	MAXIMUM RADIUS
1,60	45,00 – 200,00	1,27 – 1,37	2,29	0,38
2,36	57,00 – 400,00	1,88 – 2,03	3,18	0,51
3,18	65,00 – 800,00	2,54 – 2,72	4,06	0,76
4,70	85,00 – 900,00	3,81 – 3,99	6,35	1,27
6,27	150,00 – 1200,00	5,08 – 5,28	8,89	1,52

All dimensions are in millimeters.
The Tolerance Reference table can be found on page E-22.

Seal and Cavity Sizing

Seal free height is based on cavity diameter and depth alone. Seal diameter (dimension A) is derived below.

A = D - Z (tolerance h11, see page E-22)

Where: D = Minimum cavity O.D.
Z = Diametral clearance between cavity and seal

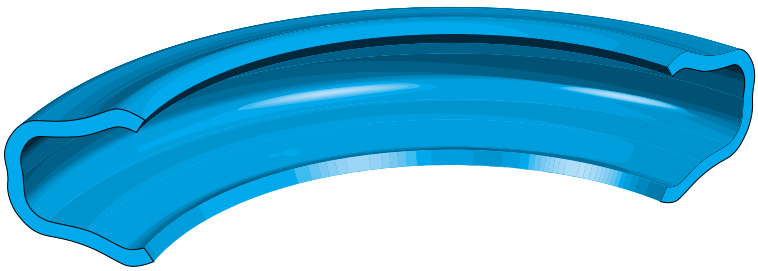
Part Numbering

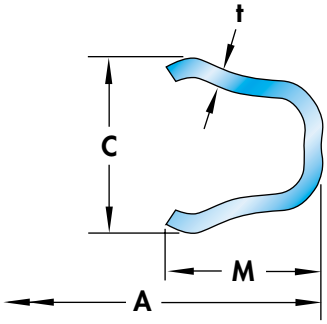
Refer to page A-2 for part numbering convention. The seal size is specified in the part number as follows:

MUI - 000000 - 00 - 00 - 0

EnerRing Cross Section Code

Seal O.D. (dimension A) to two decimal places
(Example: A 70,00 mm seal is specified as 007000)





Seal Dimensions

C SEAL FREE HEIGHT	Z DIAMETRAL CLEARANCE	t MATERIAL THICKNESS	M MAXIMUM RADIAL WIDTH	CROSS SECTION CODE
1,60 ± 0,08	0,08	0,15	1,68	05
2,36 ± 0,10	0,08	0,25	2,49	07
3,18 ± 0,13	0,13	0,30	3,33	09
4,70 ± 0,13	0,15	0,38	5,03	13
6,27 ± 0,15	0,20	0,51	6,65	15

Performance

SEATING LOAD (N per mm circumference)	SPRINGBACK (mm)	WORKING PRESSURE RATING* (MPa)
5	0,15	26
8	0,25	28
9	0,36	28
9	0,51	24
12	0,66	24

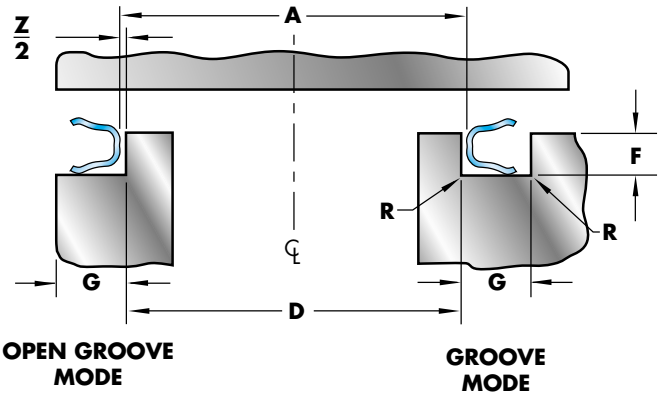
All dimensions are in millimeters.
Performance data is based on Alloy 718 material with -6 treatment. Seal Performance is discussed in Section E.

* If working pressures exceed the above ratings consult us for recommendations.

MUE Metal U-Ring, External Pressure Face Seal

Applications:

- High temperature joints with significant movement.
- Up to 28 MPa working pressure.
- Up to 870°C.
- Retrofittable in (2,36 mm seal free height and larger) metal O-Ring grooves for lower load and greater springback.



Features:

- Compliant low load seal, generally used unplated.
- Five standard free heights and any diameter from 45 mm to 1,2 m.
- Radiused footprint area protects mating surfaces.
- Good all round performance, economically priced.

Cavity Dimensions

C	D	F	G	R
SEAL FREE HEIGHT	I.D. RANGE tolerance h10	DEPTH RANGE	MINIMUM WIDTH	MAXIMUM RADIUS
1,60	45,00 – 200,00	1,27 – 1,37	2,29	0,38
2,36	57,00 – 400,00	1,88 – 2,03	3,18	0,51
3,18	65,00 – 800,00	2,54 – 2,72	4,06	0,76
4,70	85,00 – 900,00	3,81 – 3,99	6,35	1,27
6,27	150,00 – 1200,00	5,08 – 5,28	8,89	1,52

All dimensions are in millimeters.
The Tolerance Reference table can be found on page E-22.

Seal and Cavity Sizing

Seal free height is based on cavity diameter and depth alone. Seal diameter (dimension A) is derived below.

$$A = D + Z$$ (tolerance H11, see page E-22)

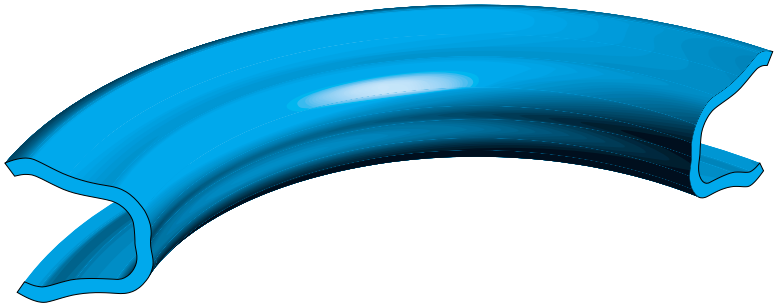
Where: D = Maximum cavity I.D.
Z = Diametral clearance between cavity and seal

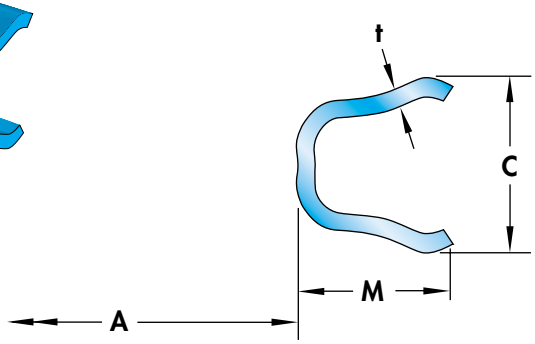
Part Numbering

Refer to page A-2 for part numbering convention. The seal size is specified in the part number as follows:

MUE - 000000 - 00 - 00 - 0

- 00 — EnerRing Cross Section Code
- 000000 — Seal I.D. (dimension A) to two decimal places (Example: A 70,00 mm seal is specified as 007000)





Seal Dimensions

C SEAL FREE HEIGHT	Z DIAMETRAL CLEARANCE	t MATERIAL THICKNESS	M MAXIMUM RADIAL WIDTH	CROSS SECTION CODE
1,60 ± 0,08	0,08	0,15	1,68	05
2,36 ± 0,10	0,08	0,25	2,49	07
3,18 ± 0,13	0,13	0,30	3,33	09
4,70 ± 0,13	0,15	0,38	5,03	13
6,27 ± 0,15	0,20	0,51	6,65	15

Performance

SEATING LOAD (N per mm circumference)	SPRINGBACK (mm)	WORKING PRESSURE RATING* (MPa)
5	0,15	26
8	0,25	28
9	0,36	28
9	0,51	24
12	0,66	24

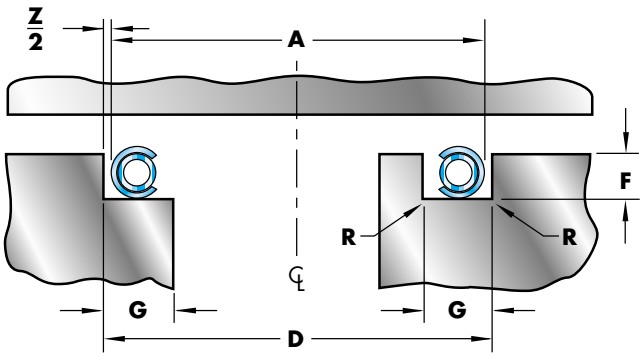
All dimensions are in millimeters.
Performance data is based on Alloy 718 material with -6 treatment. Seal Performance is discussed in Section E.

* If working pressures exceed the above ratings consult us for recommendations.

MSI Spring Energized Metal C-Ring, Internal Pressure Face Seal

Applications:

- Similar to MCI, but higher loads for use with rougher mating surfaces.
- Excellent for pressure vessel closures; manways, hand-holes; steam generators, petrol/diesel engine fire rings, exhaust joints, flanges with circular lay.
- Best choice for non-flat mating surfaces.
- For internally pressurized joints.
- For externally pressurized joints to avoid ingress of working fluid into the seal cavity (reduced working pressure rating).



Features:

- Lowest leak rate.
- Internal spring provides high pressure capabilities of up to 650 MPa.
- All plating options available.
- Excellent footprint with good plastic flow of plating material.
- Available in any diameter from 20 mm to 7,6 m, plus hundreds of preferred sizes (see page E-18).
- Wide range of 8 standard free heights from 1,57 mm to 12,70 mm.
- Multiple material choices for high temperature strength, good springback, corrosion and fatigue resistance.
- Uses jacket forces, spring forces and hydrostatic forces additively, to increase sealing forces at higher pressures.
- Circular, race-track, and other custom shapes available. Tri-lobed or elliptical Spring Energized C-Rings available for snap-in/snap-out convenience.

Cavity Dimensions

C SEAL FREE HEIGHT	D O.D. RANGE tolerance H10	F DEPTH RANGE	G MINIMUM WIDTH	R MAXIMUM RADIUS
1,57	20,00 – 200,00	1,27 – 1,37	2,29	0,38
2,39	25,00 – 400,00	1,91 – 2,01	3,18	0,51
3,18	25,00 – 600,00	2,54 – 2,67	4,06	0,76
3,96	32,00 – 750,00	3,18 – 3,30	5,08	1,27
4,78	75,00 – 900,00	3,84 – 3,99	6,35	1,27
6,35	100,00 – 1800,00	5,08 – 5,28	8,89	1,52
9,53	300,00 – 3000,00	7,62 – 8,03	12,70	1,52
12,70	600,00 – 7600,00	10,16 – 10,67	16,51	1,52

All dimensions are in millimeters.
The Tolerance Reference table can be found on page E-22.

Seal and Cavity Sizing

Seal free height is based on cavity diameter and depth alone. Seal diameter (dimension A) is derived below.

$$A = D - Z - 2P_{max}$$ (tolerance h11, see page E-22)

Where: D = Minimum cavity O.D.
Z = Diametral clearance between cavity and seal
P_{max} = Maximum plating thickness (from page D-7)

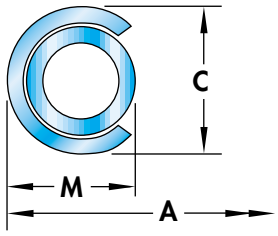
Part Numbering

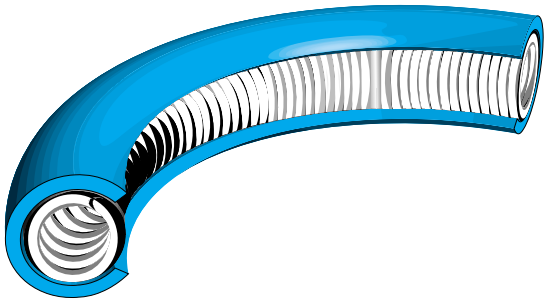
Refer to page A-2 for part numbering convention. The seal size is specified in the part number as follows:

MSI - 000000 - 00 - 00 - 0 - XXX

EnerRing Cross Section Code

Seal O.D. prior to plating (dimension A) to two decimal places
(Example: A 70,00 mm seal is specified as 007000)





Seal Dimensions

C SEAL FREE HEIGHT	Z DIAMETRAL CLEARANCE	M MAXIMUM RADIAL WIDTH	CROSS SECTION CODE
1,57 $^{+0,08}_{-0,05}$	0,15	1,50	05
2,39 $^{+0,10}_{-0,05}$	0,20	2,21	07
3,18 $^{+0,10}_{-0,08}$	0,30	2,90	09
3,96 $^{+0,10}_{-0,08}$	0,41	3,66	11
4,78 $^{+0,13}_{-0,10}$	0,46	4,39	13
6,35 $^{+0,15}_{-0,10}$	0,51	5,84	15
9,53 $^{+0,20}_{-0,10}$	0,76	8,69	17
12,70 $^{+0,25}_{-0,13}$	1,02	11,58	19

Performance

SEATING LOAD (N per mm circumference)	SPRINGBACK (mm)	WORKING PRESSURE RATING* (MPa)
90	0,08	450
150	0,13	450
170	0,15	650
230	0,20	450
260	0,23	500
350	0,28	400
440	0,43	400
510	0,56	400

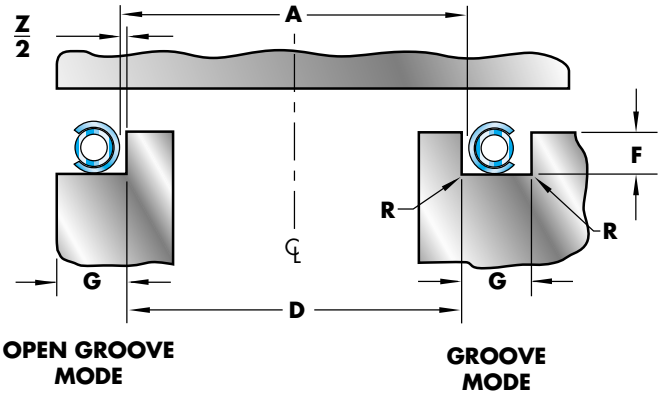
All dimensions are in millimeters and prior to plating.
Performance data is based on Alloy X-750 jacket and spring. Seal Performance is discussed in Section E.

* If working pressures exceed the above ratings consult us for recommendations.

MSE Spring Energized Metal C-Ring, External Pressure Face Seal

Applications:

- Similar to MCE, but higher loads for use with rougher mating surfaces.
- Externally pressurized joints. Flanges with circular lay.
- Internally pressurized joints to avoid ingress of working fluid into the seal cavity (reduced working pressure rating).



Features:

- Lowest leak rate.
- Internal spring provides high pressure capabilities of up to 650 MPa.
- All plating options available.
- Excellent footprint with good plastic flow of plating material.
- Available in any diameter from 17 mm to 7,6 m, plus hundreds of preferred sizes (see page E-18).
- Wide range of 8 standard free heights from 1,57 mm to 12,70 mm.
- Multiple material choices for high temperature strength, good springback, corrosion and fatigue resistance.
- Uses jacket forces, spring forces and hydrostatic forces additively, to increase sealing forces at higher pressures when used with external pressurization.
- Circular, race-track, and other custom shapes available. Tri-lobed or elliptical Spring Energized C-Rings available for snap-in/snap-out convenience.

Cavity Dimensions

C	D	F	G	R
SEAL FREE HEIGHT	I.D. RANGE tolerance h10	DEPTH RANGE	MINIMUM WIDTH	MAXIMUM RADIUS
1,57	17,00 – 200,00	1,27 – 1,37	2,29	0,38
2,39	23,00 – 400,00	1,91 – 2,01	3,18	0,51
3,18	25,00 – 600,00	2,54 – 2,67	4,06	0,76
3,96	32,00 – 750,00	3,18 – 3,30	5,08	1,27
4,78	75,00 – 900,00	3,84 – 3,99	6,35	1,27
6,35	100,00 – 1800,00	5,08 – 5,28	8,89	1,52
9,53	300,00 – 3000,00	7,62 – 8,03	12,70	1,52
12,70	600,00 – 7600,00	10,16 – 10,67	16,51	1,52

All dimensions are in millimeters.
The Tolerance Reference table can be found on page E-22.

Seal and Cavity Sizing

Seal free height is based on cavity diameter and depth alone. Seal diameter (dimension A) is derived below.

$$A = D + Z + 2P_{max}$$ (tolerance H11, see page E-22)

Where: D = Maximum cavity I.D.
Z = Diametral clearance between cavity and seal
P_{max} = Maximum plating thickness (from page D-7)

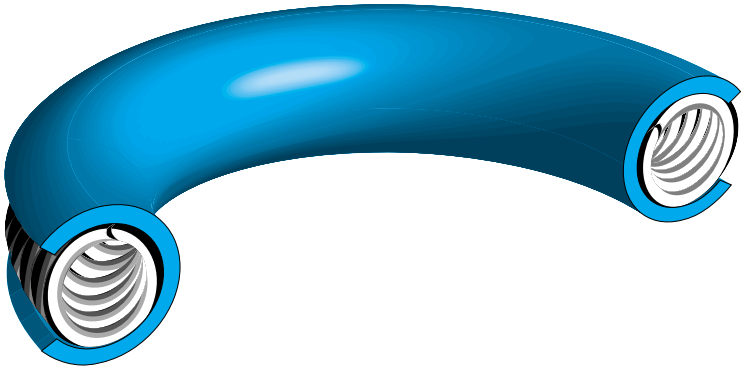
Part Numbering

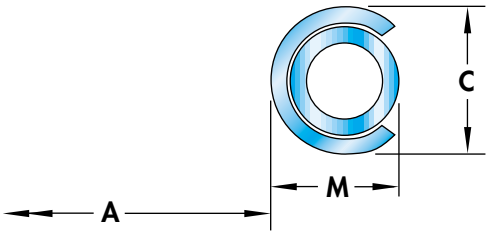
Refer to page A-2 for part numbering convention. The seal size is specified in the part number as follows:

MSE - 000000 - 00 - 00 - 0 - XXX

EnerRing Cross Section Code

Seal I.D. prior to plating (dimension A) to two decimal places
(Example: A 70,00 mm seal is specified as 007000)





Seal Dimensions

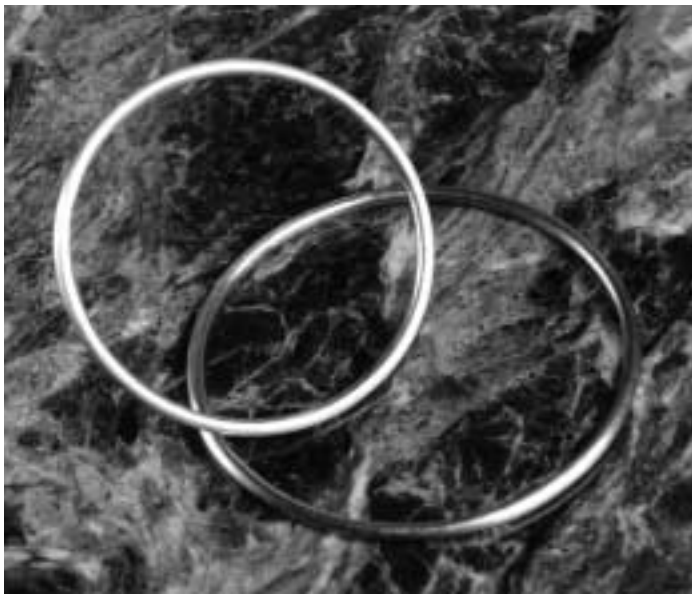
C SEAL FREE HEIGHT	Z DIAMETRAL CLEARANCE	M MAXIMUM RADIAL WIDTH	CROSS SECTION CODE
1,57 $^{+0,08}_{-0,05}$	0,15	1,50	05
2,39 $^{+0,10}_{-0,05}$	0,20	2,21	07
3,18 $^{+0,10}_{-0,08}$	0,30	2,90	09
3,96 $^{+0,10}_{-0,08}$	0,41	3,66	11
4,78 $^{+0,13}_{-0,10}$	0,46	4,39	13
6,35 $^{+0,15}_{-0,10}$	0,51	5,84	15
9,53 $^{+0,20}_{-0,10}$	0,76	8,69	17
12,70 $^{+0,25}_{-0,13}$	1,02	11,58	19

Performance

SEATING LOAD (N per mm circumference)	SPRINGBACK (mm)	WORKING PRESSURE RATING* (MPa)
90	0,08	450
150	0,13	450
170	0,15	650
230	0,20	450
260	0,23	500
350	0,28	400
440	0,43	400
510	0,56	400

All dimensions are in millimeters and prior to plating.
Performance data is based on Alloy X-750 jacket and spring. Seal Performance is discussed in Section E.
* If working pressures exceed the above ratings consult us for recommendations.

MWI Metal Wire Ring, Internal Pressure Face Seal

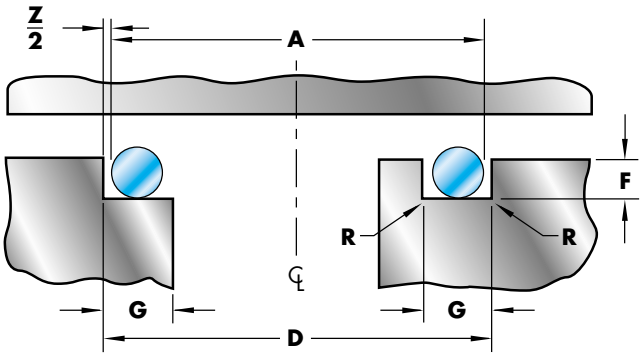


Applications:

- Low cost, high load 'crush' sealing.
- Contiguous sealing surface permits use within triple-surface, chamfered joints and non-rectangular section grooves.
- Best with rigid mating surfaces with minimum relative movement.
- Small process valves.
- Fits standard metal O-Ring grooves.

Features:

- Wide variety of material options.
- High pressure rating.
- Many other custom cross sections are available. Contact your local representative.



Cavity Dimensions

C	D	F	G	R
SEAL FREE HEIGHT	O.D. RANGE tolerance H10	DEPTH RANGE	MINIMUM WIDTH	MAXIMUM RADIUS
0,89	6,35 – 25,00	0,64 – 0,69	1,40	0,25
1,57	13,00 – 200,00	1,14 – 1,27	2,29	0,38
2,39	25,00 – 400,00	1,88 – 2,01	3,18	0,51
3,18	38,00 – 600,00	2,54 – 2,67	4,06	0,76

All dimensions are in millimeters.
The Tolerance Reference table can be found on page E-22.

Seal and Cavity Sizing

Seal free height is based on cavity diameter and depth alone. Seal diameter (dimension A) is derived below.

$$A = D - Z \quad \text{(tolerance} \pm 0{,}13\text{)}$$

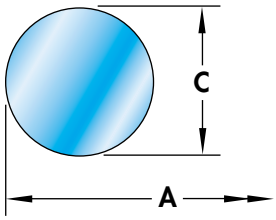
Where: D = Minimum cavity O.D.
Z = Diametral clearance between cavity and seal

Part Numbering

Refer to page A-2 for part numbering convention. The seal size is specified in the part number as follows:

MWI - 000000 - 00 - 00 - 0

- 00 — EnerRing Cross Section Code
- 000000 — Seal O.D. (dimension A) to two decimal places (Example: A 70,00 mm seal is specified as 007000)



Seal Dimensions

C SEAL FREE HEIGHT	Z DIAMETRAL CLEARANCE	CROSS SECTION CODE
0,89 $^{+0,08}_{-0,03}$	0,20	03
1,57 $^{+0,08}_{-0,03}$	0,28	05
2,39 $^{+0,08}_{-0,03}$	0,33	06
3,18 $^{+0,08}_{-0,03}$	0,43	07

Performance

SEATING LOAD (N per mm circumference)	SPRINGBACK (mm)	WORKING PRESSURE RATING (MPa)
740	0	140
1050	0,01	140
1050	0,03	140
1050	0,05	140

All dimensions are in millimeters.
Performance data is based on annealed 304 Stainless Steel. Seal Performance is discussed in Section E.

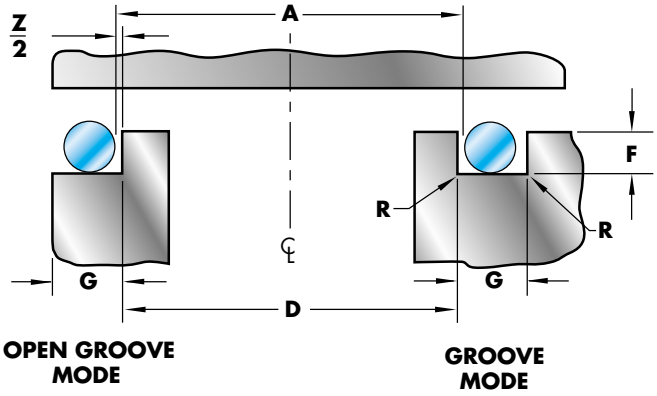
MWE Metal Wire Ring, External Pressure Face Seal

Applications:

- Low cost, high load 'crush' sealing.
- Contiguous sealing surface permits use within triple-surface, chamfered joints and non-rectangular section grooves.
- Best with rigid mating surfaces with minimum relative movement.
- Small process valves.
- Fits standard metal O-Ring grooves.

Features:

- Wide variety of material options.
- High pressure rating.
- Many other custom cross sections are available. Contact your local representative.



Cavity Dimensions

C	D	F	G	R
SEAL FREE HEIGHT	I.D. RANGE tolerance h10	DEPTH RANGE	MINIMUM WIDTH	MAXIMUM RADIUS
0,89	5,00 – 25,00	0,64 – 0,69	1,40	0,25
1,57	10,00 – 200,00	1,14 – 1,27	2,29	0,38
2,39	20,00 – 400,00	1,88 – 2,01	3,18	0,51
3,18	32,00 – 600,00	2,54 – 2,67	4,06	0,76

All dimensions are in millimeters.
The Tolerance Reference table can be found on page E-22.

Seal and Cavity Sizing

Seal free height is based on cavity diameter and depth alone. Seal diameter (dimension A) is derived below.

$$A = D + Z \quad \text{(tolerance} \pm 0{,}13\text{)}$$

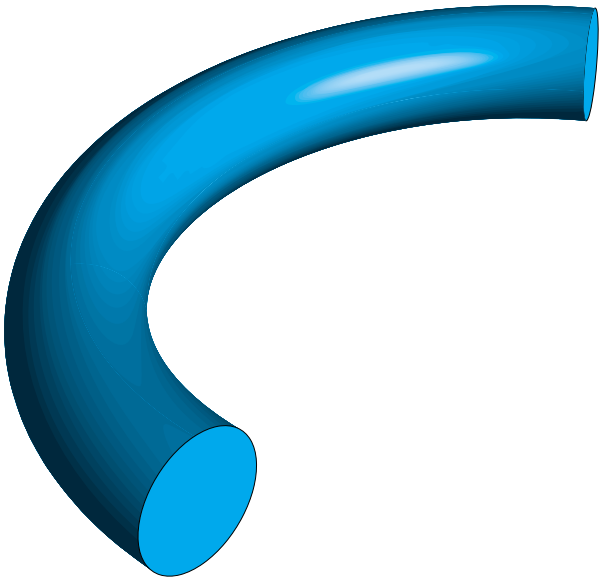
Where: D = Maximum cavity I.D.
Z = Diametral clearance between cavity and seal

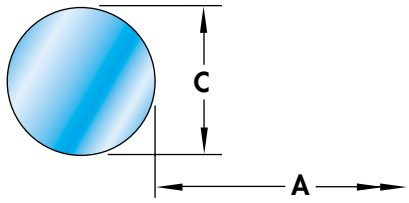
Part Numbering

Refer to page A-2 for part numbering convention. The seal size is specified in the part number as follows:

MWE - 000000 - 00 - 00 - 0

- 00 — EnerRing Cross Section Code
- 000000 — Seal I.D. (dimension A) to two decimal places (Example: A 70,00 mm seal is specified as 007000)





Seal Dimensions

C SEAL FREE HEIGHT	Z DIAMETRAL CLEARANCE	CROSS SECTION CODE
0,89 $^{+0,08}_{-0,03}$	0,20	03
1,57 $^{+0,08}_{-0,03}$	0,28	05
2,39 $^{+0,08}_{-0,03}$	0,33	06
3,18 $^{+0,08}_{-0,03}$	0,43	07

Performance

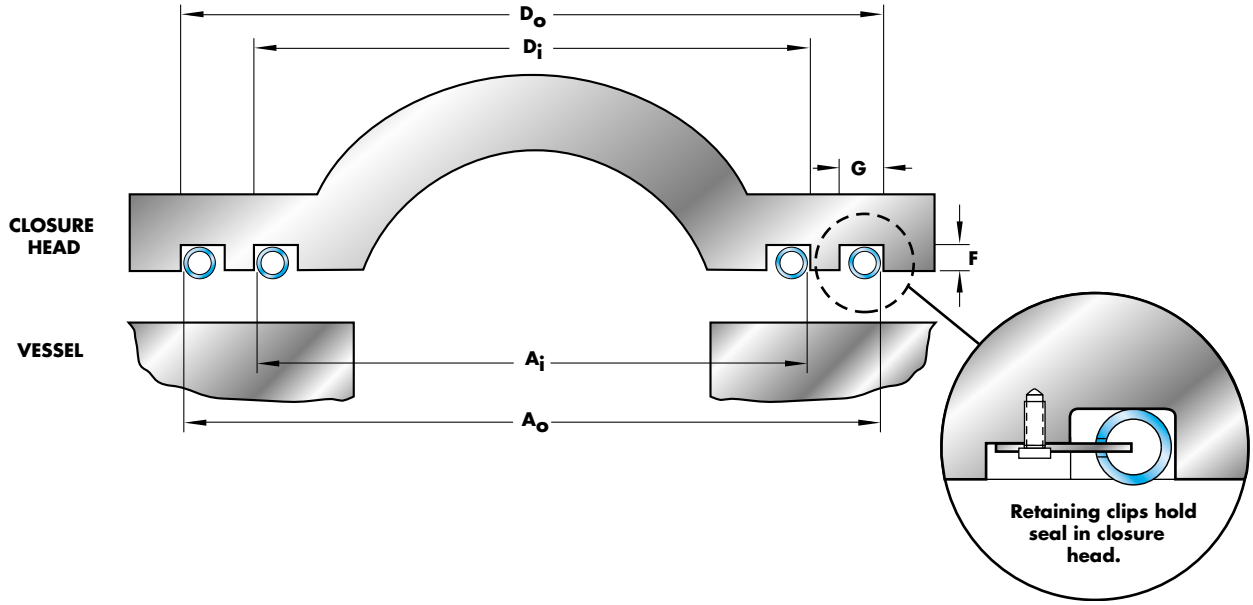
SEATING LOAD (N per mm circumference)	SPRINGBACK (mm)	WORKING PRESSURE RATING (MPa)
740	0	140
1050	0,01	140
1050	0,03	140
1050	0,05	140

All dimensions are in millimeters.
Performance data is based on annealed 304 Stainless Steel. Seal Performance is discussed in Section E.

MNI Nuclear Pressure Vessel Seal

Applications:

- Very high integrity metal O-Ring for Nuclear Reactor Pressure Vessel Closure Head sealing.
- Proven over 30 years, at more than 200 nuclear plants worldwide.
- Sizes available for every PWR & BWR in service.
- Retrofit sizes available to upgrade/enhance older installations.



Features:

- Uses highly reliable metal O-Ring technology: monolithic construction eliminates potential failure modes from sub-components.
- Internally vented and pressure energized for enhanced sealing load at working pressure and 'hydrotest'. Accurately positioned vent holes also serve as mounting locations.
- Guaranteed springback for optimum performance during plant transients.
- Highest grade vacuum remelt, age hardened alloy 718 tubing for excellent sealing stress/maximum footprint (304 stainless steel also available).
- Heavy electroplated silver directly bonded to tubing is not susceptible to delamination.
- Fully compatible with borated water.
- Robust, thick-walled tubing resists buckling during handling within containment. Requires minimum use of personnel in accordance with "ALARA".
- Seals may be ovalized for convenient crating and transport.
- Mounting hardware (clips, screws) available.
- All raw materials are held in our inventory for rapid response to an unplanned outage.
- Quality system complies with 10CFR50 Appendix B. All seals are supplied with comprehensive material, performance and radiographic certification package.
- Emergency Technical Support "hot-line" 24 hr/day, 365 day/year. Worldwide repair/replating service in the case of accidental damage.

Seal Sizing

Select seal free height according to cavity depth. Seal diameter (dimension A) is derived below:

$$A = D - 0{,}76 - 2P_{max}$$ Seal Diameter Tolerance: +0,25, -0,00

Where: D = Minimum cavity O.D. (as built)

P_{max} = Maximum plating thickness: 0,15 for silver plate G (SPG) or 0,23 for silver plate H (SPH)

Part Numbering

Every Advanced Products ENI Nuclear Pressure Vessel Seal Set (comprising inner and outer seals) is assigned a unique 5 digit drawing number for configuration control. Please contact us for a copy of the drawing applicable to your reactor. Additionally, all seals are serialized and fully traceable. The part number example below serves as a convenient reference and shorthand description only.

MNI - 600000/610000 - 19 - 14 - 6 - SPG - 24CR

- 600000: Inner seal O.D. prior to plating (dimension A_i specified to two decimal places)
- 610000: Outer seal O.D. prior to plating (dimension A_o specified to two decimal places)
- 19: Cross Section Code
- 14: Material Code (Alloy 718)
- 6: Temper Code (-6 solution annealed and age hardened only)
- SPG: Plating Code Silver Plate (G or H thickness only)
- 24CR: Number of critically positioned vent/mounting holes

Cavity Dimensions

Standard Cross Sections

F DEPTH RANGE Tolerance on selected depth (+0,13, -0,00)	G MINIMUM WIDTH
8,38 – 8,64	12,70
11,18 – 11,56	16,51
13,97 – 14,48	20,57

7,24 – 7,44	11,18
9,70 – 10,03	14,48
10,16 – 10,49	15,24

Seal Dimensions

C FREE HEIGHT (-0,00)	t MATERIAL THICKNESS	CROSS SECTION CODE
9,53 + 0,10	0,94 ± 0,10	17
12,70 + 0,13	1,27 ± 0,13	19
15,88 + 0,13	1,60 ± 0,15	21

8,23 + 0,10	0,81 ± 0,08	26
11,05 + 0,13	1,12 ± 0,10	27
11,56 + 0,13	1,17 ± 0,13	28

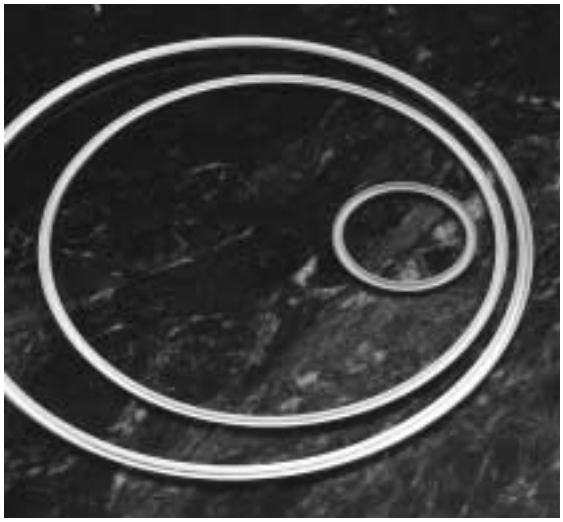
Performance

SEATING LOAD (N per mm circumference)	SPRINGBACK (mm)
400	0,28
440	0,36
470	0,46

320	0,23
420	0,30
440	0,33

Performance data is for Alloy 718 at nominal 10% compression. Depth range defines the limits for preferred compressions of 8-12%. Please contact us for review of applications using MNI Metal O-Rings beyond these limits. All dimensions are in millimeters and prior to plating.

MCA Metal C-Ring, Axial Seal

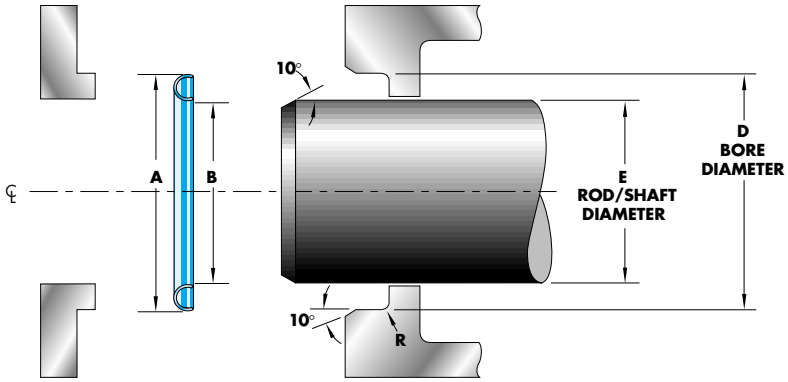


Applications:

- Static and low cycle dynamic axial sealing.
- Fire-safe quarter turn valve stem sealing: up to 30,000 operating cycles.
- 'Plug-in' connector sealing.
- High temperature sealing of mechanical seal to shaft interface.

Features:

- Close tolerance seal for light installation loads.
- Plating provides low wear characteristics on quarter turn applications.



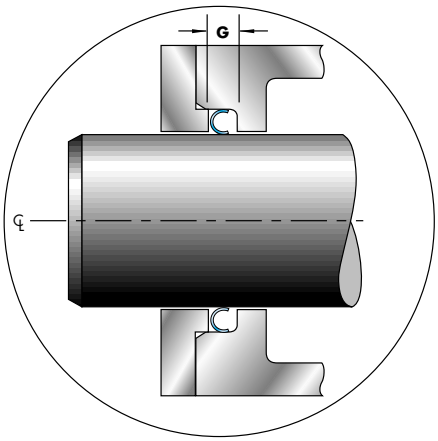
Cavity Requirements:

- Requires careful control of diametral tolerances and concentricity between bore and shaft.

BORE DIAMETER D	CONCENTRICITY ◎
≤ 85,00	0,015
> 85,00	0,03

- Static mating surfaces should be 0,4 µm R_a or smoother, 60 Rc.
- Dynamic mating surfaces should be 0,2 µm R_a or smoother, 60 Rc.

INSTALLED VIEW



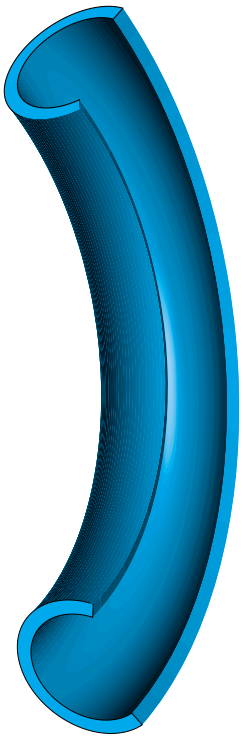
Cavity Dimensions

CROSS SECTION CODE	D BORE DIAMETER RANGE	D BORE DIAMETER tol.	E ROD/SHAFT DIAMETER	E ROD/SHAFT DIAMETER tol.	G MIN. WIDTH	R MAX. RADIUS
05	(12,70 – 38,00)	+0,03 -0,00	(D_{min} – 3,12)	+0,00 -0,03	1,30	0,38
	(38,01 – 45,00)	+0,03 -0,00	(D_{min} – 3,07)	+0,00 -0,03	1,30	0,38
07	(30,00 – 38,00)	+0,03 -0,00	(D_{min} – 4,70)	+0,00 -0,03	1,98	0,51
	(38,01 – 85,00)	+0,03 -0,00	(D_{min} – 4,65)	+0,00 -0,03	1,98	0,51
09	(50,00 – 85,00)	+0,03 -0,00	(D_{min} – 6,25)	+0,00 -0,03	2,64	0,76
	(85,01 – 150,00)	+0,05 -0,00	(D_{min} – 6,15)	+0,00 -0,05	2,64	0,76
	(150,01 – 200,00)	+0,05 -0,00	(D_{min} – 6,05)	+0,00 -0,05	2,64	0,76
11	(85,00 – 150,00)	+0,05 -0,00	(D_{min} – 7,72)	+0,00 -0,05	3,28	1,27
	(150,01 – 250,00)	+0,05 -0,00	(D_{min} – 7,62)	+0,00 -0,05	3,28	1,27
13	(100,00 – 150,00)	+0,05 -0,00	(D_{min} – 9,32)	+0,00 -0,05	3,96	1,27
	(150,01 – 300,00)	+0,05 -0,00	(D_{min} – 9,22)	+0,00 -0,05	3,96	1,27
15	(150,00 – 300,00)	+0,05 -0,00	(D_{min} – 12,40)	+0,00 -0,05	5,28	1,52

All dimensions are in millimeters.

Seal and Cavity Sizing

From Bore Diameter (dim. D) derive the Rod/Shaft Diameter (dim. E) and Seal O.D. (dim. A) using the tables below.

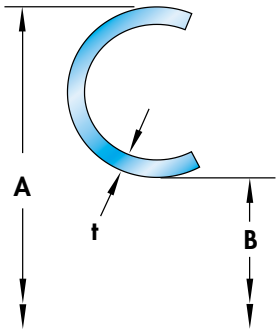


Part Numbering

Refer to page A-2 for part numbering convention. The seal size is specified in the part number as follows:

MCA - 000000 - 00 - 00 - 0 - XXA

- Standard plating thickness for ECA seal is 0,01 to 0,03 (thickness code A)
- EnerRing Cross Section Code
- Seal O.D. prior to plating (dimension A) to two decimal places (Example: A 70,00 mm seal is specified as 007000)



Seal Dimensions

A SEAL O.D.	tol.	B SEAL I.D.	tol.	t MATERIAL THICKNESS	CROSS SECTION CODE
(D_{min} + 0,08)	+0,03 -0,03	(A – 3,28)	+0,03 -0,03	0,15	05
(D_{min} + 0,10)	+0,08 -0,03	(A – 3,33)	+0,03 -0,08		
(D_{min} + 0,08)	+0,08 -0,03	(A – 4,90)	+0,03 -0,08	0,25	07
(D_{min} + 0,10)	+0,08 -0,03	(A – 4,90)	+0,03 -0,08		
(D_{min} + 0,10)	+0,13 -0,03	(A – 6,55)	+0,03 -0,13	0,38	09
(D_{min} + 0,15)	+0,10 -0,05	(A – 6,50)	+0,05 -0,10		
(D_{min} + 0,20)	+0,10 -0,05	(A – 6,45)	+0,05 -0,10		
(D_{min} + 0,15)	+0,10 -0,05	(A – 8,13)	+0,05 -0,10	0,41	11
(D_{min} + 0,20)	+0,15 -0,05	(A – 8,23)	+0,05 -0,15		
(D_{min} + 0,15)	+0,15 -0,05	(A – 9,83)	+0,05 -0,15	0,51	13
(D_{min} + 0,20)	+0,15 -0,05	(A – 9,73)	+0,05 -0,15		
(D_{min} + 0,20)	+0,20 -0,05	(A – 12,90)	+0,05 -0,20	0,64	15

All dimensions are in millimeters and prior to plating.
* If working pressures exceed the above ratings consult us for recommendations.

Pressure Rating

WORKING PRESSURE RATING * (MPa)
190
220
250
200
210
200

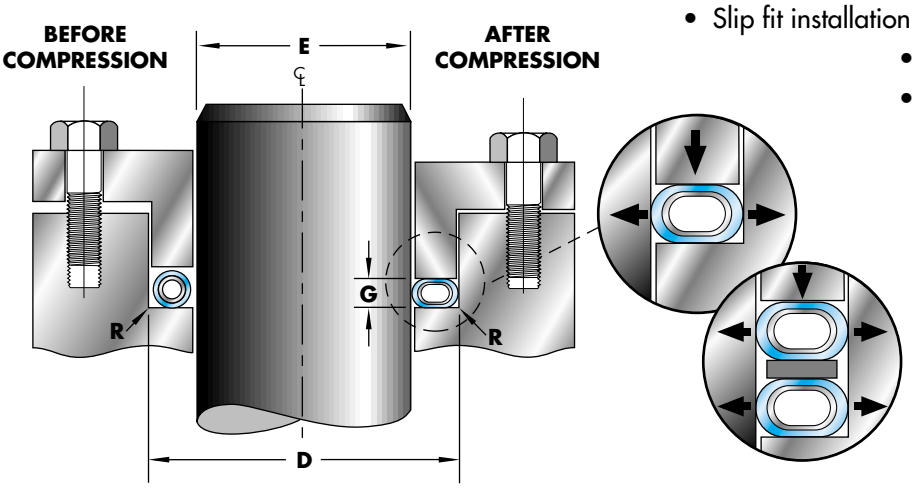
MSO Spring Energized Metal O-Ring (SEMOR), Axial Seal

Applications:

- Lowest leakage static axial sealing.
- Critical sealing of degraded surfaces using multiple redundant seals.
- High temperature sealing of mechanical seal to shaft interface.
- Triple or quadruple surface sealing.

Features:

- Uses proven O-Ring reliability supplemented by internal spring for combination of high load and high compliance.
- Efficient conversion of axial compression force to radial sealing force.
- High sealing stress for good plastic flow of plating and excellent footprint.
- Slip fit installation requires no lead in chamfer.
- Springback permits easy disassembly.
- 100% fluorescent penetrant inspected for total reliability.



Multiple seals may also be used in series for redundancy.

Cavity Dimensions

C	D		E		G	R
SEAL FREE HEIGHT	O.D. RANGE	tol.	ROD/SHAFT DIAMETER	tol.	MINIMUM DEPTH AFTER COMPRESSION	MAXIMUM RADIUS
2,39	25,00 – 100,00	+0,05 -0,00	D_{min} – 5,46	+0,00 -0,05	1,68	0,51
3,18	50,00 – 200,00	+0,08 -0,00	D_{min} – 7,14	+0,00 -0,08	2,24	0,76
3,96	100,00 – 250,00	+0,08 -0,00	D_{min} – 8,76	+0,00 -0,08	2,77	1,27
4,78	150,00 – 300,00	+0,10 -0,00	D_{min} – 10,54	+0,00 -0,10	3,35	1,27
6,35	200,00 – 400,00	+0,15 -0,00	D_{min} – 13,79	+0,00 -0,15	4,45	1,52

All dimensions are in millimeters.
The Tolerance Reference table can be found on page E-22.

Installation Requirements

AXIAL COMPRESSION FORCE (N per mm circumference)
210
280
350
530
790

Seal and Cavity Sizing

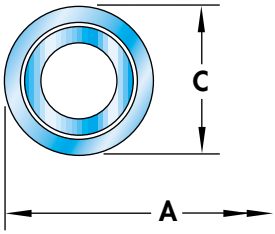
From Bore Diameter (dim. D) derive the Rod/Shaft Diameter (dim. E) and Seal O.D. (dim. A) using the tables below.

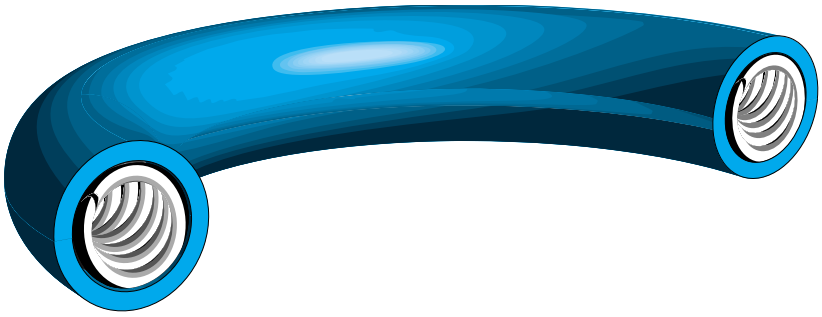
Part Numbering

Refer to page A-2 for part numbering convention. The seal size is specified in the part number as follows:

MSO - 000000 - 00 - 00 - 0 - XXX

- Required plating thickness code for MSO seal is provided in the table below
- EnerRing Cross Section Code
- Seal O.D. prior to plating (dimension A) to two decimal places (Example: A 70,00 mm seal is specified as 007000)





Seal Dimensions

C		A	PLATING		CROSS SECTION CODE
SEAL FREE HEIGHT		SEAL O.D. (+0,00, -0,10)	THICKNESS	THICKNESS CODE	
2,39	+0,08 -0,03	D_{min} – 0,23	0,08 – 0,10	F	05
3,18	+0,08 -0,03	D_{min} – 0,28	0,10 – 0,13	M	07
3,96	+0,10 -0,00	D_{min} – 0,28	0,10 – 0,13	M	11
4,78	+0,13 -0,00	D_{min} – 0,33	0,10 – 0,15	G	13
6,35	+0,13 -0,00	D_{min} – 0,38	0,13 – 0,18	K	15

All dimensions are in millimeters and prior to plating.
* If working pressures exceed the above ratings consult us for recommendations.

Pressure Rating

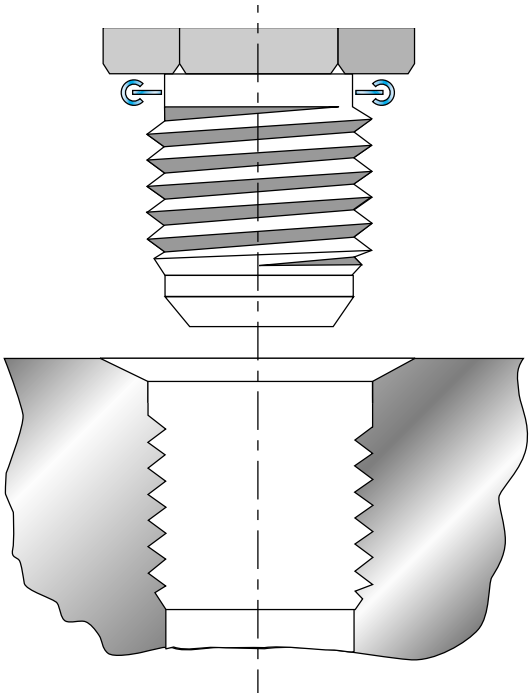
WORKING PRESSURE RATING* (MPa)
24
24
28
28
28

MBI Boss Seal

for MS-33649 Fluid Connection Boss and MS-33514/33656 Fitting Ends

Applications:

- Direct replacement/upgrade for elastomeric O-Rings on MS-33514 flared and MS-33656 flareless fitting ends, installed into MS-33649 fluid bosses.
- Temperatures to 650°C.
- System pressures to 35 MPa and above.
  (Seal is capable of higher pressures. Boss or fitting may be limiting item. Consult your local representative for assistance if pressures exceed 35 MPa.)



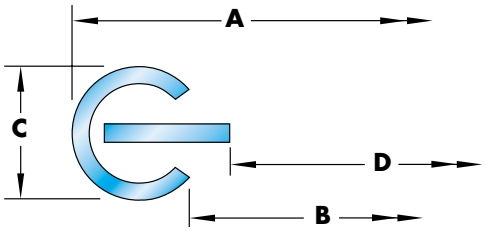
Features:

- No rework of boss or fitting is necessary.
- Utilizes proven silver plated alloy X-750 C-Ring technology.
- Washer engages with fitting threads for centering the seal in the boss.
- Designed for installation in either direction.
- Internally pressure-energized to maintain sealing stress. No need to retorque.
- Cannot extrude or fail due to ageing, pressure impulses, proof testing or extreme temperatures.
- Fully compatible with all hydraulic fluids and fuels. One seal type works for all fluids.
- Easy selection for all standard dash sizes.

Part Number/Ordering

Simply refer to the table below to determine the appropriate boss seal part number for the specific MS Dash Number.

The standard boss seal is made from Alloy X-750, work hardened, and silver plated to a thickness of 0,01 to 0,03 mm. Other materials are available and you may contact your local representative for assistance.

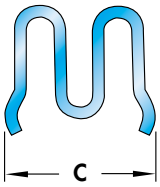


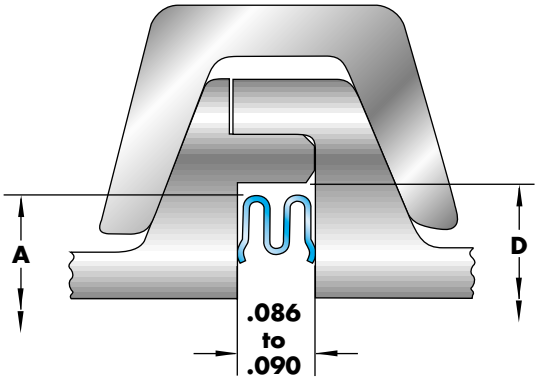
MS DASH NUMBER	BOSS SEAL PART NUMBER	SEAL DIMENSIONS			
		A O.D. (tol. + 0,00, -0,13)	B SEAL I.D. (min.)	C FREE HEIGHT (tol. ± 0,05)	D Washer I.D. Ref.
- 02	**66690 - 02 - 07 - 1 - SPA**	9,68	7,67	1,19	7,06
- 03	**66690 - 03 - 07 - 1 - SPA**	11,28	9,27	1,19	8,66
- 04	**66690 - 04 - 07 - 1 - SPA**	12,85	10,85	1,19	10,08
- 05	**66690 - 05 - 07 - 1 - SPA**	14,45	12,45	1,19	11,66
- 06	**66690 - 06 - 07 - 1 - SPA**	16,03	14,02	1,19	13,13
- 07	**66690 - 07 - 07 - 1 - SPA**	17,63	15,62	1,19	14,71
- 08	**66690 - 08 - 07 - 1 - SPA**	20,80	18,80	1,19	17,75
- 09	**66690 - 09 - 07 - 1 - SPA**	22,40	20,40	1,19	19,33
- 10	**66690 - 10 - 07 - 1 - SPA**	23,98	21,97	1,19	20,75
- 11	**66690 - 11 - 07 - 1 - SPA**	27,94	25,93	1,57	23,67
- 12	**66690 - 12 - 07 - 1 - SPA**	29,36	26,70	1,57	25,27
- 14	**66690 - 14 - 07 - 1 - SPA**	32,54	29,87	1,57	28,45
- 16	**66690 - 16 - 07 - 1 - SPA**	35,71	33,05	1,57	31,62
- 18	**66690 - 18 - 07 - 1 - SPA**	40,46	37,80	1,57	36,37
- 20	**66690 - 20 - 07 - 1 - SPA**	43,64	40,97	1,57	39,55
- 24	**66690 - 24 - 07 - 1 - SPA**	49,99	47,32	1,57	45,90
- 28	**66690 - 28 - 07 - 1 - SPA**	59,51	56,85	1,57	55,42
- 32	**66690 - 32 - 07 - 1 - SPA**	65,89	63,22	1,57	61,77

All dimensions are in millimeters and are prior to plating.

Metal E-Ring, for AS1895 Flanges

- Specially sized E-Rings are listed below to fit all AS1895 (dash number -100 to -750) flanges.
- E-Rings are manufactured from unplated Alloy 718, solution annealed and age-hardened. Other high strength/higher temperature nickel alloys are available including Waspaloy and Rene 41.





AS1895 DASH NUMBER	D CAVITY (+0,08, -0,00)	E-RING PART NUMBER	A SEAL O.D. (tol. h11)	C SEAL FREE HEIGHT ±0,13
–100	31,75	MEI-69025 -100 - XX	31,67	2,74
–125	38,10	MEI-69025 -125 - XX	38,02	2,74
–150	44,45	MEI-69025 -150 - XX	44,37	2,74
–175	50,80	MEI-69025 -175 - XX	50,72	2,74
–200	57,15	MEI-69025 -200 - XX	57,07	2,74
–225	63,50	MEI-69025 -225 - XX	63,42	2,74
–250	69,85	MEI-69025 -250 - XX	69,77	2,74
–275	76,20	MEI-69025 -275 - XX	76,12	2,74
–300	82,55	MEI-69025 -300 - XX	82,47	2,74
–325	88,90	MEI-69025 -325 - XX	88,82	2,74
–350	95,25	MEI-69025 -350 - XX	95,17	2,74
–400	107,95	MEI-69025 -400 - XX	107,87	2,74
–450	120,65	MEI-69025 -450 - XX	120,57	2,74
–500	133,35	MEI-69025 -500 - XX	133,27	2,74
–550	146,05	MEI-69025 -550 - XX	145,97	2,74
–600	158,75	MEI-69025 -600 - XX	158,67	2,74
–650	171,45	MEI-69025 -650 - XX	171,37	2,74
–700	184,15	MEI-69025 -700 - XX	184,07	2,74
–750	196,85	MEI-69025 -750 - XX	196,77	2,74

Material Code Choice (XX):	Material	Material Code
	Alloy 718	14
	Waspaloy	23
	Rene 41	29

All dimensions are in millimeters converted from inches as specified in AS1895. The Tolerance Reference table can be found on page E-22.

Metal O-Rings for U.S. Military Standards

MS9141

Advanced Products Part Number **EON -** *Seal diameter code from table below* **- 01 - 03 - 1**

MS Dash Number	Seal Diameter Code	MS Dash Number	Seal Diameter Code	MS Dash Number	Seal Diameter Code	MS Dash Number	Seal Diameter Code
-03	000250	-10	000469	-17	000875	-24	001625
-04	000281	-11	000500	-18	000938	-25	001750
-05	000312	-12	000562	-19	001000	-26	001875
-06	000344	-13	000625	-20	001125	-27	002000
-07	000375	-14	000688	-21	001250		
-08	000406	-15	000750	-22	001375		
-09	000438	-16	000812	-23	001500		

MS9142

Advanced Products Part Number **EON -** *Seal diameter code from table below* **- 02 - 03 - 1**

MS Dash Number	Seal Diameter Code	MS Dash Number	Seal Diameter Code	MS Dash Number	Seal Diameter Code	MS Dash Number	Seal Diameter Code
-013	000438	-031	001000	-049	001875	-067	003000
-014	000469	-032	001031	-050	001938	-069	003125
-015	000500	-033	001062	-051	002000	-071	003250
-016	000531	-034	001094	-052	002062	-073	003375
-017	000562	-035	001125	-053	002125	-075	003500
-018	000594	-036	001156	-054	002188	-077	003625
-019	000625	-037	001188	-055	002250	-079	003750
-020	000656	-038	001219	-056	002312	-081	003875
-021	000688	-039	001250	-057	002375	-083	004000
-022	000719	-040	001312	-058	002438	-085	004125
-023	000750	-041	001375	-059	002500	-087	004250
-024	000781	-042	001438	-060	002562	-089	004375
-025	000812	-043	001500	-061	002625	-091	004500
-026	000844	-044	001562	-062	002688	-093	004625
-027	000875	-045	001625	-063	002750	-095	004750
-028	000906	-046	001688	-064	002812	-097	004875
-029	000938	-047	001750	-065	002875	-099	005000
-030	000969	-048	001812	-066	002938		

MS9202

Advanced Products Part Number **EON -** *Seal diameter code from table below* **- 03 - 03 - 1**

MS Dash Number	Seal Diameter Code	MS Dash Number	Seal Diameter Code	MS Dash Number	Seal Diameter Code	MS Dash Number	Seal Diameter Code
-013	000438	-037	001188	-061	002625	-103	005250
-014	000469	-038	001219	-062	002688	-105	005375
-015	000500	-039	001250	-063	002750	-107	005500
-016	000531	-040	001312	-064	002812	-109	005625
-017	000562	-041	001375	-065	002875	-111	005750
-018	000594	-042	001438	-066	002938	-113	005875
-019	000625	-043	001500	-067	003000	-115	006000
-020	000656	-044	001562	-069	003125	-117	006125
-021	000688	-045	001625	-071	003250	-119	006250
-022	000719	-046	001688	-073	003375	-121	006375
-023	000750	-047	001750	-075	003500	-123	006500
-024	000781	-048	001812	-077	003625	-125	006625
-025	000812	-049	001875	-079	003750	-127	006750
-026	000844	-050	001938	-081	003875	-129	006875
-027	000875	-051	002000	-083	004000	-131	007000
-028	000906	-052	002062	-085	004125	-133	007125
-029	000938	-053	002125	-087	004250	-135	007250
-030	000969	-054	002188	-089	004375	-137	007375
-031	001000	-055	002250	-091	004500	-139	007500
-032	001031	-056	002312	-093	004625	-141	007625
-033	001062	-057	002375	-095	004750	-143	007750
-034	001094	-058	002438	-097	004875	-145	007875
-035	001125	-059	002500	-099	005000	-147	008000
-036	001156	-060	002562	-101	005125		

Metal O-Rings for U.S. Military Standards

MS9203

Advanced Products Part Number **EON -** *Seal diameter code from table below* **- 04 - 03 - 1**

MS Dash Number	Seal Diameter Code	MS Dash Number	Seal Diameter Code	MS Dash Number	Seal Diameter Code	MS Dash Number	Seal Diameter Code
-010	001000	-036	002062	-061	003625	-119	007250
-012	001031	-037	002125	-062	003688	-123	007500
-013	001062	-038	002188	-063	003750	-127	007750
-014	001094	-039	002250	-064	003812	-131	008000
-015	001125	-040	002312	-065	003875	-135	008250
-016	001156	-041	002375	-066	003938	-139	008500
-017	001188	-042	002438	-067	004000	-143	008750
-018	001219	-043	002500	-069	004125	-147	009000
-019	001250	-044	002562	-071	004250	-151	009250
-020	001281	-045	002625	-073	004375	-155	009500
-021	001312	-046	002688	-075	004500	-159	009750
-022	001344	-047	002750	-077	004625	-163	010000
-023	001375	-048	002812	-079	004750	-167	010250
-024	001406	-049	002875	-081	004875	-171	010500
-025	001438	-050	002938	-083	005000	-175	010750
-026	001469	-051	003000	-085	005125	-179	011000
-027	001500	-052	003062	-087	005250	-183	011250
-028	001562	-053	003125	-089	005375	-187	011500
-029	001625	-054	003188	-091	005500	-191	011750
-030	001688	-055	003250	-095	005750	-195	012000
-031	001750	-056	003312	-099	006000	-203	012500
-032	001812	-057	003375	-103	006250	-211	013000
-033	001875	-058	003438	-107	006500	-219	013500
-034	001938	-059	003500	-111	006750	-227	014000
-035	002000	-060	003562	-115	007000		

MS9204

Advanced Products Part Number **EON -** *Seal diameter code from table below* **- 05 - 03 - 1**

MS Dash Number	Seal Diameter Code	MS Dash Number	Seal Diameter Code	MS Dash Number	Seal Diameter Code	MS Dash Number	Seal Diameter Code
-010	001000	-036	002062	-061	003625	-119	007250
-012	001031	-037	002125	-062	003688	-123	007500
-013	001062	-038	002188	-063	003750	-127	007750
-014	001094	-039	002250	-064	003812	-131	008000
-015	001125	-040	002312	-065	003875	-135	008250
-016	001156	-041	002375	-066	003938	-139	008500
-017	001188	-042	002438	-067	004000	-143	008750
-018	001219	-043	002500	-069	004125	-147	009000
-019	001250	-044	002562	-071	004250	-151	009250
-020	001281	-045	002625	-073	004375	-155	009500
-021	001312	-046	002688	-075	004500	-159	009750
-022	001344	-047	002750	-077	004625	-163	010000
-023	001375	-048	002812	-079	004750	-167	010250
-024	001406	-049	002875	-081	004875	-171	010500
-025	001438	-050	002938	-083	005000	-175	010750
-026	001469	-051	003000	-085	005125	-179	011000
-027	001500	-052	003062	-087	005250	-183	011250
-028	001562	-053	003125	-089	005375	-187	011500
-029	001625	-054	003188	-091	005500	-191	011750
-030	001688	-055	003250	-095	005750	-195	012000
-031	001750	-056	003312	-099	006000	-203	012500
-032	001812	-057	003375	-103	006250	-211	013000
-033	001875	-058	003438	-107	006500	-219	013500
-034	001938	-059	003500	-111	006750	-227	014000
-035	002000	-060	003562	-115	007000		

Metal O-Rings for U.S. Military Standards

MS9205

Advanced Products Part Number **EON -** *Seal diameter code from table below* **- 07 - 03 - 1**

MS Dash Number	Seal Diameter Code	MS Dash Number	Seal Diameter Code	MS Dash Number	Seal Diameter Code	MS Dash Number	Seal Diameter Code
-010	002000	-056	004875	-138	010000	-346	023000
-011	002062	-057	004938	-142	010250	-354	023500
-012	002125	-058	005000	-146	010500	-362	024000
-013	002188	-059	005062	-150	010750	-370	024500
-014	002250	-060	005125	-154	011000	-378	025000
-015	002312	-061	005188	-158	011250	-386	025500
-016	002375	-062	005250	-162	011500	-394	026000
-017	002438	-063	005312	-166	011750	-402	026500
-018	002500	-064	005375	-170	012000	-410	027000
-019	002562	-065	005438	-174	012250	-418	027500
-020	002625	-066	005500	-178	012500	-426	028000
-021	002688	-067	005562	-182	012750	-434	028500
-022	002750	-068	005625	-186	013000	-442	029000
-023	002812	-069	005688	-190	013250	-450	029500
-024	002875	-070	005750	-194	013500	-458	030000
-025	002938	-071	005812	-198	013750	-466	030500
-026	003000	-072	005875	-202	014000	-474	031000
-027	003062	-073	005938	-206	014250	-482	031500
-028	003125	-074	006000	-210	014500	-490	032000
-029	003188	-076	006125	-214	014750	-498	032500
-030	003250	-078	006250	-218	015000	-506	033000
-031	003312	-080	006375	-222	015250	-514	033500
-032	003375	-082	006500	-226	015500	-522	034000
-033	003438	-084	006625	-230	015750	-530	034500
-034	003500	-086	006750	-234	016000	-538	035000
-035	003562	-088	006875	-238	016250	-546	035500
-036	003625	-090	007000	-242	016500	-554	036000
-037	003688	-092	007125	-246	016750	-562	036500
-038	003750	-094	007250	-250	017000	-570	037000
-039	003812	-096	007375	-254	017250	-578	037500
-040	003875	-098	007500	-258	017500	-586	038000
-041	003938	-100	007625	-262	017750	-594	038500
-042	004000	-102	007750	-266	018000	-602	039000
-043	004062	-104	007875	-270	018250	-610	039500
-044	004125	-106	008000	-274	018500	-618	040000
-045	004188	-108	008125	-278	018750	-634	041000
-046	004250	-110	008250	-282	019000	-650	042000
-047	004312	-112	008375	-286	019250	-666	043000
-048	004375	-114	008500	-290	019500	-682	044000
-049	004438	-116	008625	-294	019750	-698	045000
-050	004500	-118	008750	-298	020000	-714	046000
-051	004562	-120	008875	-306	020500	-730	047000
-052	004625	-122	009000	-314	021000	-746	048000
-053	004688	-124	009250	-322	021500	-762	049000
-054	004750	-130	009500	-330	022000	-778	050000
-055	004812	-134	009750	-338	022500		

Metal O-Rings for U.S. Military Standards

MS9371

Advanced Products Part Number **EON -** *Seal diameter code from table below* **- 01 - 03 - 1 - SPB**

MS Dash Number	Seal Diameter Code	MS Dash Number	Seal Diameter Code	MS Dash Number	Seal Diameter Code	MS Dash Number	Seal Diameter Code
-03	000250	-10	000469	-17	000875	-24	001625
-04	000281	-11	000500	-18	000938	-25	001750
-05	000312	-12	000562	-19	001000	-26	001875
-06	000344	-13	000625	-20	001125	-27	002000
-07	000375	-14	000688	-21	001250		
-08	000406	-15	000750	-22	001375		
-09	000438	-16	000812	-23	001500		

MS9372

Advanced Products Part Number **EON -** *Seal diameter code from table below* **- 02 - 03 - 1 - SPB**

MS Dash Number	Seal Diameter Code	MS Dash Number	Seal Diameter Code	MS Dash Number	Seal Diameter Code	MS Dash Number	Seal Diameter Code
-013	000438	-031	001000	-049	001875	-067	003000
-014	000469	-032	001031	-050	001938	-069	003125
-015	000500	-033	001062	-051	002000	-071	003250
-016	000531	-034	001094	-052	002062	-073	003375
-017	000562	-035	001125	-053	002125	-075	003500
-018	000594	-036	001156	-054	002188	-077	003625
-019	000625	-037	001188	-055	002250	-079	003750
-020	000656	-038	001219	-056	002312	-081	003875
-021	000688	-039	001250	-057	002375	-083	004000
-022	000719	-040	001312	-058	002438	-085	004125
-023	000750	-041	001375	-059	002500	-087	004250
-024	000781	-042	001438	-060	002562	-089	004375
-025	000812	-043	001500	-061	002625	-091	004500
-026	000844	-044	001562	-062	002688	-093	004625
-027	000875	-045	001625	-063	002750	-095	004750
-028	000906	-046	001688	-064	002812	-097	004875
-029	000938	-047	001750	-065	002875	-099	005000
-030	000969	-048	001812	-066	002938		

MS9373

Advanced Products Part Number **EON -** *Seal diameter code from table below* **- 03 - 03 - 1 - SPB**

MS Dash Number	Seal Diameter Code	MS Dash Number	Seal Diameter Code	MS Dash Number	Seal Diameter Code	MS Dash Number	Seal Diameter Code
-013	000438	-037	001188	-061	002625	-103	005250
-014	000469	-038	001219	-062	002688	-105	005375
-015	000500	-039	001250	-063	002750	-107	005500
-016	000531	-040	001312	-064	002812	-109	005625
-017	000562	-041	001375	-065	002875	-111	005750
-018	000594	-042	001438	-066	002938	-113	005875
-019	000625	-043	001500	-067	003000	-115	006000
-020	000656	-044	001562	-069	003125	-117	006125
-021	000688	-045	001625	-071	003250	-119	006250
-022	000719	-046	001688	-073	003375	-121	006375
-023	000750	-047	001750	-075	003500	-123	006500
-024	000781	-048	001812	-077	003625	-125	006625
-025	000812	-049	001875	-079	003750	-127	006750
-026	000844	-050	001938	-081	003875	-129	006875
-027	000875	-051	002000	-083	004000	-131	007000
-028	000906	-052	002062	-085	004125	-133	007125
-029	000938	-053	002125	-087	004250	-135	007250
-030	000969	-054	002188	-089	004375	-137	007375
-031	001000	-055	002250	-091	004500	-139	007500
-032	001031	-056	002312	-093	004625	-141	007625
-033	001062	-057	002375	-095	004750	-143	007750
-034	001094	-058	002438	-097	004875	-145	007875
-035	001125	-059	002500	-099	005000	-147	008000
-036	001156	-060	002562	-101	005125		

Metal O-Rings for U.S. Military Standards

MS9374

Advanced Products Part Number **EON -** *Seal diameter code from table below* **- 04 - 03 - 1 - SPB**

MS Dash Number	Seal Diameter Code	MS Dash Number	Seal Diameter Code	MS Dash Number	Seal Diameter Code	MS Dash Number	Seal Diameter Code
-010	001000	-035	002000	-059	003500	-107	006500
-012	001031	-036	002062	-060	003562	-111	006750
-013	001062	-037	002125	-061	003625	-115	007000
-014	001094	-038	002188	-062	003688	-119	007250
-015	001125	-039	002250	-063	003750	-123	007500
-016	001156	-040	002312	-064	003812	-127	007750
-017	001188	-041	002375	-065	003875	-131	008000
-018	001219	-042	002438	-066	003938	-135	008250
-019	001250	-043	002500	-067	004000	-139	008500
-020	001281	-044	002562	-069	004125	-143	008750
-021	001312	-045	002625	-071	004250	-147	009000
-022	001344	-046	002688	-073	004375	-151	009250
-023	001375	-047	002750	-075	004500	-155	009500
-024	001406	-048	002812	-077	004625	-159	009750
-025	001438	-049	002875	-079	004750	-163	010000
-026	001469	-050	002938	-081	004875	-167	010250
-027	001500	-051	003000	-083	005000	-171	010500
-028	001562	-052	003062	-085	005125	-175	010750
-029	001625	-053	003125	-087	005250	-179	011000
-030	001688	-054	003188	-089	005375	-183	011250
-031	001750	-055	003250	-091	005500	-187	011500
-032	001812	-056	003312	-095	005750	-191	011750
-033	001875	-057	003375	-099	006000	-195	012000
-034	001938	-058	003438	-103	006250		

MS9375

Advanced Products Part Number **EON -** *Seal diameter code from table below* **- 05 - 03 - 1 - SPB**

MS Dash Number	Seal Diameter Code	MS Dash Number	Seal Diameter Code	MS Dash Number	Seal Diameter Code	MS Dash Number	Seal Diameter Code
-010	001000	-035	002000	-059	003500	-107	006500
-012	001031	-036	002062	-060	003562	-111	006750
-013	001062	-037	002125	-061	003625	-115	007000
-014	001094	-038	002188	-062	003688	-119	007250
-015	001125	-039	002250	-063	003750	-123	007500
-016	001156	-040	002312	-064	003812	-127	007750
-017	001188	-041	002375	-065	003875	-131	008000
-018	001219	-042	002438	-066	003938	-135	008250
-019	001250	-043	002500	-067	004000	-139	008500
-020	001281	-044	002562	-069	004125	-143	008750
-021	001312	-045	002625	-071	004250	-147	009000
-022	001344	-046	002688	-073	004375	-151	009250
-023	001375	-047	002750	-075	004500	-155	009500
-024	001406	-048	002812	-077	004625	-159	009750
-025	001438	-049	002875	-079	004750	-163	010000
-026	001469	-050	002938	-081	004875	-167	010250
-027	001500	-051	003000	-083	005000	-171	010500
-028	001562	-052	003062	-085	005125	-175	010750
-029	001625	-053	003125	-087	005250	-179	011000
-030	001688	-054	003188	-089	005375	-183	011250
-031	001750	-055	003250	-091	005500	-187	011500
-032	001812	-056	003312	-095	005750	-191	011750
-033	001875	-057	003375	-099	006000	-195	012000
-034	001938	-058	003438	-103	006250		

Metal O-Rings for U.S. Military Standards

MS9376

Advanced Products Part Number **EON -** *Seal diameter code from table below* **- 07 - 03 - 1 - SPB**

MS Dash Number	Seal Diameter Code	MS Dash Number	Seal Diameter Code	MS Dash Number	Seal Diameter Code	MS Dash Number	Seal Diameter Code
-010	002000	-036	003625	-062	005250	-102	007750
-011	002062	-037	003688	-063	005312	-104	007875
-012	002125	-038	003750	-064	005375	-106	008000
-013	002188	-039	003812	-065	005438	-108	008125
-014	002250	-040	003875	-066	005500	-110	008250
-015	002312	-041	003938	-067	005562	-112	008375
-016	002375	-042	004000	-068	005625	-114	008500
-017	002438	-043	004062	-069	005688	-116	008625
-018	002500	-044	004125	-070	005750	-118	008750
-019	002562	-045	004188	-071	005812	-120	008875
-020	002625	-046	004250	-072	005875	-122	009000
-021	002688	-047	004312	-073	005938	-124	009250
-022	002750	-048	004375	-074	006000	-130	009500
-023	002812	-049	004438	-076	006125	-134	009750
-024	002875	-050	004500	-078	006250	-138	010000
-025	002938	-051	004562	-080	006375	-142	010250
-026	003000	-052	004625	-082	006500	-146	010500
-027	003062	-053	004688	-084	006625	-150	010750
-028	003125	-054	004750	-086	006750	-154	011000
-029	003188	-055	004812	-088	006875	-158	011250
-030	003250	-056	004875	-090	007000	-162	011500
-031	003312	-057	004938	-092	007125	-166	011750
-032	003375	-058	005000	-094	007250	-170	012000
-033	003438	-059	005062	-096	007375		
-034	003500	-060	005125	-098	007500		
-035	003562	-061	005188	-100	007625		

Introduction to the Material Selection Process

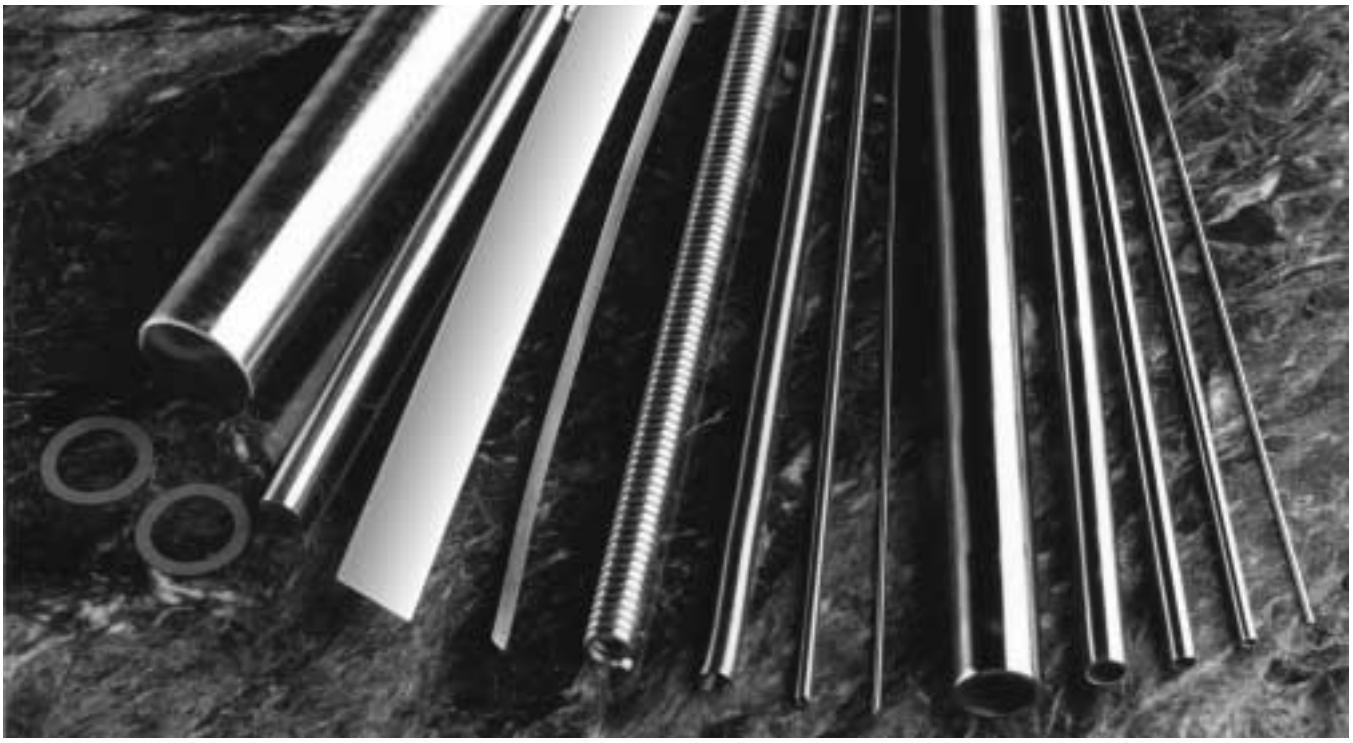
With the seal type, diameter and cross-section already determined, the following pages (D-2 to D-11) provide specific guidance in selecting the appropriate material(s), temper, and finish.

Comprehensive data is given to ensure an optimum match between the many material choices and the application. However, we are always pleased to offer additional technical consulting and advice if required. To obtain the fastest response please fax us your completed Application Data Sheet (E-24) for immediate review by our product specialists and Engineering staff.

EnerRing Material, Temper, and Finish are designated in the Part Number as shown below.

MXX - 000000 - 00 - 00 - 0 - XXX

- 00 — Material Code
- 0 — Temper Code
- XXX — Finish Code (material & thickness)



Selecting the EnerRing Material

The tables below and opposite list all the available materials for non-spring energized seals and spring energized seals.

Starting in the column appropriate to the chosen EnerRing type, make the primary material selection by choosing a "preferred", or possibly "optional" material compatible with the maximum working temperature in the application. Information on temperature resistance is given on the facing page.

Other factors that may also require consideration include 'NACE' approval (corrosion resistance) and chemical compatibility. A detailed listing of chemical compatibilities is given on pages D-8 to D-11. Additional guidance on the effects of material choices on seal performance (load, springback, and pressure rating) may be found on pages E-2 to E-9.

Special materials are also available to meet unusually severe operational requirements, or unique procurement specifications. Generally, these will not be stock item materials and may be subject to some additional lead time and material lot charges.

MXX - 000000 - 00 - 00 - 0 - XXX

Material Code

Non-Spring Energized Seals

Material Code	Material (Common Designation)	NACE approved (See note 3)	C-Ring	E-Ring	O-Ring	U-Ring	Wire Ring	Nuclear Pressure Vessel O-Ring
01	304 Stainless Steel				Preferred[1]		Preferred	Optional
02	316 Stainless Steel				Special		Special	
03	321 Stainless Steel				Preferred[1]		Special	
04	347 Stainless Steel				Special		Special	
15	Stainless Steel Alloy A-286		Special					
16	17-4 PH Stainless Steel		Special					
06	Alloy 600				Special			
25	Alloy 625		Special					
14	Alloy 718	Yes	Preferred	Preferred	Optional[2]	Preferred		Preferred
07	Alloy X-750		Optional	Optional	Optional[2]	Optional		
20	Hastelloy C-276	Yes	Special					
23	Waspaloy		Optional	Optional		Optional		
29	Rene 41		Special	Special		Special		
05	Monel 400				Special		Special	
30	Haynes 188		Special			Special		
09	Haynes 25		Special		Special			
31	Titanium		Special			Special		
08	Aluminum Al 1100-0						Preferred[4]	
12	Copper						Preferred[4]	
10	Gold						Preferred[4]	
13	Nickel						Preferred[4]	
11	Silver						Preferred[4]	

1: 321 Stainless Steel is standard for 3,18 mm and smaller free height Metal O-Rings. 304 Stainless Steel is standard for 3,96 mm and larger free height Metal O-Rings.
2: Alloy X-750 is optional for 6,35 mm and smaller free height Metal O-Rings. Alloy 718 is optional for 9,53 mm and larger free height Metal O-Rings.
3: Approved for use in corrosive seal service per NACE MR-01-075 Specification in certain heat treated conditions.
4. 2,39 mm and above free height wire rings are only available in stainless steel, nickel, and nickel alloys.

Temperature Capability

Maximum Recommended Temperature

Some materials are suitable for temperatures above the Maximum Recommended Temperature Limit depending upon other conditions such as pressure, stress relaxation, and flange separation. Contact one of our Applications Engineers for assistance.

Material	Maximum Recommended Temperature Degrees C	
Nickel	700	1200
Haynes 188	700	1100
Haynes 25	700	1100
Copper (wire)	700	930
Gold (wire)	700	930
Rene 41	700	870
Waspaloy	700	870
Hastelloy C-276	650	760
Alloy 600	650	
Alloy 625	650	
Alloy 718	650	
Silver (wire)	650	
Alloy X-750	590	
Cobalt Chromium-Nickel Alloy	540	
Monel 400	540	
17-4PH Stainless Steel	430	
304 Stainless Steel	430	
316 Stainless Steel	430	
321 Stainless Steel	430	
347 Stainless Steel	430	
Stainless Steel Alloy A-286	430	
Titanium	260	
Aluminum Al 1100-0	200	

Spring Energized Seals

Material Code	Jacket/Spring Material Combination (Common Designation) Jacket/Spring	NACE approved (See note 3 on previous page)	Spring Energized Metal C-Ring	Spring Energized Metal O-Ring
01	304 Stainless Steel / 304 Stainless Steel		Optional	Preferred
02	304 Stainless Steel / Cobalt Chromium-Nickel Alloy		Special	
03	Alloy X-750 / Cobalt Chromium-Nickel Alloy	Yes	Special	
04	Aluminum Al 1100-0 / 304 Stainless Steel		Special	
05	Alloy X-750 / 304 Stainless Steel		Special	
06	Alloy X-750 / Alloy X-750	Yes	Preferred	Special
07	304 Stainless Steel / Alloy X-750		Optional	
08	304 Stainless Steel / Nimonic 90		Special	
09	Alloy X-750 / Nimonic 90		Special	
10	Alloy X-750 / Alloy 718		Optional	
11	Alloy 718 / Alloy 718	Yes	Optional	
12	Alloy 718 / Alloy X-750	Yes	Optional	
13	Nickel / Alloy X-750		Special	
14	Alloy 718 / Cobalt Chromium-Nickel Alloy	Yes	Special	
15	Cobalt Chromium-Nickel Alloy / Cobalt Chromium-Nickel Alloy		Special	
16	Hastelloy C-276 / Hastelloy C-276	Yes	Special	
17	Alloy 625 / Alloy 625		Special	

Other materials are available upon special request. Please contact one of our Applications Engineers at any of our worldwide locations for assistance.

Aerospace Material Specification (AMS) Reference

Our material procurement specifications ensure that we receive only the highest quality materials in a condition best suited for seal manufacture. This ensures that you receive the highest quality seals with consistent performance. Our specifications enhance the requirements of the following AMS specifications, providing the special properties needed for high quality seal fabrication.

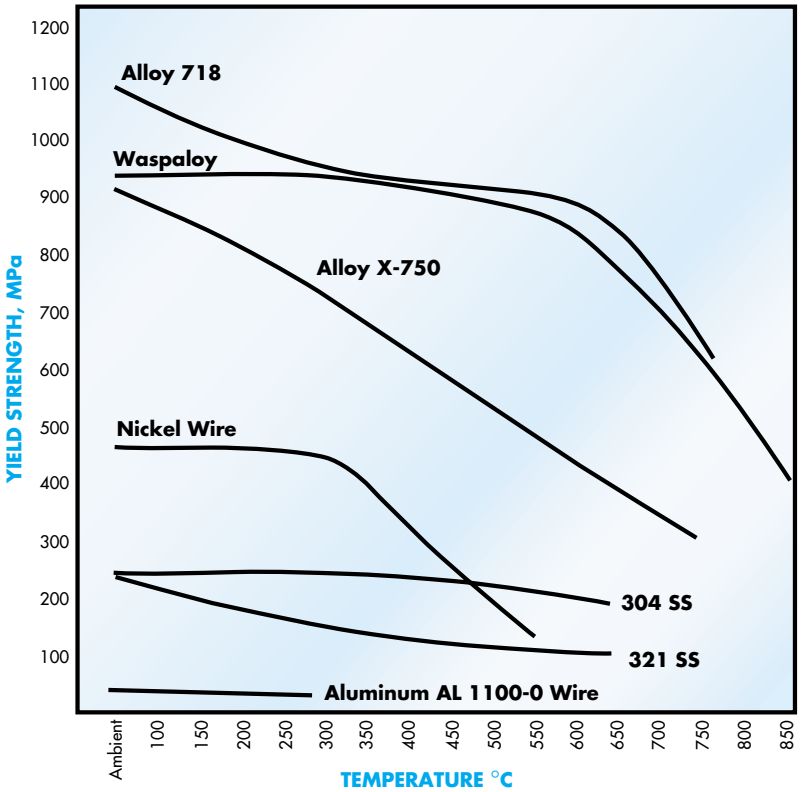
MATERIAL (Common Designation)	STRIP & SHEET	TUBING	WIRE		German Material Number (Reference)
	C-Rings, E-Rings, U-Rings	O-Rings	Wire Rings	Springs	
304 Stainless Steel	AMS 5513	AMS 5560, 5565	AMS 5697	AMS 5857	1.4301
316 Stainless Steel		AMS 5584	AMS 5690		1.4401, 1.4436
321 Stainless Steel		AMS 5570, 5576	AMS 5689		1.4541
347 Stainless Steel		AMS 5575	AMS 5674		1.4550
Stainless Steel Alloy A-286	AMS 5525				1.4980, 1.4944
17-4PH Stainless Steel					1.4542, 1.4548
Alloy 600		AMS 5580			2.4816
Alloy 625	AMS 5599				2.4856
Alloy 718	AMS 5596	AMS 5590			2.4668
Alloy X-750	AMS 5598	AMS 5582		AMS 5699	2.4669
Hastelloy C-276	AMS 5530				2.4819
Waspaloy	AMS 5544				2.4654
Rene 41	AMS 5545				2.4973
Haynes 188	AMS 5608				
Monel 400		AMS 4574	AMS 4730		2.4360
Titanium	AMS 4900, 4901				99% pure
Aluminum Al 1100-0	AMS 4001				99% pure
Nickel	AMS 5563				2.4060, 2.4066
Cobalt Chromium-Nickel Alloy	AMS 5876			AMS 5833	2.4711

Yield Strength, Relaxation & Springback

Yield strength and stress relaxation are particularly important in the design and application of resilient metal seals for elevated temperatures. For any given seal design, springback is a function of yield strength and stress relaxation (as well as modulus of elasticity).

A useful estimation of springback for short term exposure to elevated temperatures may be obtained by derating the published springback by the ratio of the yield strength at the elevated temperature to the yield strength at ambient temperature.

Stress relaxation occurs when material is exposed to long term elevated temperatures. This results in reduced load and springback.



EnerRing Material Temper

We provide clear recommendations on the best choice of material condition for the type of seal selected and material type. For high performance resilient metal seals manufactured from nickel alloys such as X-750, 718 and Waspaloy, we recommend a solution annealed and age hardened heat treatment to our standard (-6) condition after forming. This increases springback and load by increasing yield strength, as well as improving fatigue resistance and creep resistance. Metal O-Rings and Spring Energized C-Rings are frequently manufactured from austenitic stainless steels which are not precipitation hardenable. These seals are supplied in the work hardened condition.

TEMPER CODE	TEMPER DESCRIPTION
1	Work Hardened
2	Age Hardened
4	Annealed
6	Solution Heat Treat, (Stabilization Heat Treat if applicable), and Precipitation Heat Treat

MXX - 000000 - 00 - 00 - 0 - XXX

Temper Code

Temper Codes for Non-Spring Energized Seals

Material Code	Material (Common Designation)	C-Ring (face seal)	Axial C-Ring	E-Ring	O-Ring	U-Ring	Wire Ring	Nuclear Pressure Vessel O-Ring
01	304 Stainless Steel				1		4	1
02	316 Stainless Steel				1		4	
03	321 Stainless Steel				1		4	
04	347 Stainless Steel				1		4	
15	Stainless Steel Alloy A-286	6	1					
16	17-4 PH Stainless Steel	6	1					
06	Alloy 600				1			
25	Alloy 625	6	1					
14	Alloy 718	6 *	1 or 6*	6 *	1 †	6 *		6
07	Alloy X-750	6	1		1 †			
20	Hastelloy C-276	1	1					
23	Waspaloy	6	6	6		6		
29	Rene 41	6	6	6		6		
05	Monel 400				1		4	
30	Haynes 188	1	1			1		
09	Haynes 25				1			
31	Titanium	1	1			1		
08	Aluminum Al 1100-0						4	
12	Copper						4	
10	Gold						4	
13	Nickel						4	
11	Silver						4	

* **NACE APPROVAL** – For approval in corrosive service per NACE MR-01-075 Specification, specify temper code 8. Contact one of our Application Engineers for assistance.
† Alloy X-750 and 718 O-Rings are available in -6 and -2 tempers for increased fatigue and stress relaxation resistance and seating load.

Temper Codes for Spring Energized Seals

The -1 Work Hardened temper code is standard for all Spring Energized Seals. All springs are supplied in an appropriate spring temper prior to installation in the seal jacket. The -6 Solution Annealed and Age Hardened temper code is available for increased fatigue resistance of the jacket/spring combinations (at right) in cyclic operating conditions such as piston engines.

Material Code	Jacket/Spring Materials
06	Alloy X-750/Alloy X-750
11	Alloy 718/Alloy 718

EnerRing Platings, Coatings and Finishes

MXX - 000000 - 00 - 00 - 0 - XXX

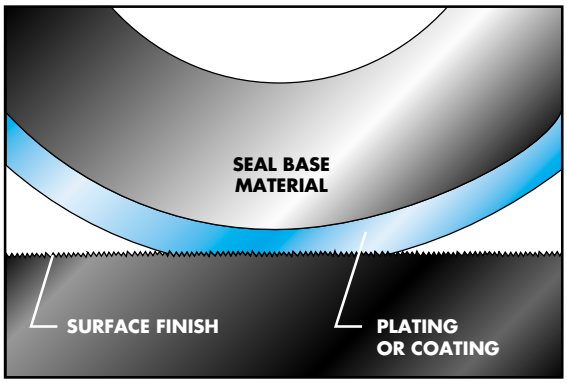
Finish Thickness

Finish Material

Specialized platings and coatings allow us to modify the surface properties of an EnerRing to create a ductile, low hardness outer surface layer. This acts as an integral "gasket" and ensures optimum sealing *despite mating surface imperfections*. However, unlike a large surface area, traditional, flat gasket, the narrow footprint of an EnerRing produces a high localized contact stress without excessive bolt-up loads.

Platings and coatings can also improve seal performance by reducing the coefficient of friction of the seal and preventing galling. This assists the seal to slide and "bed down" properly during initial compression or permit, for example, limited dynamic use as a valve stem seal.

In addition to the primary physical properties of ductility and softness, seal coatings are also chosen to withstand high temperatures and often corrosive or oxidizing environments. With a wide choice of surface coatings available, we recommend the selection be made by the following process of elimination.



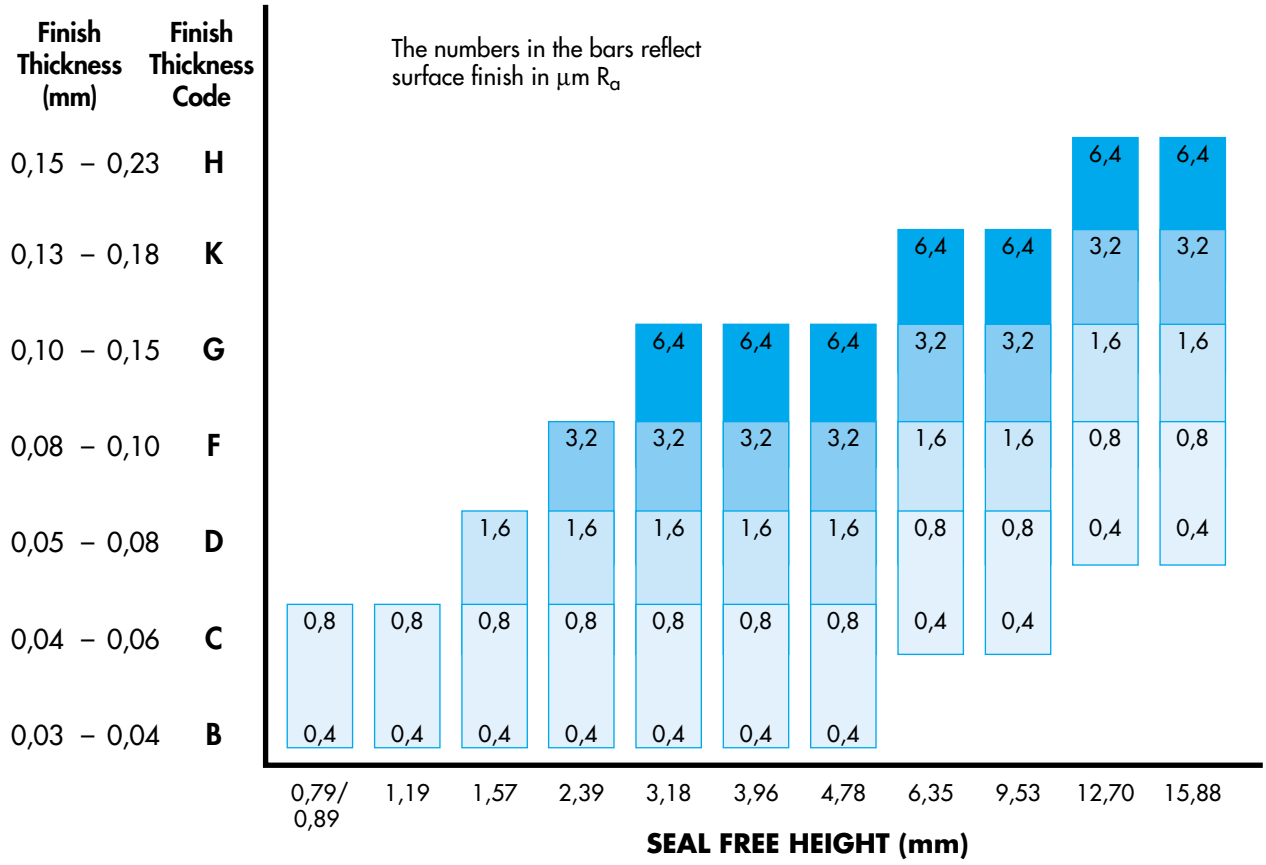
1. Eliminate all platings and coatings with inadequate high temperature capability (see table below).
2. Eliminate all coatings chemically incompatible with the fluid medium (see pages D-8 to D-11).
3. Choose the softest remaining coating able to withstand the seating stresses. (Ultra soft materials such as Indium and Lead are very easily damaged and subject to creep if overstressed. They should only be selected for specially critical applications with well controlled handling and installation instructions.)
4. NOTE: Silver remains, for many applications, the preferred choice.

Finish Code	Finish Material	Properties, Uses and Limitations	Maximum Temp °C	Maximum Seal Load (N/mm)
	Unplated	Typically air applications where total leaktightness is not required. Lowest cost. Contact your local representative for anti-gall coating options.	depends on base	not limited
SFX (unplated) SSX (Silver) SGX (Gold) etc.	Super–Finishing	Spin-polished substrate sealing surfaces with a circular lay. Improves leakage control on unplated or low load seals, or for high vacuum.	depends on base & plating	depends on plating
IP	Indium (In)	Extremely soft metal, excellent for cryogenics, low strength flanges, optical components and vacuum. Not for use with high load seals or at high pressures, due to creep and extrusion.	65	60
LP	Lead (Pb)	Similar properties to Indium, although slightly harder and higher temperature capability. Not for use with high load seals.	200	70
GP	Gold (Au)	Soft metal with excellent chemical and oxidation resistance and very high temperature capability. Expensive for larger sizes.	930	not limited
SP	Silver (Ag)	Closest to an ideal plating material and therefore most frequently selected for a wide variety of applications. Soft in its pure and annealed form. Good corrosion and temperature resistance. Used in nuclear seals/borated water. Excellent anti-galling properties. Inexpensive.	430 (oxidizing) 650 (non-oxidizing)	not limited not limited
CP	Copper (Cu)	Relatively soft and inexpensive plating. Good high temperature resistance. Not for use with Waspaloy.	930	not limited
NP	Nickel (Ni)	Very high temperature capability, but harder than either Silver or Copper even when annealed. Used instead of silver in hot, oxidizing environments.	1200	not limited
AP	Gold under Silver	Oxidizing environments above 430°C. As high temperature oxygen permeates the outer silver layer, the thin gold layer ensures proper adhesion of the silver.	650	not limited
TC	Teflon (PTFE)	Chemically inert soft polymer. Not for use with high load seals. Permits some permeation of gases.	230	80

Shaded Boxes represent the most common finishes.

Finish Thickness Selection Guidelines

Finish of the mating surfaces is an important factor in selecting the most appropriate plating or coating thickness. Generally, rougher surfaces require thicker finishes to ensure proper sealing. Refer to the appropriate seal cross section in the bar chart below. Locate the flange surface finish in the bar above the seal free height to determine the appropriate finish thickness on the left.



Available Finish Thicknesses

Finish Thickness Code	P Finish Thickness (mm)
A	0,01 – 0,03
B	0,03 – 0,04
C	0,04 – 0,06
D	0,05 – 0,08
E	0,06 – 0,09
F	0,08 – 0,10
G	0,10 – 0,15
H	0,15 – 0,23
J	0,09 – 0,13
K	0,13 – 0,18
M	0,10 – 0,13
N	0,03 – 0,05

Chemical Compatibility Guidelines

NOTE The following table is intended as a guide to the engineer in the selection of EnerRing materials. Since the resistance of the material to the chemical can be affected by concentration, temperature, the presence of impurities, and other factors, this information should only be used as a general guide. Advanced Products cannot accept responsibility for problems arising from the use of this information.

All recommendations assume ambient temperature unless otherwise noted.

RATINGS

★ GOOD
☆ FAIR
⊘ NOT RECOMMENDED
blank NO INFORMATION AVAILABLE

Medium to be sealed	304 Stainless Steel	316 Stainless Steel	321 Stainless Steel	347 Stainless Steel	17-4 PH Stainless Steel	Stainless Steel Alloy A-286	Alloy 600	Alloy 625	Alloy 718	Alloy X-750	Hastelloy C-276	Waspaloy	Rene 41	Monel 400	Haynes 25, Haynes 188	Cobalt Chromium-Nickel Alloy	Aluminum Al 1100-0	Copper	Gold	Nickel	Silver	Titanium
Acetic Acid	☆	☆	☆	☆	★		☆	☆	☆	☆	★	☆	☆	☆	☆	★	☆	⊘	☆	☆	★	★
Acetone	☆	☆	☆	☆	★		★	★	★	★	★	★	★	★		★	☆	★	☆	★		★
Alcohol	☆	★	☆	☆			★	★	★	★	★	★	★	★		★	☆	★	☆	☆		★
Aluminum Sulphate	★	★	★	★	★		⊘	⊘	⊘	⊘	★	⊘	⊘	⊘			⊘	⊘		☆		★
Alum	⊘	⊘	⊘	⊘	☆		⊘	⊘	⊘	⊘	★	⊘	⊘	⊘			⊘	⊘		☆	⊘	⊘
Ammonia	⊘	⊘	⊘	⊘			☆	☆	☆	☆	★	☆	☆	⊘			☆	⊘		★	★	★
Ammonium Chloride	☆	☆	☆	☆	☆		☆	☆	☆	☆	★	☆	☆	☆		★	⊘	⊘		☆		★
Ammonium Hydroxide	★	★	★	★	★		★	★	★	★	★	★	★	★			⊘	⊘	☆	☆		★
Ammonium Nitrate	★	★	★	★	★		⊘	⊘	⊘	⊘	★	⊘	⊘	⊘			☆	⊘		☆		⊘
Ammonium Persulphate	☆	☆	☆	☆			☆	☆	☆	☆	★	☆	☆	⊘			⊘	⊘		⊘		☆
Ammonium Sulphate	☆	☆	☆	☆	★		☆	☆	☆	☆	★	☆	☆	☆		★	⊘	⊘		☆		★
Amyl Alcohol	☆	☆	☆	☆			☆	☆	☆	☆	★	☆	☆	☆		★	☆	★	☆	☆		★
Aniline	★	★	★	★			☆	☆	☆	☆	★	☆	☆	☆			☆	⊘	☆	☆	★	★
Asphalt	★	★	★	★			★	★	★	★	★	★	★	☆			⊘	⊘				★
Barium Hydroxide	☆	★	☆	☆	★		☆	☆	☆	☆	★	☆	☆	☆	★		⊘	⊘	☆	★		⊘
Barium Sulphate	☆	☆	☆	☆			☆	☆	☆	☆	★	☆	☆	☆			☆	☆	☆	☆		★
Boric Acid	☆	☆	☆	☆			☆	☆	☆	☆	★	☆	☆	☆			⊘	☆		☆	★	★
Butanol	★	★	★	★			★	★	★	★	★	★	★	★		★	☆	★	☆	☆		★
Calcium Chlorate	☆	☆	☆	☆			☆	☆	☆	☆	★	☆	☆	☆			☆	☆		☆		★

This chart is to be modified in accordance with the American Design Manual Revisions.

Medium to be sealed	304 Stainless Steel	316 Stainless Steel	321 Stainless Steel	347 Stainless Steel	17-4 PH Stainless Steel	Stainless Steel Alloy A-286	Alloy 600	Alloy 625	Alloy 718	Alloy X-750	Hastelloy C-276	Waspaloy	Rene 41	Monel 400	Haynes 25, Haynes 188	Cobalt Chromium-Nickel Alloy	Aluminum Al 1100-0	Copper	Gold	Nickel	Silver	Titanium
Calcium Chloride	☆	☆	☆	☆	★		☆	☆	☆	☆	★	☆	☆	☆		★	★	☆		⊘		★
Carbon Dioxide - Dry Gas	★	★	★	★	★	★	★	★	★	★		★	★	★		★	★	★		☆	★	⊘
Carbon Dioxide - Wet Gas	★	★	★	★	★	★	★	★	★	★	★	★	★	★		★	★	⊘		☆	★	⊘
Carbon Tetrachloride	★	★	★	★	★	★	★	★	★	★	★	★	★	★			⊘	★		⊘		★
Castor Oil	★	★	★	★		★	★	★	★	★	★	★	★	★			★	★				★
Caustic Soda	⊘	☆	⊘	⊘	☆		☆	☆	☆	☆	☆	☆	☆	☆			⊘	⊘	☆	⊘		★
Chlorine Gas - Dry	☆	☆	☆	☆	☆		☆	☆	☆	☆	★	☆	☆	☆			⊘	⊘	⊘	☆	⊘	★
Chlorine Gas - Wet	⊘	⊘	⊘	⊘			⊘	⊘	⊘	⊘	☆	⊘	⊘	⊘			⊘	⊘	⊘		⊘	★
Chromic Acid	⊘	⊘	⊘	⊘	⊘		⊘	⊘	⊘	⊘	★	⊘	⊘	⊘	☆	⊘	⊘	⊘		⊘		★
Citric Acid	☆	☆	☆	☆	☆		☆	☆	☆	☆	★	☆	☆	☆		★	⊘	⊘	★	☆		★
Copper Chloride	⊘	⊘	⊘	⊘			⊘	⊘	⊘	⊘	★	⊘	⊘	⊘	☆		⊘	⊘		⊘		★
Copper Nitrate	☆	☆	☆	☆			⊘	⊘	⊘	⊘	★	⊘	⊘	⊘			⊘	⊘		☆		★
Copper Sulphate	☆	☆	☆	☆	★		⊘	⊘	⊘	⊘	★	⊘	⊘	⊘			⊘	⊘		☆		★
Creosote	☆	☆	☆	☆	★		☆	☆	☆	☆	★	☆	☆	☆			☆	☆		☆		
Diethylene Glycol	★	★	★	★			☆	☆	☆	☆		☆	☆	☆			☆	☆	☆			★
Ether	☆	☆	☆	☆	★		☆	☆	☆	☆	★	☆	☆	☆		★	☆	☆	☆	☆		★
Ethyl Chloride	☆	★	☆	☆	★		★	★	★	★	★	★	★	☆			☆	★		☆		★
Ethylene Glycol	☆	☆	☆	☆	★		☆	☆	☆	☆	★	☆	☆	☆		★	★	☆	☆	☆		★
Fatty Acids	☆	★	☆	☆			☆	☆	☆	☆	★	☆	☆	☆			★	⊘		☆	★	★
Ferric Chloride	⊘	⊘	⊘	⊘			⊘	⊘	⊘	⊘	★	⊘	⊘	⊘	☆	★	⊘	⊘		⊘		★
Ferric Nitrate	☆	☆	☆	☆	★		⊘	⊘	⊘	⊘	★	⊘	⊘	⊘			⊘	⊘		⊘		★
Ferric Sulphate	☆	☆	☆	☆	★		☆	☆	☆	☆	★	☆	☆	⊘		☆	⊘	⊘		⊘		★
Fluorine Gas - Wet																				★		
Fluorine Gas - Dry	☆	☆	☆	☆			★	★	★	★	★	★	★	★			⊘	⊘	☆			★
Formaldehyde	★	★	★	★	★		☆	☆	☆	☆	★	☆	☆	☆			☆	☆		☆	★	★
Formic Acid	★	★	★	★	★		☆	☆	☆	☆	★	☆	☆	☆			☆	☆		☆	★	☆
Freon	★	★	★	★	★	★	★	★	★	★	★	★	★	★	☆	★	★	★				
Fuel Oil - Normal	★	★	★	★		★	☆	☆	☆	☆	★	☆	☆	☆		★	★	★		☆		★
Fuel Oil - Acid	☆	☆	☆	☆			☆	☆	☆	☆		☆	☆	☆			⊘	⊘		☆		
Gasoline - Refined	★	★	★	★			☆	☆	☆	☆	★	☆	☆	☆		★	★	★		☆		
Gasoline - Sour	☆	☆	☆	☆			⊘	⊘	⊘	⊘	★	⊘	⊘	⊘		★	☆	☆		⊘		
Glycerin, Glycerol	★	★	★	★	★	★	★	★	★	★	★	★	★	★		★	★	☆				★
Hydrochloric Acid	⊘	⊘	⊘	⊘			⊘	⊘	⊘	⊘	★	⊘	⊘	⊘	☆	⊘	⊘	⊘	☆	⊘	⊘	⊘
Hydrocyanic Acid	☆	☆	☆	☆			☆	☆	☆	☆	★	☆	☆	☆			☆	⊘		☆		★

This chart is to be modified in accordance with the American Design Manual Revisions.

Medium to be sealed	304 Stainless Steel	316 Stainless Steel	321 Stainless Steel	347 Stainless Steel	17-4 PH Stainless Steel	Stainless Steel Alloy A-286	Alloy 600	Alloy 625	Alloy 718	Alloy X-750	Hastelloy C-276	Waspaloy	Rene 41	Monel 400	Haynes 25, Haynes 188	Cobalt Chromium-Nickel Alloy	Aluminum Al 1100-0	Copper	Gold	Nickel	Silver	Titanium
Hydrofluoric Acid	⊘	⊘	⊘	⊘			⊘	⊘	⊘	⊘	☆	⊘	⊘	⊘			⊘	⊘	☆	☆	★	⊘
Hydrogen Peroxide	☆	☆	☆	☆			☆	☆	☆	☆	★	☆	☆	☆			★	⊘				★
Kerosene	★	★	★	★		★	★	★	★	★	★	★	★	★		★	★	★		☆		★
Lacquer Solvent	★	★	★	★			☆	☆	☆	☆		☆	☆	☆			★	★				★
Lead Acetate	★	★	★	★			★	★	★	★	★	★	★	★			⊘	⊘		☆		★
Lead Acid Salts	★		★	★																		
Linseed Oil	★	★	★	★			☆	☆	☆	☆		☆	☆	☆			☆	☆		☆		
Magnesium Chloride	☆	☆	☆	☆	☆		★	★	★	★	★	★	★	⊘			⊘	☆		★	★	★
Magnesium Hydroxide	★	★	★	★		★	★	★	★	★	★	★	★	☆		★	⊘	★		★		★
Mercury	★	★	★	★			☆	☆	☆	☆	★	☆	☆	☆			⊘	⊘		☆	⊘	★
Methyl Chloride	☆	☆	☆	☆			☆	☆	☆	☆	★	☆	☆	☆			⊘	★		☆		★
Methylene Chloride	☆	☆	☆	☆			☆	☆	☆	☆	★	☆	☆	☆			☆	☆		☆		★
Mineral Oil	★	★	★	★		★	★	★	★	★		★	★	★		★	★	★		☆		★
Muriatic Acid	⊘	⊘	⊘	⊘			⊘	⊘	⊘	⊘		⊘	⊘	⊘			⊘	⊘	☆	⊘		
Naphtha	★	★	★	★			★	★	★	★	★	★	★	★			★	★		☆		★
Nickel Chloride	⊘	⊘	⊘	⊘			☆	☆	☆	☆	★	☆	☆	☆			⊘	⊘		☆		★
Nickel Sulphate	☆	☆	☆	☆			☆	☆	☆	☆	★	☆	☆	☆			⊘	☆	☆	☆		★
Nitric Acid	☆	☆	☆	☆	⊘		⊘	⊘	⊘	⊘	★	⊘	⊘	⊘	☆	☆	⊘	⊘	☆	⊘	⊘	★
Nitrobenzene	☆	☆	☆	☆			☆	☆	☆	☆	★	☆	☆	☆			☆	☆		☆		★
Oil	★	★	★	★		★	★	★	★	★	★	★	★	★		★	★	★				★
Oleic Acid	☆	☆	☆	☆			★	★	★	★	★	★	★	☆			☆	☆		☆		☆
Oxalic Acid	⊘	⊘	⊘	⊘	⊘		☆	☆	☆	☆	★	☆	☆	☆		★	⊘	☆		☆	⊘	⊘
Paraffin	★	★	★	★							★			☆			★	★		☆		
Petroleum - Crude	★	★	★	★										★			★					
Phenol	☆	☆	☆	☆	★		☆	☆	☆	☆	★	☆	☆	☆		★	☆	★	☆	☆	★	☆
Phosphate		★																	☆			
Phosphoric Acid	⊘	☆	⊘	⊘	★		☆	☆	☆	☆	★	☆	☆	☆	☆	☆	⊘	☆	☆		★	⊘
Potassium Acid Sulphate																			☆	☆		
Potassium Chloride	☆	★	☆	☆	★		☆	☆	☆	☆	★	☆	☆	☆			⊘	⊘	☆	☆		★
Potassium Cyanide	☆	☆	☆	☆			☆	☆	☆	☆	★	☆	☆	☆			⊘	⊘	⊘	☆	⊘	⊘
Potassium Hydroxide	☆	☆	☆	☆	☆		☆	☆	☆	☆	★	☆	☆	☆			⊘	⊘	☆	☆	★	☆
Potassium Nitrate	☆	☆	☆	☆	★		☆	☆	☆	☆	★	☆	☆	☆			★	☆		☆		★
Potassium Sulphate	★	★	★	★	★		☆	☆	☆	☆	★	☆	☆	★			★	☆	☆	☆	★	★

This chart is to be modified in accordance with the American Design Manual Revisions.

Medium to be sealed	304 Stainless Steel	316 Stainless Steel	321 Stainless Steel	347 Stainless Steel	17-4 PH Stainless Steel	Stainless Steel Alloy A-286	Alloy 600	Alloy 625	Alloy 718	Alloy X-750	Hastelloy C-276	Waspaloy	Rene 41	Monel 400	Haynes 25, Haynes 188	Cobalt Chromium-Nickel Alloy	Aluminum Al 1100-0	Copper	Gold	Nickel	Silver	Titanium
Silver Bromide	⊘	⊘	⊘	⊘	⊘									☆			⊘	⊘				★
Silver Cyanide	★	★	★	★										☆			⊘	⊘				
Silver Nitrate	☆	☆	☆	☆			☆	☆	☆	☆	★	☆	☆	⊘			⊘	⊘		⊘		★
Soap Solutions	★	★									★			★			⊘			☆		
Sodium Chloride	⊘	⊘	⊘	⊘			★	★	★	★	★	★	★	★		★	⊘	☆	☆	☆	★	★
Sodium Cyanide	★	★	★	★	★		★	★	★	★		★	★	⊘		★	⊘	⊘	⊘	⊘		★
Sodium Hydroxide	⊘	☆	⊘	⊘	☆		☆	☆	☆	☆	★	☆	☆	☆	☆	★	⊘	⊘	☆	☆	★	★
Sodium Hypochlorite	⊘	⊘	⊘	⊘	⊘		⊘	⊘	⊘	⊘	★	⊘	⊘	⊘		★	⊘	⊘		⊘		★
Sodium Nitrate	★	★	★	★	★		★	★	★	★	★	★	★	☆			⊘	☆		☆	⊘	★
Sodium Peroxide	☆	★	☆	☆	★						★			☆			☆	⊘		☆		
Sodium Phosphate	☆	☆	☆	☆	★		☆	☆	☆	☆	★	☆	☆	☆			⊘	☆	☆	☆	★	★
Sodium Silicate	☆	☆	☆	☆			☆	☆	☆	☆		☆	☆	☆			⊘	☆		☆		★
Sodium Sulphate	⊘	☆	⊘	⊘	★		☆	☆	☆	☆		☆	☆	☆		★	★	☆	☆	☆		★
Sodium Sulphide	⊘	☆	⊘	⊘	★		☆	☆	☆	☆		☆	☆	☆		★	⊘	⊘	☆	☆		★
Stearic Acid	☆	★	☆	☆			★	★	★	★	★	★	★	⊘			☆	⊘		☆		★
Sugar Solution	★	★	★	★			★	★	★	★		★	★				★	★				★
Sulfuric Acid	⊘	⊘	⊘	⊘			⊘	⊘	⊘	⊘		⊘	⊘	⊘		⊘	⊘	⊘	☆	⊘	⊘	⊘
Sulfurous Acid	⊘	⊘	⊘	⊘			⊘	⊘	⊘	⊘	★	⊘	⊘	⊘	☆		☆	⊘	☆	⊘		★
Sulfamic Acid	⊘	⊘	⊘	⊘													⊘			⊘		
Sulfur	★	★	★	★			★	★	★	★		★	★	☆			★	⊘	☆		⊘	★
Sulfur Chloride	☆	☆	☆	☆			☆	☆	☆	☆		☆	☆	☆			⊘	⊘	☆			
Sulfur Dioxide	☆	☆	☆	☆	★		☆	☆	☆	☆	★	☆	☆	⊘			☆	☆	★	☆	⊘	★
Tannic Acid	☆	☆	☆	☆	★		☆	☆	☆	☆	★	☆	☆	☆			☆	⊘		☆		★
Trichloroethane	★	★	★	★			★	★	★	★		★	★	★		★	★	★				★
Trichlorethylane	★	★	★	★	★		★	★	★	★	★	★	★	☆		★	★	☆		☆		★
Trisodium Phosphate	☆	☆	☆	☆							★			☆			⊘	☆		☆	★	
Vinegar	★	★									★			★							★	★
Water - Deionized	★	★	★	★		★	★	★	★	★	★	★	★	★		★	⊘	⊘				★
Water - Demineralized	★	★	★	★		★	★	★	★	★	★	★	★	★		★	⊘	⊘		☆		★
Water - Pure	★	★	★	★	★	★	★	★	★	★	★	★	★	★		★	⊘	⊘		☆		★
Water - Potable	☆	☆	☆	☆	★		★	★	★	★	★	★	★	★		★	☆	☆		☆		★
Water - Sea	☆	☆	☆	☆			☆	☆	☆	☆	★	☆	☆	★		★		⊘			★	★
Whiskey	★	★	★	★							★			★		★		★		☆		
Zinc Chloride	⊘	⊘	⊘	⊘			☆	☆	☆	☆		☆	☆	☆		★	⊘	⊘		☆		☆

This chart is to be modified in accordance with the American Design Manual Revisions.


ER0597

Technical Information

This section provides additional information about EnerRing design, use and performance. It allows the design engineer to fine tune the cavity requirements to ensure optimum seal performance.

This section includes:

Performance Data: Load, Deflection and Springback

All EnerRing seals, except for metal wire rings, are designed to undergo both plastic and elastic deformation when installed. (Wire rings are essentially limited to plastic deformation only.)

Plastic deformation of the jacket, or O-Ring tubing, enlarges the contact area, or "footprint", to bridge across surface imperfections or tool marks in the mating surfaces. It also creates a reduced gradient in the load/deflection curve to permit a wide tolerance in the working height, resulting in a robust sealing process. High integrity sealing is ensured by the ductile outer layer or coating which, being inelastic and of low compressive yield strength, flows into and fills the mating surface asperities.

Elastic deformation provides elastic recovery or "springback" to maintain good sealing, despite separation of the mating surfaces due to the effects of thermal cycling, flange rotation, applied mechanical or hydrostatic loads or creep.

TERMINOLOGY

Free Height: The cross-sectional height of an uncompressed seal. This is conventionally stated *before* platings or coatings.

Working Height: The cross-sectional height of an installed seal, which is equivalent to the groove depth. Many EnerRings allow wide tolerance in the permissible working height, to accommodate tolerance stack ups.

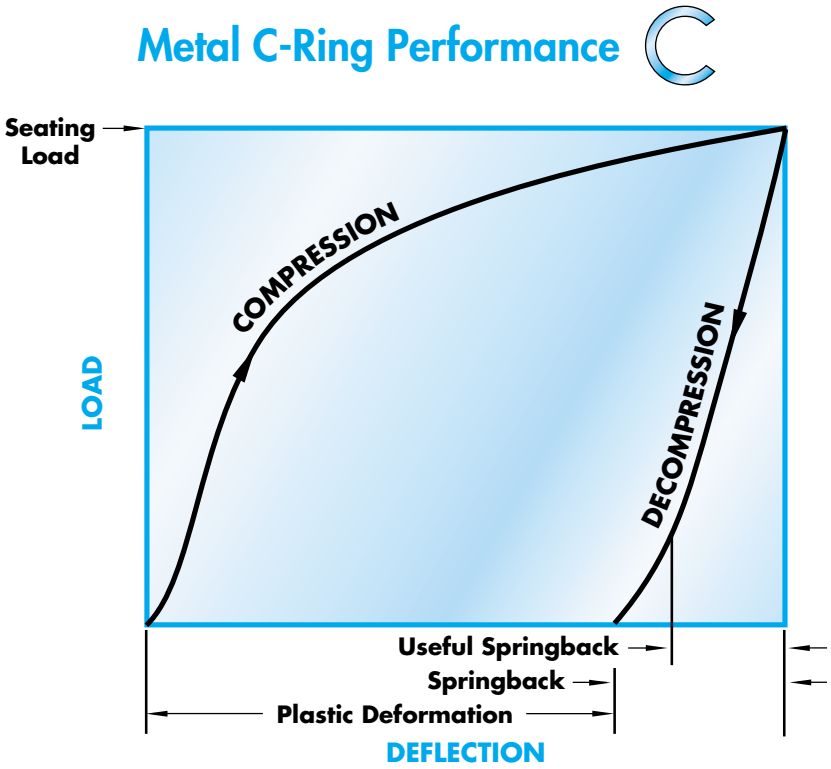
Seating Load: The load required to compress a seal to the working height: for convenience, all loads are conventionally stated per unit circumferential length. Generally, a higher seating load will ensure greater leak tightness.

Springback: The difference between the working height and the (reduced) free height after all applied loads have been released: this represents the total elastic recovery of the seal.

Useful Springback: That portion of the springback curve where the load exceeds 20-25% of the load at working height. Below this, the load may be insufficient to maintain good seal performance.

Working, Proof, and Burst Pressures: The working pressures given in this Design Manual are the maximum for both steady-state and cyclical pressures (subject to fatigue considerations) with the groove to seal diametrical clearances recommended in Section C.

Where high pressure transients are expected, or installed seals are subject to a proof test (as part of a 100% acceptance test, not a type test), designers should select a metal seal with a working pressure sufficient to accommodate such high pressure exposures.



Burst testing may be performed at pressures higher than the rated working pressure. Experience has shown that pressure energized metal seals will seal effectively at pressures significantly beyond their working pressure, although some permissible permanent deformation of the seal may occur.

Leakage failure may occur at extremely high pressures, however, this is typically the result of flange or joint separation or distortion, due to the high hydrostatic loads under such conditions. The onset of leakage will be detected when such flange separation exceeds the useful springback of the seal.

Metal C-Ring Performance

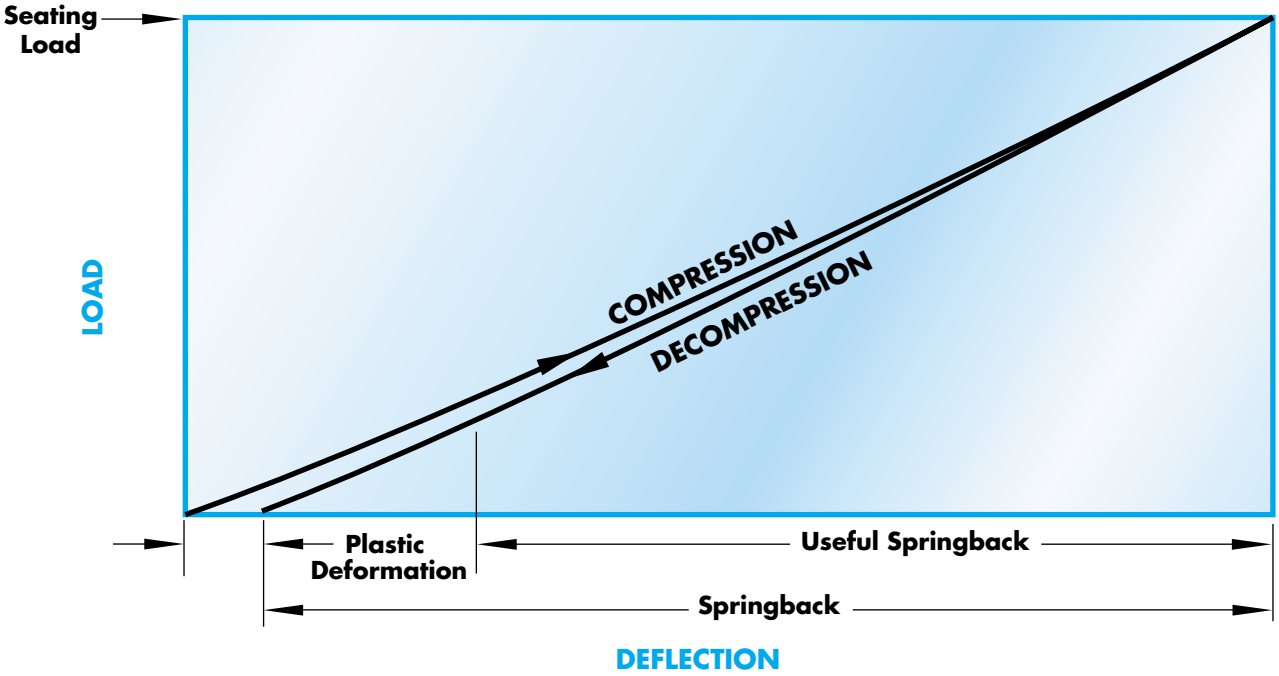
Based on nominal seal dimensions, recommended cavity dimensions, and ambient temperature. If working pressures exceed the ratings below, consult us for recommendations.

FREE HEIGHT	MATERIAL THICKNESS	CROSS SECTION CODE	TEMPER CODE	MATERIAL	SEATING LOAD (N/mm circum)	SPRINGBACK (mm)	WORKING PRESSURE RATING (MPa)
0,79	0,15	01	-6	Alloy X-750 Alloy 718 Waspaloy	25 30 25	0,04 0,04 0,04	480 530 480
	0,18	02	-6	Alloy X-750 Alloy 718 Waspaloy	35 40 35	0,03 0,03 0,03	620 690 620
1,19	0,15	03	-6	Alloy X-750 Alloy 718 Waspaloy	15 20 15	0,05 0,05 0,05	260 290 260
	0,20	04	-6	Alloy X-750 Alloy 718 Waspaloy	35 40 35	0,05 0,05 0,05	390 430 390
1,57	0,15	05	-6	Alloy X-750 Alloy 718 Waspaloy	12 15 12	0,08 0,08 0,08	180 200 180
	0,25	06	-6	Alloy X-750 Alloy 718 Waspaloy	45 50 45	0,05 0,05 0,05	360 400 360
2,39	0,25	07	-6	Alloy X-750 Alloy 718 Waspaloy	25 30 25	0,13 0,15 0,13	200 230 200
	0,38	08	-6	Alloy X-750 Alloy 718 Waspaloy	60 70 60	0,10 0,13 0,10	360 390 360
3,18	0,38	09	-6	Alloy X-750 Alloy 718 Waspaloy	45 55 45	0,15 0,18 0,15	240 260 240
	0,51	10	-6	Alloy X-750 Alloy 718 Waspaloy	95 100 95	0,13 0,15 0,13	360 390 360
3,96	0,41	11	-6	Alloy X-750 Alloy 718 Waspaloy	40 45 40	0,20 0,23 0,20	200 220 200
	0,61	12	-6	Alloy X-750 Alloy 718 Waspaloy	95 100 95	0,15 0,18 0,15	340 370 340
4,78	0,51	13	-6	Alloy X-750 Alloy 718 Waspaloy	55 60 55	0,23 0,25 0,23	200 220 200
	0,76	14	-6	Alloy X-750 Alloy 718 Waspaloy	115 130 115	0,18 0,20 0,18	360 390 360
6,35	0,64	15	-6	Alloy X-750 Alloy 718 Waspaloy	60 70 60	0,28 0,33 0,28	190 210 190
	0,97	16	-6	Alloy X-750 Alloy 718 Waspaloy	150 180 150	0,20 0,23 0,20	330 360 330
9,53	0,97	17	-6	Alloy X-750 Alloy 718 Waspaloy	90 110 90	0,43 0,51 0,43	190 210 190
	1,45	18	-6	Alloy X-750 Alloy 718 Waspaloy	230 260 230	0,33 0,38 0,33	280 300 280
12,70	1,27	19	-6	Alloy X-750 Alloy 718 Waspaloy	120 140 120	0,56 0,64 0,56	190 210 190
	1,91	20	-6	Alloy X-750 Alloy 718 Waspaloy	260 300 260	0,43 0,51 0,43	270 290 270

Metal E-Ring Performance

FREE HEIGHT	MATERIAL THICKNESS	CROSS SECTION CODE	TEMPER CODE	MATERIAL	SEATING LOAD (N/mm circum)	SPRINGBACK (mm)	WORKING PRESSURE RATING (MPa)
1,88	0,13	05	-6	Alloy 718 Waspaloy	5 4	0,23 0,20	10 10
2,74	0,25	07	-6	Alloy 718 Waspaloy	7 6	0,46 0,38	10 10
	0,25	08	-6	Alloy 718 Waspaloy	16 13	0,33 0,28	35 35
3,53	0,30	09	-6	Alloy 718 Waspaloy	8 7	0,53 0,46	10 10
	0,30	10	-6	Alloy 718 Waspaloy	11 9	0,51 0,43	25 25
5,54	0,38	13	-6	Alloy 718 Waspaloy	9 8	0,89 0,76	15 15
7,49	0,51	15	-6	Alloy 718 Waspaloy	14 12	1,17 1,02	15 15

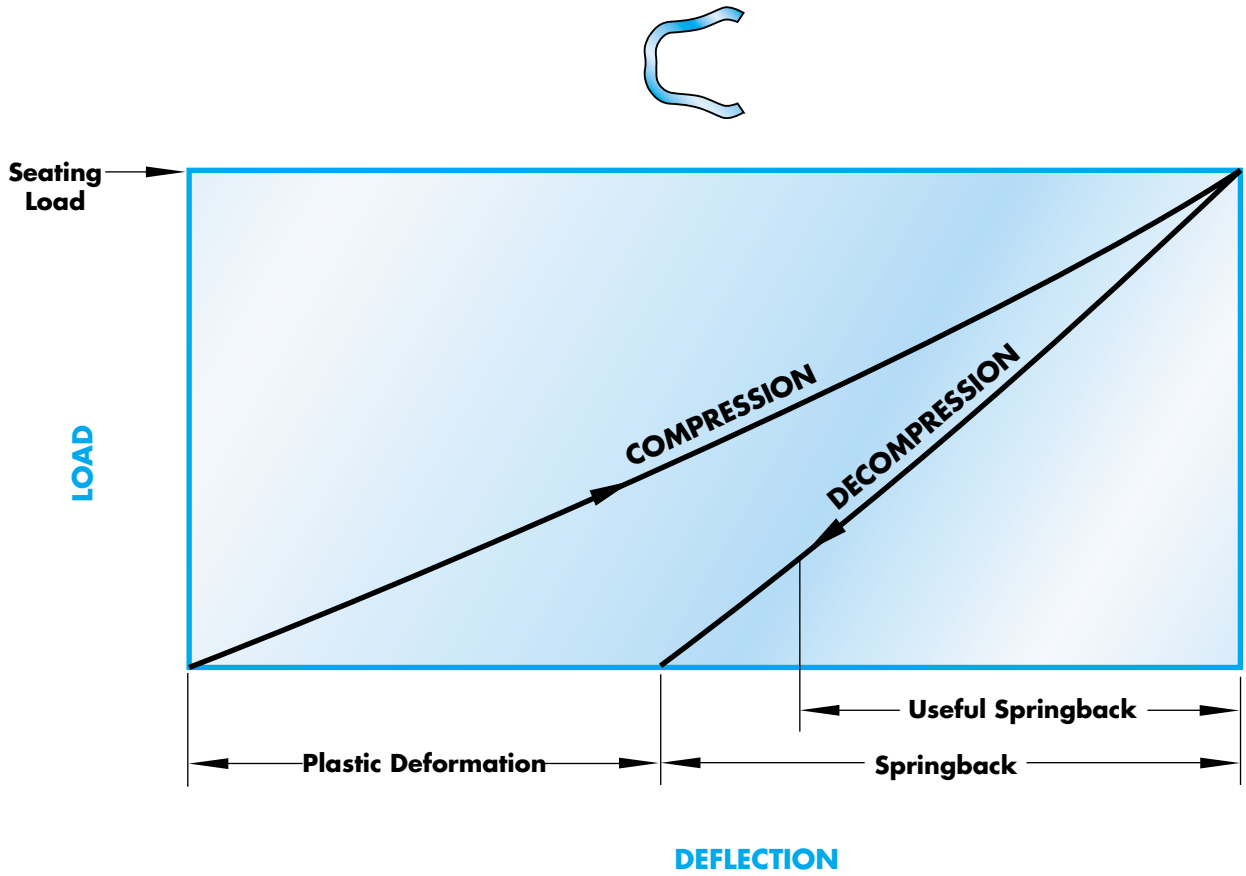
Based on nominal seal dimensions, recommended cavity dimensions, and ambient temperature.
If working pressures exceed the above ratings consult us for recommendations.
Refer to page E-2 for a definition of the above performance terminology.



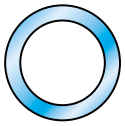
Metal U-Ring Performance

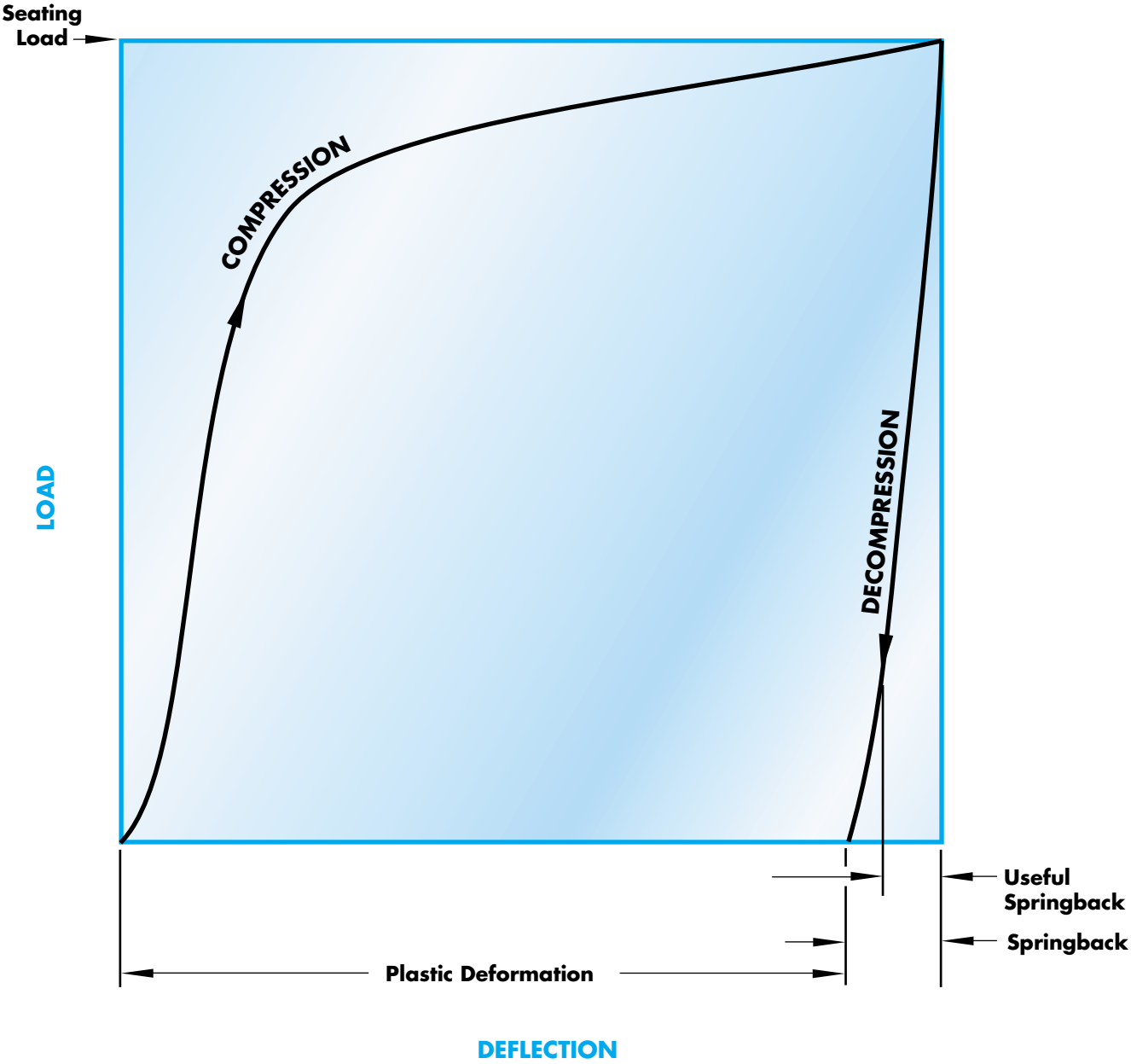
FREE HEIGHT	MATERIAL THICKNESS	CROSS SECTION CODE	TEMPER CODE	MATERIAL	SEATING LOAD (N/mm circum)	SPRINGBACK (mm)	WORKING PRESSURE RATING (MPa)
1,60	0,15	05	-6	Alloy 718 Waspaloy	5 4	0,15 0,13	26 26
2,36	0,25	07	-6	Alloy 718 Waspaloy	8 7	0,25 0,23	28 28
3,18	0,30	09	-6	Alloy 718 Waspaloy	9 8	0,36 0,30	28 28
4,70	0,38	13	-6	Alloy 718 Waspaloy	9 8	0,51 0,43	24 24
6,27	0,51	15	-6	Alloy 718 Waspaloy	12 11	0,66 0,58	24 24

Based on nominal seal dimensions, recommended cavity dimensions, and ambient temperature.
If working pressures exceed the above ratings consult us for recommendations.
Refer to page E-2 for a definition of the above performance terminology.



Metal O-Ring Performance





Metal O-Ring Performance

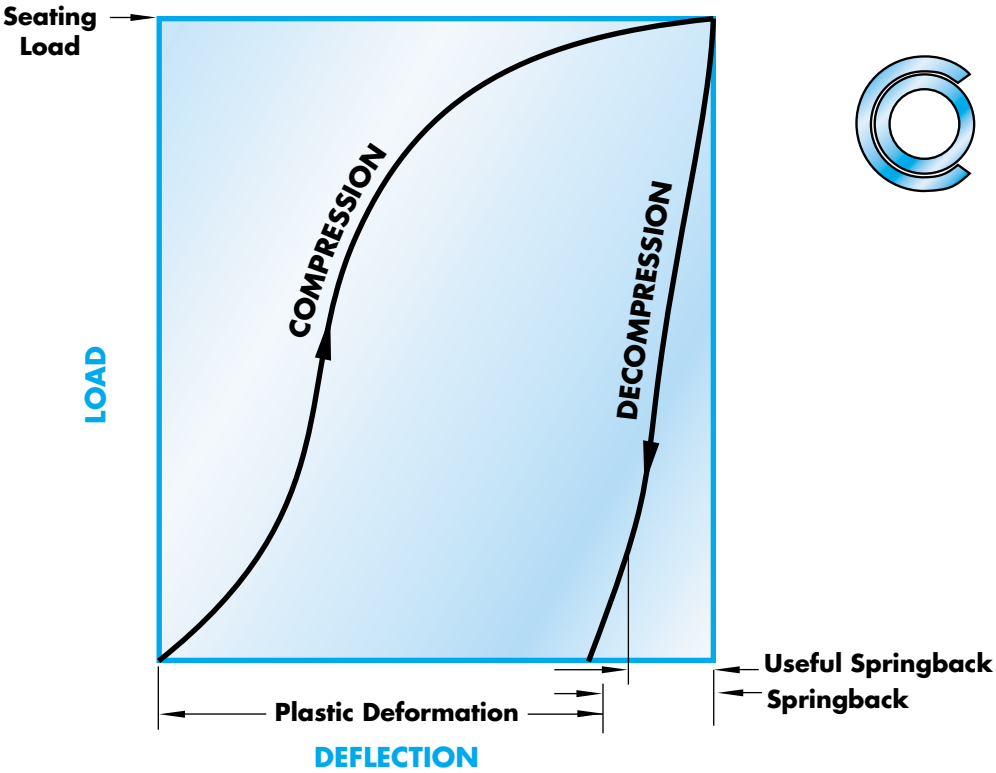
FREE HEIGHT	MATERIAL THICKNESS	CROSS SECTION CODE	TEMPER CODE	MATERIAL	SEATING LOAD (N/mm circum)	SPRINGBACK (mm)	WORKING PRESSURE RATING (MPa)	
							VENTED	NON-VENTED
0,89	0,15	01	-1	321 SS Alloy X-750	70 100	0,01 0,01	70 100	5 7
1,19	0,18	29	-1	321 SS Alloy X-750	70 100	0,03 0,03	50 70	5 7
1,57	0,15	02	-1	321 SS Alloy X-750	50 60	0,04 0,05	30 45	4 6
	0,25	03	-1	321 SS Alloy X-750	100 130	0,03 0,04	80 110	5 7
	0,30	31	-1	321 SS Alloy X-750	140 190	0,03 0,03	100 140	5 8
	0,36	08	-1	321 SS Alloy X-750	190 260	0,03 0,03	120 170	6 8
2,39	0,15	04	-1	321 SS Alloy X-750	30 40	0,05 0,05	10 15	5 7
	0,25	05	-1	321 SS Alloy X-750	50 70	0,05 0,05	30 40	6 8
	0,30	32	-1	321 SS Alloy X-750	70 100	0,03 0,04	40 70	6 8
	0,46	09	-1	321 SS Alloy X-750	210 280	0,03 0,04	110 170	6 9
3,18	0,20	06	-1	321 SS Alloy X-750	20 20	0,10 0,13	15 30	3 5
	0,25	07	-1	321 SS Alloy X-750	30 40	0,08 0,10	30 40	3 6
	0,30	25	-1	321 SS Alloy X-750	50 70	0,05 0,08	40 70	4 6
	0,51	10	-1	321 SS Alloy X-750	160 210	0,05 0,05	110 170	5 7
3,96	0,41	11	-1	304 SS Alloy X-750	70 100	0,10 0,13	30 40	5 7
	0,51	12	-1	304 SS Alloy X-750	130 180	0,08 0,10	90 140	5 8
4,78	0,51	13	-1	304 SS Alloy X-750	80 110	0,10 0,13	30 40	5 7
	0,64	14	-1	304 SS Alloy X-750	120 170	0,08 0,10	100 150	5 8
6,35	0,64	15	-1	304 SS Alloy X-750	80 110	0,13 0,15	30 40	5 7
	0,81	16	-1	304 SS Alloy X-750	170 230	0,10 0,13	90 140	5 8
9,53	0,97	17	-1 -6	304 SS Alloy 718	110 180	0,15 0,23	30 60	8 11
	1,24	18	-1 -6	304 SS Alloy 718	190 300	0,13 0,18	50 100	9 14
12,70	1,27	19	-1 -6	304 SS Alloy 718	180 420	0,23 0,43	30 60	8 11
	1,65	20	-1 -6	304 SS Alloy 718	300 670	0,18 0,30	50 100	9 14
15,88	1,60	21	-1 -6	304 SS Alloy 718	250 580	0,28 0,51	30 60	8 11

Based on nominal seal dimensions, recommended cavity dimensions, and ambient temperature. If working pressures exceed the above ratings consult us for recommendations. Refer to page E-2 for a definition of the above performance terminology.

Spring Energized Metal C-Ring Performance

FREE HEIGHT	CROSS SECTION CODE	TEMPER CODE	MATERIAL		SEATING LOAD (N/mm circum)	SPRINGBACK (mm)	WORKING PRESSURE RATING (MPa)
			JACKET	SPRING			
1,57	05	-1	304 SS	304 SS	80	0,08	300
			Alloy X-750	Alloy X-750	90	0,08	450
			Alloy 718	Alloy 718	100	0,08	450
2,39	07	-1	304 SS	304 SS	140	0,10	300
			Alloy X-750	Alloy X-750	150	0,13	450
			Alloy 718	Alloy 718	160	0,15	450
3,18	09	-1	304 SS	304 SS	160	0,13	400
			Alloy X-750	Alloy X-750	170	0,15	650
			Alloy 718	Alloy 718	180	0,18	650
3,96	11	-1	304 SS	304 SS	210	0,18	300
			Alloy X-750	Alloy X-750	230	0,20	450
			Alloy 718	Alloy 718	250	0,23	450
4,78	13	-1	304 SS	304 SS	250	0,20	300
			Alloy X-750	Alloy X-750	260	0,23	500
			Alloy 718	Alloy 718	280	0,25	500
6,35	15	-1	304 SS	304 SS	330	0,25	300
			Alloy X-750	Alloy X-750	350	0,28	400
			Alloy 718	Alloy 718	370	0,30	400
9,53	17	-1	304 SS	304 SS	420	0,38	300
			Alloy X-750	Alloy X-750	440	0,43	400
			Alloy 718	Alloy 718	460	0,46	400
12,70	19	-1	304 SS	304 SS	490	0,51	300
			Alloy X-750	Alloy X-750	510	0,56	400
			Alloy 718	Alloy 718	540	0,61	400

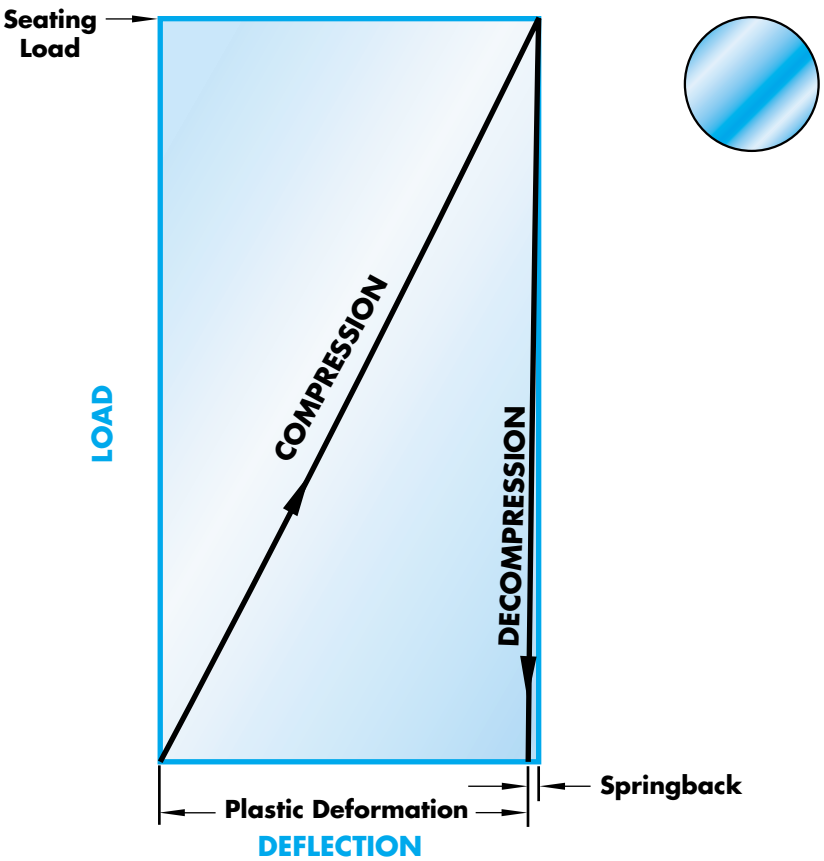
Based on nominal seal dimensions, recommended cavity dimensions, and ambient temperature. If working pressures exceed the above ratings consult us for recommendations. Refer to page E-2 for a definition of the above performance terminology.



Metal Wire Ring Performance

FREE HEIGHT	CROSS SECTION CODE	TEMPER CODE	MATERIAL	SEATING LOAD (N/mm circum)	SPRINGBACK (mm)	WORKING PRESSURE RATING (MPa)
0,89	03	-4	Silver/Gold	160	0	50
			Aluminum	180	0	50
			Copper	420	0	100
			Nickel	530	0	140
			304 Stainless Steel	740	0	140
1,57	05	-4	Silver/Gold	210	0,01	50
			Aluminum	250	0	50
			Copper	600	0	100
			Nickel	740	0	140
			304 Stainless Steel	1050	0,01	140
2,39	06	-4	Nickel	740	0,01	140
			304 Stainless Steel	1050	0,03	140
3,18	07	-4	Nickel	740	0,03	140
			304 Stainless Steel	1050	0,05	140

Based on nominal seal dimensions, recommended cavity dimensions, and ambient temperature. If working pressures exceed the above ratings consult us for recommendations. Refer to page E-2 for a definition of the above performance terminology.

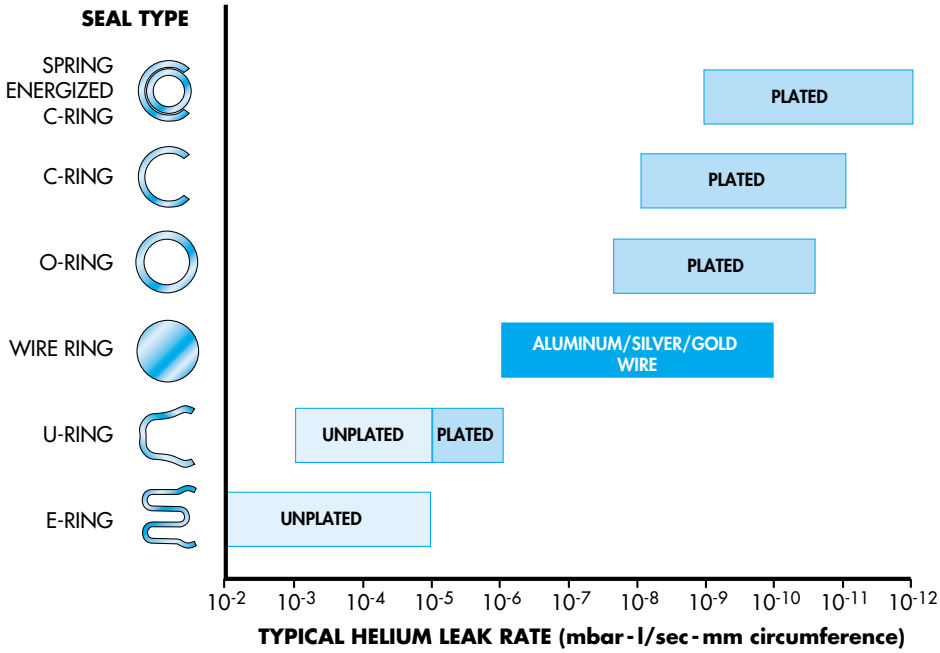


Leak Rate Information

The graph below shows typical ranges of leakage rates that may be expected with various types of seals. Testing was performed in our laboratories in Connecticut, USA and Belgium, using helium mass-spectroscopy leakage detection. A standardized condition of 1 atmosphere differential pressure at 21°C was used in all cases. Test procedures and installation parameters were in accordance with the recommendations given in this Design Manual, including a surface roughness of 0,4-0,8 µm R_a.

The widths of the horizontal bars indicate the spread of leakage values that may be expected depending on the specific plating selection and surface condition. (It should be noted that these results are not directly applicable to liquids, since the much higher viscosities and surface tension will generally prevent leakage entirely).

As a service to our customers, we are pleased to offer specific seal performance testing and analysis for unusually challenging and "mission critical" applications. Testing can be set up to reproduce the actual conditions expected in service. To insure gas-tight seal performance, please contact your local Advanced Products' representative to review both the seal selection and mating hardware configuration.



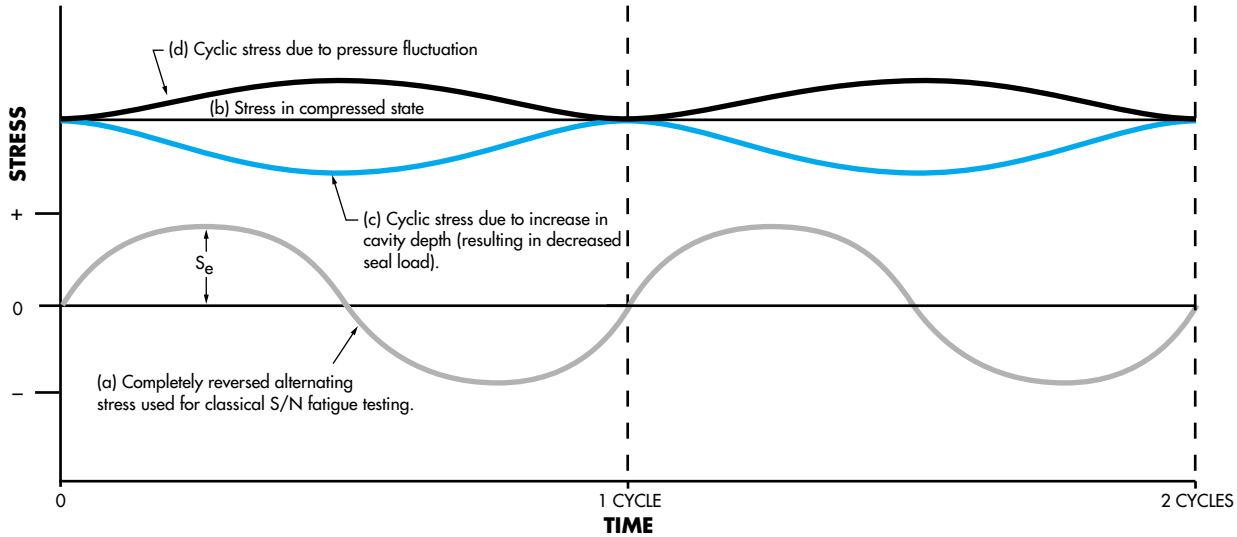
Equivalent leak rates for other gases:
Multiply the helium leakage rate by the following factors to obtain the leakage rate of the following gases: Oxygen: 0.35, Nitrogen: 0.37, Hydrogen: 1.42, Air: 0.37

Leak Rate Equivalents

cc/sec	mbar - l/sec	Torr - l/sec	Pa - m^3/sec	Approximate Equivalent	Approximate 1mm^3 Bubble Equivalent
1	1.01	7.6×10^{-1}	1.01×10^{-1}	2×10^{-3} SCFM	Steady Stream
1×10^{-1}	1.01×10^{-1}	7.6×10^{-2}	1.01×10^{-2}	1 cc every 10 seconds	Steady Stream
1×10^{-2}	1.01×10^{-2}	7.6×10^{-3}	1.01×10^{-3}	1 cc every 100 seconds	10 per second
1×10^{-3}	1.01×10^{-3}	7.6×10^{-4}	1.01×10^{-4}	3 cc per hour	1 per second
1×10^{-4}	1.01×10^{-4}	7.6×10^{-5}	1.01×10^{-5}	1 cc every 3 hours	1 every 10 seconds
1×10^{-5}	1.01×10^{-5}	7.6×10^{-6}	1.01×10^{-6}	1 cc every 24 hours	1 every 100 seconds
1×10^{-6}	1.01×10^{-6}	7.6×10^{-7}	1.01×10^{-7}	1 cc every 2 weeks	3 per hour
1×10^{-7}	1.01×10^{-7}	7.6×10^{-8}	1.01×10^{-8}	3 cc per year	Bubbles too infrequent to observe
1×10^{-8}	1.01×10^{-8}	7.6×10^{-9}	1.01×10^{-9}	1 cc every 3 years	
1×10^{-9}	1.01×10^{-9}	7.6×10^{-10}	1.01×10^{-10}	1 cc every 30 years	
1×10^{-10}	1.01×10^{-10}	7.6×10^{-11}	1.01×10^{-11}	1 cc every 300 years	
1×10^{-11}	1.01×10^{-11}	7.6×10^{-12}	1.01×10^{-12}	1 cc every 3000 years	

Fatigue

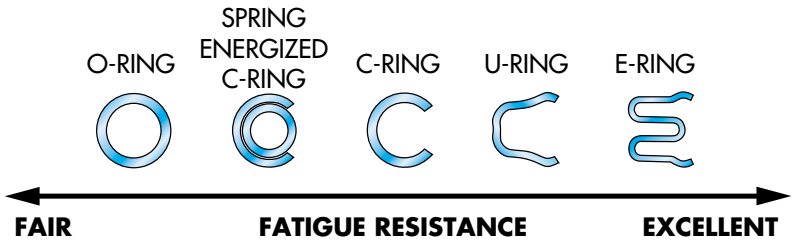
Fatigue is the main failure mechanism in a material that is subjected to fluctuating loads. Under cyclic loading, localized slip bands can form in regions of high localized stresses. As fluctuating loading continues, these bands increase in number and small microscopic cracks form. Given enough time and stress amplitude, the cracks will grow and propagate through the wall of the seal resulting in a fatigue failure and leakage.



There are several types of loading that can result in fatigue failure, the most common type being alternating tension and compression or reversed loading. Loading of this type is illustrated in line (a) in the figure above, and is the type used in fatigue testing to develop the endurance or fatigue limits (S_e) of materials. The endurance limit is the stress below which fatigue failure will not occur, regardless of the number of applied cycles (generally considered 10^7 cycles).

Another type of loading results in stresses modulating from one magnitude to another, in the same direction (low to high tensile stress). This is the type of loading most commonly seen in resilient metal seals. Referring to the figure, the seal is deflected or compressed at installation to a stress level corresponding to line (b). If the seal is then exposed to fluctuating flange separation or cavity growth, the stresses in the seal decrease, then increase as illustrated in line (c). If the seal is subjected to pressure cycling, the stresses in the seal can increase beyond the assembly stresses as illustrated in line (d).

Seals designed for greater springback are more resistant to fatigue due to a combination of cross sectional geometry and material properties including temper.



Stress Relaxation

Any highly stressed component, held at elevated temperatures, is subject to stress relaxation and creep. This is an important consideration in any critical sealing application requiring extended service life at high temperatures. The springback and load retention properties of metallic seals are very important to maintain sealing integrity despite creep in the bolts, for example of a bolted joint.

To maintain these essential properties of springback and load, with as little reduction as possible over extended time, Advanced Products' EnerRings are available in appropriately heat treated, stress relaxation resistant, high temperature alloys.

Installation Guidelines

In addition to the required cavity dimensions provided in Section C, there are other important cavity design issues which affect seal performance.

Surface Roughness Recommendations

The roughness of the mating surfaces directly affects the leak rate when using unplated seals. Selecting high load seals with appropriate plating can substantially offset the affects of rough finishes; however, the guidelines in the adjacent table should be followed whenever possible. We also recommend a turned finish with a circular lay. This is always preferable to a random or radial lay. Discontinuities, radial scratches or pits may be blended, subject to the flatness recommendations given below.

Surfaces with a smoother finish than recommended may actually impair sealing. With the optimum surface roughness and circular lay, the finish embeds within the seal surface. Each ridge of the surface roughness acts as a stress riser and as an independent, redundant sealing line.

To select the appropriate plating or coating material and thickness refer to Page D-6 in the EnerRing Material Selection Section.

Application/Medium Being Sealed	Surface Roughness, R_a	
	μ inch	μ m
Dynamic Axial Seal	4 – 8	0,1 – 0,2
Vacuum Applications	8 – 16	0,2 – 0,4
Helium Gas Hydrogen Gas Freon	8 – 16	0,2 – 0,4
Air Nitrogen Gas Argon Natural Gas Fuel (Aircraft and Automotive)	16 – 32	0,4 – 0,8
Water Hydraulic Oil Crude Oil Sealants	16 – 63	0,4 – 1,6

Surface Flatness Recommendations

EnerRings can accommodate some degree of waviness, or lack of flatness of the mating surfaces. Spring energized seals offer the greatest amount of compliance since each coil of the spring acts as an independent force to assist the jacket in conforming to the mating surface.

Specific surface flatness recommendations:

- Maximum waviness of the cavity mating surfaces must be with in the limits given in the table below.
- The sum of the flatness tolerances of the opposing mating surfaces shall not exceed 4% of the seal free height.
- The cavity depth limits provided in Section C shall not be exceeded.

Maximum Waviness of Cavity Mating Surfaces

	C-Ring	E-Ring	O-Ring	U-Ring	Wire Ring	Spring Energized C-Ring
						
SEAL FREE HEIGHT	**MAXIMUM GRADIENT**					
Less than 2,74 mm	0,002	0,004	0,001	0,002	0,001	0,003
Greater than or equal to 2,74 mm	0,004	0,007	0,002	0,004	0,002	0,005

Surface Hardness Recommendations

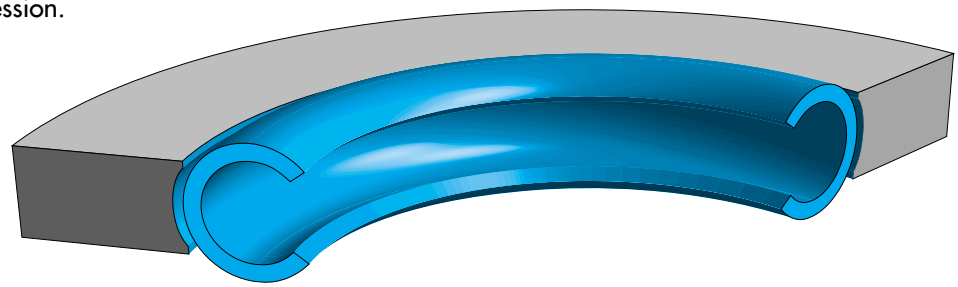
Many EnerRings are designed to produce high seating loads against the mating surfaces to meet ultra low leakage requirements. To withstand these high compressive stresses, without damage to the sealing surfaces, requires these surfaces to have a hardness of at least 35 Rc. This is particularly important when the seal seating load exceeds 200 lb/inch (35 N/mm) of circumference. Dynamic axial seals require a hardness of at least 60 Rc.

Compression Limiters

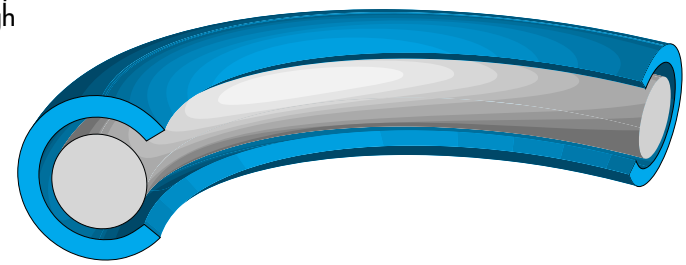
Section C provides the required cavity depths for each type of EnerRing. Using the specified groove depths results in optimal seal compression with the proper seating load and excellent resiliency. Excessive compression can actually reduce sealing stress by creating an excessively broad, or even double footprint. Additionally, the seal may be crushed so that normal springback cannot occur. Equally, under-compression must also be avoided, since it results in low sealing stresses and potential leakage.

When it is not possible or practical to machine the required hardware cavity or cavity depth, a compression limiter may be used. Two types of limiters are available:

External Limiter: The external limiter is a metal plate manufactured to a thickness corresponding to the required working height of the seal. This is the preferred type of compression limiter. It is designed with a large surface area which does not compress even under the highest of compressive loads thus always ensuring proper seal compression. This type of limiter also supports the seal against hoop stresses from internal pressures as well as providing convenient centering within a bolt circle. External limiters are available with a relieved inside diameter which allows the seal to snap into the limiter resulting in a convenient one piece assembly.



Internal Limiter: A solid wire installed within the seal serves as an internal limiter and prevents over-compression of the seal. This method is available with all C-Rings, O-Rings, and Spring Energized C-Rings. Because the wire will also compress under high loads, seal compression with this method may not be as consistent as with the external limiter. Seating loads over 1000 lb/inch (175 N/mm) of circumference may result in excessive compression of the seal and reduced seal performance. The internal limiter also offers no support to the seal against pressure induced hoop stresses and will require a groove for high pressure applications.



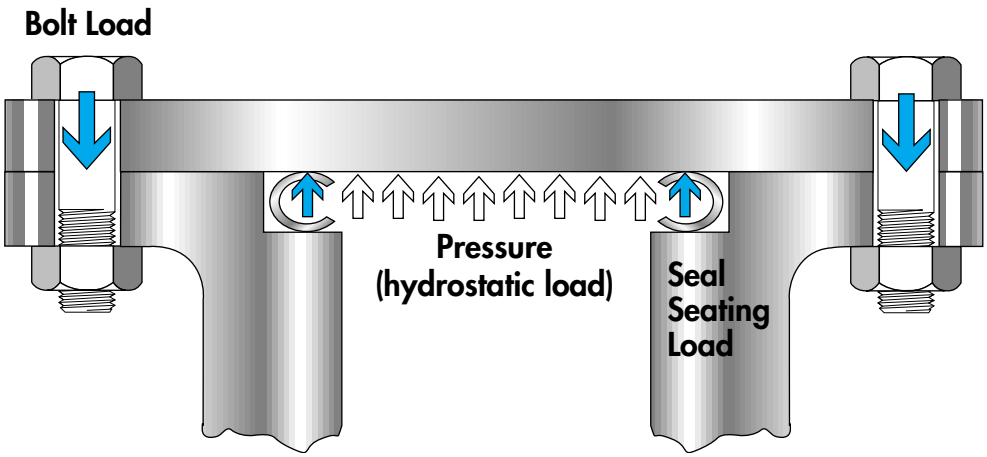
Availability of Limiters

External and Internal limiters can be custom designed for all applications. Contact your nearest Advanced Products office for more information.

Bolt Load & Tightening Torque Guidelines

The EnerRing seating load, or load required to compress the seal, is typically achieved by tightening a number of bolts spaced around the flange. The number, size, and grade of these bolts must be sufficient to compress the seal during installation and withstand the system operating pressure which acts upon the surface of the flange.

Note: These Bolt Load and Tightening Torque Guidelines are not intended to be used as design criteria and are only offered as a general guide. Many other factors such as flange thickness, flange rotation, thermal cycling, bolt stress relaxation, externally applied loads, temperature derating, impulse and fatigue, etc., must be considered by the design engineer to ensure proper bolt and torque selection.



Bolt Load Required ≥ Hydrostatic Load + Seal Seating Load + Safety Margin

The equation below provides the tightening torque required to produce a bolt load for various bolt geometries.

$$T = \frac{L}{1000}\left(0{,}16p + \mu\left(0{,}58d + \frac{D}{2}\right)\right)$$

Where:
- T = torque applied to the bolt, N•m
- L = bolt load, N
- p = bolt thread pitch, mm
- μ = coefficient of friction (assumes thread coefficient = bearing circle coefficient)
- d = bolt pitch diameter, mm
- D = mean bearing circle diameter, mm

The table can be used as a guideline for estimating the bolt load and tightening torque requirements.

Seal Seating Load:

Step 1: Obtain the seal seating load (N/mm circumference) from the tables on pages E-2 through E-9.
Step 2: Multiply the seating load by the seal circumference (mm) to obtain the total seal seating load (N).

Hydrostatic Load:

Step 3: Calculate the differential area (in mm^2) : $(\pi/4) \cdot (\text{Seal O.D.})^2$
Step 4: Multiply the pressure (MPa) by the differential area to obtain the hydrostatic load (N).

Number of Bolts required:

Step 5: Total clamping load = seal seating load + hydrostatic load.
Step 6: Divide total clamping load by the maximum clamping load for the chosen bolt size from the table to obtain the number of bolts required.

Apply suitable safety and design margin:

Step 7: The design engineer must consider other influences such as elevated temperatures and pressure impulses. A sufficient safety margin should be applied when determining the required number of bolts in order to meet Code or other design requirements.

		DIN 13 Grade 6.9 Bolts			DIN 13 Grade 8.8 Bolts			DIN 13 Grade 10.9 Bolts			DIN 13 Grade 12.9 Bolts		
Size	Bolt Stress Area (sq. mm)	Maximum Bolt Clamping Load (N)	Torque Dry (N•m)	Torque Lubricated (N•m)	Maximum Bolt Clamping Load (N)	Torque Dry (N•m)	Torque Lubricated (N•m)	Maximum Bolt Clamping Load (N)	Torque Dry (N•m)	Torque Lubricated (N•m)	Maximum Bolt Clamping Load (N)	Torque Dry (N•m)	Torque Lubricated (N•m)
M4 X 0,7	8,78	3400	2,4	2,3	4000	2,9	2,7	5650	4,1	3,8	6750	4,9	4,6
M5 X 0,8	14,2	5550	5,0	4,7	6550	6,0	5,5	9200	8,5	8,0	11100	10	9,5
M6 X 1,0	20,1	7800	8,5	8,0	9250	10	9,5	13000	14	13	15600	17	16
M8 X 1,25	36,6	14300	21	19	17000	25	23	23900	35	32	28700	41	39
M10 X 1,5	58,0	22800	41	39	27100	49	46	38000	69	64	45700	83	77
M12 X 1,75	84,3	33400	72	67	39500	86	80	55500	120	110	66700	145	135
M14 X 2,0	115	45600	115	105	54000	135	125	76000	190	180	91300	230	215
M16 X 2,0	157	63000	180	165	75000	210	195	105000	295	275	126000	355	330
M18 X 2,5	192	76500	245	225	90500	290	270	127000	405	390	153000	485	455
M20 X 2,5	245	98500	345	325	117000	410	385	164000	580	540	197000	690	650
M22 X 2,5	303	123000	465	435	145000	550	510	205000	780	720	245000	930	870
M24 X 3,0	353	142000	600	560	169000	710	660	237000	1000	930	284000	1200	1100
M27 X 3,0	459	187000	890	830	221000	1050	980	311000	1500	1400	374000	1800	1650
M30 X 3,5	561	227000	1200	1100	269000	1450	1350	379000	2000	1850	454000	2400	2250

Dry torque assumes $\mu = 0{,}14$
Lubricated torque assumes $\mu = 0{,}125$

Shaped Seals

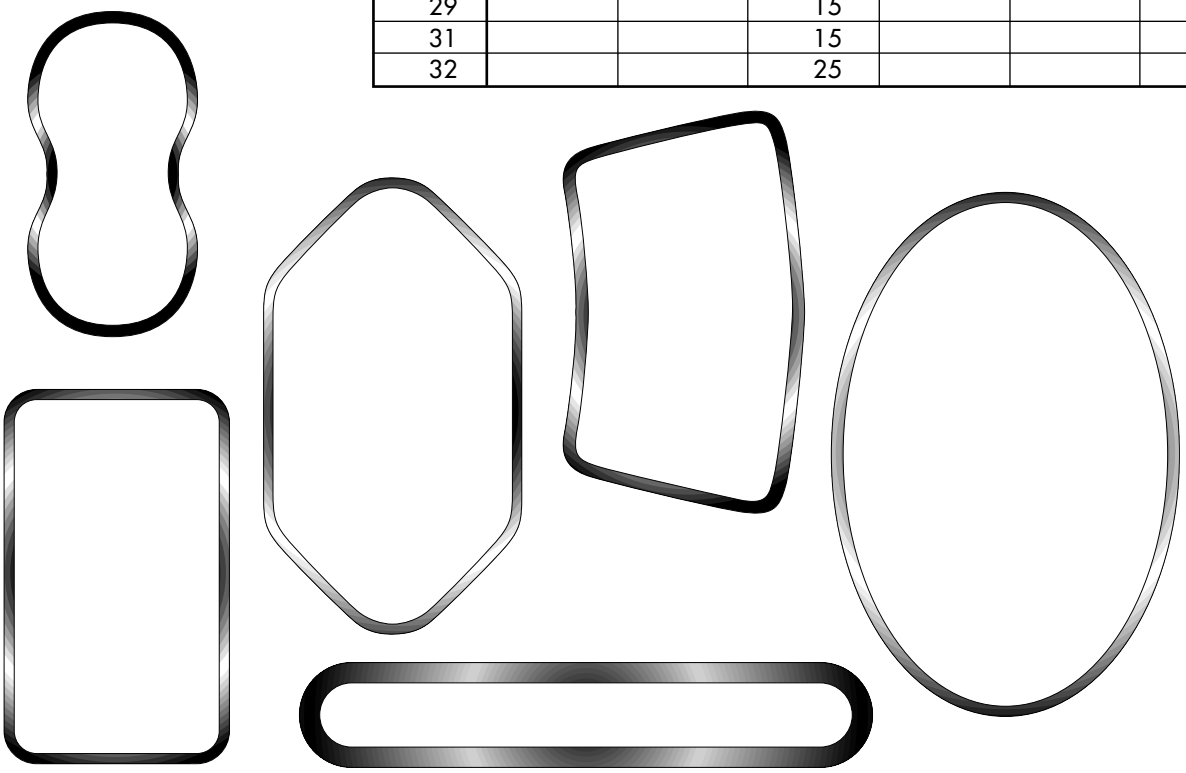
All standard EnerRings can be formed into various shapes. The illustration below shows some of the many shapes in which EnerRings can be made.

For applications as varied as fuel nozzle mounting flanges on aircraft gas turbine engines, or dies for extrusion of plastic film, the availability of specially shaped EnerRings offers the greatest design flexibility.

The table, right, provides the minimum inner corner radius for the various cross sections of Metal C-Rings, O-Rings, Spring Energized C-Rings, Wire Rings, E-Rings and U-Rings. All shaped seals are custom designed by our engineers. Please fax us your completed "Application Data Sheet" provided as page E-24 of this design manual including a sketch of the non-circular cavity and we will assist you in determining the best seal type and shape for your application.

Minimum Corner Radii for Shaped Seals

Cross Section Code	Minimum Inside Bend Radius of Seal (mm)					
	C-Ring	E-Ring	O-Ring	U-Ring	Spring Energized C-Ring	Wire Ring
01	5		10			
02	5		15			
03	5		15			10
04	5		25			
05	10	20	25	20	10	15
06	10	25	35			
07	15	40	35	25	15	25
08	15	25	10			
09	15	50	15	35	20	35
10	15	30	20			
11	20	30	40		25	
12	20		25			
13	25	50	50	50	30	
14	25		30			
15	30	70	65	65	40	
16	30		40			
17	45		95		60	
18	45		60			
19	60		125		75	
20	60		75			
21			160			
25			35			
29			15			
31			15			
32			25			



EnerRing Manufacturing Specifications

EnerRing Roundness & Flatness Specifications

The table below provides the allowable roundness and flatness for the standard EnerRings: C-Rings, E-Rings, O-Rings, U-Rings, Wire Rings, Spring Energized C-Rings, and Spring Energized O-Rings in an unrestrained state. When restrained, the seal diameter shall be within the limits specified in Section C.

Seal Diameter Range (millimeters)	Roundness & Flatness (millimeters)
4,57 - 25,40	0,51
25,41 - 63,50	0,76
63,51 - 127,00	1,52
127,01 - 254,00	2,29
254,01 - 304,80	3,18
304,81 - 355,60	3,81
355,61 - 406,40	4,45
406,41 - 457,20	5,08
457,21 - 558,80	6,35
558,81 - 914,40	12,70

EnerRing Surface Finish

All unplated and plated EnerRings are produced with a 0,4 µm R_a surface finish.

Metal O-Ring Weld Finishing

The Metal O-Ring weld process results in a weld fillet which is finished and smoothed to the adjacent surfaces. In accordance with U.S. Military Standards for Metal O-Rings, the surface at the blend area shall not be more than 0,05 mm below the adjacent surfaces. The blend area has no significance on seal performance and is eliminated when the seal is compressed to the proper working height as specified in Section C.

Preferred C-Ring and Spring Energized C-Ring Sizes

Advanced Products C-Rings and Spring Energized C-Rings are available in a virtually unlimited number of sizes. Each uniquely sized seal is produced with tooling specifically made for that size. Choosing one of the diameters listed below will result in a cost saving, as there will be no tooling charges, and reduced delivery times since it will not be necessary to manufacture the tooling. Following is a list of the preferred C-Ring (MCI, MCE, MCA) and Spring Energized C-Ring sizes (MSI, MSE).

SEAL TYPE	FREE HEIGHT	CROSS SECTION CODE	METAL C-RING FOR INTERNAL PRESSURES PREFERRED SEAL DIAMETERS All dimensions are in millimeters									
MCI	**0,79**	**01 & 02**	6,35	7,29	8,18	9,70	11,30	11,99	13,44	14,73	19,05	21,56
			6,40	7,39	8,31	10,11	11,35	12,19	13,49	15,72	19,30	22,23
			6,53	7,44	8,61	10,16	11,38	12,55	13,59	15,88	19,56	23,01
			6,60	7,82	9,40	10,31	11,63	12,70	13,79	17,27	19,63	24,41
			6,83	7,92	9,50	10,57	11,81	12,85	14,20	18,39	19,94	
			7,14	7,98	9,53	11,10	11,96	12,90	14,66	19,00	21,51	
MCI	**1,19**	**03 & 04**	8,45	9,68	12,83	14,55	16,34	20,62	21,56	23,88	31,04	34,93
			8,74	11,28	12,85	14,96	16,74	20,80	22,40	23,98	28,91	35,00
			8,89	12,22	14,35	15,16	17,63	21,31	23,11	27,90	34,77	41,71
			9,53	12,70	14,45	16,03	18,31	21,51	23,16	28,58		
MCI	**1,57**	**05 & 06**	7,85	12,75	15,75	20,70	25,35	30,00	38,18	47,70	59,51	95,25
			9,05	12,83	15,90	20,79	25,40	30,07	38,78	47,85	60,33	98,43
			9,53	12,88	15,93	20,98	25,45	30,18	39,50	48,92	60,45	99,97
			9,58	12,93	16,51	21,49	25,48	30,25	40,13	49,10	60,50	101,35
			10,00	13,00	16,71	21,97	25,50	30,51	40,20	49,56	61,59	101,60
			10,08	13,20	17,48	21,99	26,01	31,75	41,12	49,73	63,42	107,95
			10,10	13,34	17,53	22,25	26,67	31,83	41,28	49,99	64,74	117,12
			10,12	13,41	17,65	22,30	28,75	32,54	41,35	50,55	65,89	152,40
			10,19	13,50	17,86	22,50	26,97	33,32	41,65	50,72	67,74	152,50
			10,36	13,54	18,01	22,94	27,00	33,43	42,01	50,80	68,58	158,75
			10,58	13,89	18,31	23,09	27,09	33,55	42,93	53,80	69,00	158,85
			11,00	14,00	18,35	23,42	27,71	34,11	43,64	54,30	69,55	180,34
			11,18	14,17	19,05	23,50	27,86	34,80	43,76	54,61	69,65	190,86
			11,86	14,20	19,10	23,83	27,99	35,00	44,63	55,58	72,97	203,71
			11,96	14,27	19,20	24,10	28,30	35,71	44,45	55,80	73,53	228,47
			12,00	14,35	19,43	24,38	28,32	36,07	45,92	56,06	75,11	
			12,05	14,55	19,89	24,69	28,50	36,50	46,08	56,52	75,95	
			12,50	14,99	19,99	25,00	28,65	36,60	46,13	57,15	79,38	
			12,52	15,01	20,02	25,02	31,45	36,63	47,35	59,11	80,44	
			12,65	15,10	20,37	25,20	29,36	38,02	47,63	59,23	81,20	
			12,70	15,39	20,62	25,22	29,62	38,10	47,65	59,36	88,90	
MCI	**2,39**	**07 & 08**	13,21	21,82	30,51	37,85	45,29	53,72	63,65	79,38	114,73	143,41
			14,00	21,95	30,73	38,10	45,77	53,90	63,85	79,53	115,44	145,44
			14,10	21,97	31,16	38,63	45,87	53,98	64,39	80,00	117,48	146,05
			14,35	22,12	31,29	39,42	46,36	54,16	65,25	80,44	119,33	147,70
			14,78	22,15	31,32	39,70	47,19	55,00	66,83	80,67	120,00	152,04
			15,01	22,73	31,50	40,31	47,37	55,55	68,25	82,30	120,65	152,27
			15,60	23,37	31,65	40,47	47,63	55,73	68,33	82,55	121,92	152,35
			15,72	23,55	31,70	40,65	47,68	56,74	68,43	82,70	122,45	152,40
			15,88	23,87	31,75	41,02	47,83	57,15	69,39	85,85	122,56	153,67
			16,38	24,33	32,31	41,15	48,29	57,30	69,44	87,38	123,00	154,99
			16,56	25,15	32,36	41,22	48,46	57,40	69,85	88,47	123,60	158,55
			17,17	25,40	32,59	41,28	48,95	58,00	70,00	88,65	123,70	158,70
			17,20	25,40	33,02	41,71	49,23	58,14	70,23	88,90	123,77	161,93
			17,53	26,01	33,07	42,11	49,25	58,19	70,61	91,01	127,00	184,30
			17,86	26,72	33,07	42,14	49,28	58,32	70,64	92,15	128,98	187,88
			18,00	26,77	33,35	42,19	49,43	58,90	71,09	93,83	130,30	196,85
			18,77	26,97	34,67	42,32	49,75	59,65	71,53	101,35	130,56	203,20
			18,92	27,99	34,93	42,60	50,47	60,00	71,60	101,60	130,81	212,47
			19,05	28,30	35,38	42,65	50,55	60,05	73,89	105,92	131,17	229,74
			19,56	28,32	35,50	44,00	50,57	60,07	74,19	106,10	132,84	
			20,03	28,58	35,56	44,07	50,80	60,12	74,73	107,95	133,35	
			20,09	28,78	35,71	44,20	50,88	60,33	74,78	108,00	134,80	
			20,12	29,11	36,25	44,37	50,92	60,48	75,00	108,08	136,35	
			20,32	29,66	36,42	44,40	51,90	62,08	76,20	108,40	139,24	
			20,35	29,72	36,63	44,45	52,12	62,99	76,28	109,00	139,70	
			20,70	29,77	37,19	44,50	53,59	63,50	76,81	109,90	140,21	
			21,13	29,90	37,34	45,14	53,64	63,58	79,00	113,08	143,28	

SEAL TYPE	FREE HEIGHT	CROSS SECTION CODE	METAL C-RING FOR INTERNAL PRESSURES PREFERRED SEAL DIAMETERS All dimensions are in millimeters									
MCI	**3,18**	**09 & 10**	25,40	39,70	52,40	63,50	74,90	85,73	99,75	114,20	139,70	165,10
			26,01	39,90	53,22	63,58	75,00	88,65	99,82	114,30	142,75	167,39
			26,31	40,59	53,24	64,14	75,41	88,90	100,61	114,38	143,41	168,28
			27,89	41,28	53,98	64,77	75,59	89,62	101,22	117,78	146,05	169,49
			28,60	41,82	54,89	64,82	75,77	89,99	101,60	119,82	146,43	171,45
			28,68	41,91	55,32	65,61	75,84	90,47	102,42	119,89	146,50	173,20
			29,54	42,19	55,60	65,99	75,95	91,24	102,92	120,70	147,45	179,40
			30,85	43,76	55,82	66,29	76,00	91,82	103,10	121,13	148,00	181,36
			30,86	44,45	56,90	66,42	77,52	92,08	104,52	125,00	149,99	183,49
			31,01	45,39	56,97	67,17	78,11	92,15	104,77	125,60	150,34	184,00
			31,06	46,32	57,15	68,00	79,12	92,84	104,78	125,86	151,77	190,55
			32,66	46,94	58,04	68,32	79,38	93,40	106,10	126,32	156,82	190,88
			32,72	47,50	58,17	68,82	80,70	94,11	107,67	127,00	158,55	194,82
			34,24	47,68	58,32	69,60	82,30	94,89	107,95	128,98	164,90	196,77
			34,82	47,69	59,70	69,85	82,37	95,00	108,33	129,24	171,45	196,85
			34,93	48,62	59,78	69,90	82,55	95,12	108,71	129,34	152,40	203,20
			35,13	50,11	60,07	71,17	82,62	95,25	108,89	130,56	153,85	209,55
			35,84	50,17	60,33	72,39	82,82	95,38	109,91	131,11	156,82	209,83
			36,14	50,39	61,34	72,77	84,46	96,57	109,96	131,17	157,00	252,86
			36,93	50,80	61,72	73,03	84,51	98,17	111,51	135,56	158,75	
			37,41	50,88	62,10	73,89	85,53	98,43	113,00	136,65	162,31	
			38,10	51,99	63,25	74,35	85,62	99,24	113,08	138,11	163,45	
MCI	**3,96**	**11 & 12**	31,75	50,80	61,40	76,20	86,40	101,35	115,87	123,24	146,05	178,61
			33,63	52,37	63,50	77,20	87,17	110,60	116,38	128,65	147,70	179,02
			34,93	56,00	64,52	77,22	89,99	114,30	117,22	128,98	147,79	180,01
			38,68	56,90	66,68	77,77	92,84	114,81	117,48	130,33	151,16	180,09
			40,26	57,15	69,57	82,30	94,41	117,48	118,00	135,10	152,40	196,60
			44,11	59,65	69,85	82,55	95,00	135,10	120,65	138,71	161,49	197,61
			44,45	59,94	73,41	83,57	95,25	109,60	122,07	139,70	161,72	209,55
			45,03	60,00	75,95	86,11	99,06	114,81	122,30	139,83	175,01	212,73
												232,56
MCI	**4,78**	**13 & 14**	82,50	101,45	110,87	123,75	146,96	161,67	173,46	187,22	202,95	234,98
			92,10	103,89	112,74	128,19	147,85	161,82	174,37	190,35	204,93	235,13
			95,25	104,78	120,02	129,46	149,23	162,15	177,55	190,68	212,47	237,87
			97,54	108,59	120,27	133,60	150,14	167,23	180,72	197,13	215,90	241,30
			101,83	108,77	123,57	136,00	158,93	169,67	182,55	197,87	219,20	263,53
			101,93	109,80	123,90	139,80	160,40	173,33	187,07	199,77	231,52	
MCI	**6,35**	**15 & 16**	101,60	137,00	137,21	138,56	167,13	187,07	196,85	234,01	240,41	315,21
			114,30	137,10	137,31	149,91	184,15	190,50	231,61	234,24	240,87	342,01
			123,62									

SEAL TYPE	FREE HEIGHT	CROSS SECTION CODE	METAL C-RING FOR EXTERNAL PRESSURES PREFERRED SEAL DIAMETERS All dimensions are in millimeters									
MCE	**0,79**	**01 & 02**	5,08	7,82	8,00	10,36	11,66	14,35	17,27	19,30		
			6,40	7,87	8,51	11,25	12,70	15,09	19,10	23,83		
MCE	**1,19**	**03 & 04**	8,13	14,00	15,01	22,96	23,06	23,98	27,05	29,21	29,49	46,51
			10,00	14,43	16,71							
MCE	**1,57**	**05 & 06**	9,53	12,70	14,27	16,87	23,85	27,91	32,99	40,13	58,80	63,63
			9,58	12,75	14,35	18,21	25,37	28,32	33,38	44,18	60,33	65,00
			10,10	13,41	15,75	19,41	26,72	30,07	33,63	44,45	61,93	66,75
			11,23	13,68	15,88	20,65	27,00	30,71	34,93	49,23	61,98	72,97
			11,96	13,77	16,26	22,28	27,76	31,80	38,10	58,18	63,50	98,90
			12,60									
MCE	**2,39**	**07 & 08**	11,51	22,45	29,18	36,25	41,28	47,68	62,22	80,98	111,86	154,19
			11,99	24,66	29,80	37,85	41,33	47,88	62,48	81,08	112,73	166,75
			14,35	25,15	29,85	38,02	41,71	48,64	62,74	81,09	117,35	210,82
			16,00	25,37	30,15	38,10	41,96	49,28	63,58	81,41	117,45	229,74
			18,01	25,45	31,24	38,15	42,01	50,80	63,65	88,90	117,48	
			18,45	26,82	31,67	38,35	43,05	50,88	68,33	91,29	120,65	
			19,05	27,90	31,70	38,51	44,00	52,40	69,85	92,15	127,00	
			19,30	28,58	31,75	38,56	44,20	54,05	69,93	95,00	133,35	
			19,89	28,63	31,80	39,75	44,50	55,58	73,10	95,25	135,08	
			20,70	28,68	34,93	39,88	45,77	55,80	76,28	96,52	146,05	
			22,28	29,00	35,81	40,65	46,76	59,68	80,52	105,00	147,62	

Preferred C-Ring Sizes

SEAL TYPE	FREE HEIGHT	CROSS SECTION CODE	METAL C-RING FOR EXTERNAL PRESSURES PREFERRED SEAL DIAMETERS All dimensions are in millimeters									
MCE	**3,18**	**09 & 10**	22,23 22,45 22,50 23,50 24,94 25,40 25,45 25,53 26,94 27,78 32,51	33,45 34,98 35,00 38,10 38,79 41,33 44,45 44,50 44,85 45,52 49,50	49,94 50,47 50,80 52,23 54,05 54,99 57,10 57,35 60,40 62,13 62,18	63,50 63,58 66,45 67,31 69,85 74,65 76,25 76,28 79,45 81,08 82,30	85,73 85,80 88,98 92,05 92,08 92,15 95,12 95,25 97,23 97,49 100,28	103,76 104,14 105,33 107,95 114,38 117,55 121,82 123,34 123,83 125,50 126,19	133,22 133,73 135,00 136,68 137,38 142,19 143,13 145,16 145,29 150,88 152,48	154,31 155,58 156,01 158,85 159,03 160,28 161,98 169,49 171,53 173,23 174,04	178,00 181,79 182,12 188,85 190,58 190,75 190,91 192,30 193,75 200,00 203,20	206,10 208,97 209,88 215,24 215,98 222,33 233,48 235,03 255,85 256,26 257,53
MCE	**3,96**	**11 & 12**	47,85 48,51 48,67 50,00 53,00	53,80 60,40 65,00 70,21 70,74	73,10 78,00 79,38 82,55 85,73	88,90 100,14 104,04 104,85 105,00	108,20 111,20 115,09 115,23 117,55	120,65 122,22 123,90 130,18 130,25	132,84 136,60 139,06 142,95 149,30	155,25 156,01 156,25 176,78 180,72	181,38 186,00 209,55	
MCE	**4,78**	**13 & 14**	80,00 82,75 82,85 91,67	92,15 94,95 96,01 98,50	100,00 104,70 104,85 106,87	117,40 117,55 123,90 124,10	125,00 125,23 134,11 135,03	140,07 142,80 142,95 151,51	157,66 165,10 168,50 171,45	181,37 186,00 190,50 191,54	197,13 201,93 206,45 209,14	211,15 215,90 225,17 257,18
MCE	**6,35**	**15 & 16**	132,92 138,61	140,94 140,97	141,05 150,00	156,01 167,13	185,44 186,00	191,77 193,45	193,75 199,60	203,20 241,71	242,01 279,48	292,00 307,92

Preferred Axial C-Ring Sizes

SEAL TYPE	FREE HEIGHT	CROSS SECTION CODE	METAL C-RING FOR AXIAL PRESSURES PREFERRED SEAL DIAMETERS All dimensions are in millimeters									
MCA	**1,57**	**05**	19,22 21,22 22,25	22,33 22,86 22,91	23,04 24,10 25,37	25,40 25,81 26,01	27,00 28,63 28,70	30,18 31,67 31,83	31,93 33,53 34,95	38,18 41,38 44,91		
MCA	**2,39**	**07**	30,18 30,28 30,38 31,50	32,23 34,93 35,00 36,55	39,70 41,28 41,35 41,50	42,60 42,77 42,88 44,53	47,35 47,63 49,28 49,33	50,27 50,44 51,28 55,58	55,60 58,75 59,87 91,29	166,93 324,00 388,49		
MCA	**3,18**	**09**	50,80 54,00 55,00 59,44 63,53 65,00	65,92 66,68 66,70 69,98 71,27 71,92	73,15 73,63 74,30 74,98 75,00 76,23	77,00 77,72 79,50 82,70 85,60 85,70	87,33 87,60 87,76 88,87 88,93 89,41	92,05 92,10 94,97 95,40 98,40 100,20	101,07 101,52 102,11 102,24 114,27 116,26	116,33 117,45 121,41 126,00 133,32 139,67	170,84 200,00 200,08 280,26	
MCA	**3,96**	**11**	122,07 123,47	127,18 129,57	131,87 142,62	143,61 144,42	146,20 147,62	156,46 160,32	161,93 165,28	168,00 179,25	182,12 184,15	187,53
MCA	**4,78**	**13**	174,60 177,90	180,08 180,47	184,18 187,30	200,00 200,63	183,77 209,91	219,05 231,75	236,02 250,01	292,13 304,80	309,50	
MCA	**6,35**	**15**	228,60	317,47								

Preferred Spring Energized C-Ring Sizes

SEAL TYPE	FREE HEIGHT	CROSS SECTION CODE	SPRING ENERGIZED C-RING FOR INTERNAL PRESSURES PREFERRED SEAL DIAMETERS All dimensions are in millimeters									
MSI	**1,57**	**05**	22,29	28,65	29,80	30,18	35,00	45,39	73,53			
MSI	**2,39**	**07**	17,86 25,65 26,16 26,72 26,97 27,82	28,58 28,60 29,11 29,72 29,77 29,80	30,51 31,75 33,20 37,82 38,10 39,42	39,67 40,47 40,65 41,25 41,32 42,32	42,60 44,45 47,37 47,82 49,32	51,82 52,12 52,42 52,57 55,00	55,73 59,65 62,08 64,39 66,82	66,85 68,43 68,55 68,70 68,85	75,05 82,55 84,82 99,84 101,35	116,80 116,90 117,48 130,33 136,65
MSI	**3,18**	**09**	27,62 28,60 34,87 39,62 41,70 43,82 46,35	47,50 47,80 48,00 50,00 50,80 53,24 54,89	56,82 57,15 59,72 60,00 60.07 60,33 60,70	61,12 63,25 65,00 65,82 66,42 66,48 68,82	69,00 69,24 70,00 72,77 73,35 75,00 75,95	79,40 79,90 80,00 82,62 85,53 88,65 90,47	90,65 93,40 99,24 101,22 104,52 107,95 114,20	121,13 121,80 127,00 131,17 138,84 143,41 147,45	150,00 152,40 152,42 153,60 157,93 184,00 203,20	
MSI	**3,96**	**11**	44,45 47,59 47,70	54,75 56,75 66,68	75,75 75,95 77,00	82,55 94,41 95,25	100,00 101,35 101,65	117,95 109,60 123,24	124,00 130,00 136,00	138,00 138,70 142,92	145,21 146,05 150,00	152,40 159,75 165,16
MSI	**4,78**	**13**	63,45 69,75	72,85 74,47	75,07 85,65	104,78 106,87	120,00	120,27	133,60	150,14	174,37	187,07
MSI	**6,35**	**15**	126,50	129,70	132,21	137,21	139,30	139,70	144,70	196,85		

SEAL TYPE	FREE HEIGHT	CROSS SECTION CODE	SPRING ENERGIZED C-RING FOR EXTERNAL PRESSURES PREFERRED SEAL DIAMETERS All dimensions are in millimeters									
MSE	**1,57**	**05**	26,86	34,18	50,18	58,80	66,75					
MSE	**2,39**	**07**	24,20 24,90	25,42 27,55	27,90 30,32	30,90 34,19	37,85 41,33	42,18 43,73	52,40 54,05	72,20 76,28	105,20 117,35	124,80
MSE	**3,18**	**09**	33,50 33,59 34,22 36,00	41,20 44,50 44,70 45,22	50,20 50,80 54,05 57,10	58,20 66,70 68,10 78,00	80,00 81,08 83,28 97,70	103,76 104,14 107,95 130,22	131,00 134,70 150,16 162,00	162,10 167,00 180,00 181,79		
MSE	**3,96**	**11**	36,64 58,43	60,40 73,10	83,00	90,00	99,90	104,15	104,85	115,23	120,65	135,00
MSE	**4,78**	**13**	94,90	94,95	98,44	190,50	197,13	206,45				
MSE	**6,35**	**15**	125,00	132,92	138,61	153,32	161,00	188,26				

Tolerance Reference Tables

The tolerance tables below are consistent with the American National Standard Tolerances (ANSI B4.1) and the British Standard for Metric ISO Limits and Fits (BS 4500).

ANSI B4.1

Nominal Diameter (inches) Over	To	TOLERANCE GRADE h10	H10	h11	H11
		(Dimensions are in 0.001 inches)			
0	0.12	+ 0.0 / − 1.6	− 0.0 / + 1.6	+ 0.0 / − 2.5	− 0.0 / + 2.5
0.12	0.24	+ 0.0 / − 1.8	− 0.0 / + 1.8	+ 0.0 / − 3.0	− 0.0 / + 3.0
0.24	0.40	+ 0.0 / − 2.2	− 0.0 / + 2.2	+ 0.0 / − 3.5	− 0.0 / + 3.5
0.40	0.71	+ 0.0 / − 2.8	− 0.0 / + 2.8	+ 0.0 / − 4.0	− 0.0 / + 4.0
0.71	1.19	+ 0.0 / − 3.5	− 0.0 / + 3.5	+ 0.0 / − 5.0	− 0.0 / + 5.0
1.19	1.97	+ 0.0 / − 4.0	− 0.0 / + 4.0	+ 0.0 / − 6.0	− 0.0 / + 6.0
1.97	3.15	+ 0.0 / − 4.5	− 0.0 / + 4.5	+ 0.0 / − 7.0	− 0.0 / + 7.0
3.15	4.73	+ 0.0 / − 5.0	− 0.0 / + 5.0	+ 0.0 / − 9.0	− 0.0 / + 9.0
4.73	7.09	+ 0.0 / − 6.0	− 0.0 / + 6.0	+ 0.0 / − 10.0	− 0.0 / + 10.0
7.09	9.85	+ 0.0 / − 7.0	− 0.0 / + 7.0	+ 0.0 / − 12.0	− 0.0 / + 12.0
9.85	12.41	+ 0.0 / − 8.0	− 0.0 / + 8.0	+ 0.0 / − 12.0	− 0.0 / + 12.0
12.41	15.75	+ 0.0 / − 9.0	− 0.0 / + 9.0	+ 0.0 / − 14.0	− 0.0 / + 14.0
15.75	19.69	+ 0.0 / − 10.0	− 0.0 / + 10.0	+ 0.0 / − 16.0	− 0.0 / + 16.0
19.69	30.09	+ 0.0 / − 12.0	− 0.0 / + 12.0	+ 0.0 / − 20.0	− 0.0 / + 20.0
30.09	41.49	+ 0.0 / − 16.0	− 0.0 / + 16.0	+ 0.0 / − 25.0	− 0.0 / + 25.0
41.49	56.19	+ 0.0 / − 20.0	− 0.0 / + 20.0	+ 0.0 / − 30.0	− 0.0 / + 30.0
56.19	76.39	+ 0.0 / − 25.0	− 0.0 / + 25.0	+ 0.0 / − 40.0	− 0.0 / + 40.0

BS 4500

Nominal Diameter (mm) Over	To	TOLERANCE GRADE h10	H10	h11	H11
		(Dimensions are in 0,001 millimeters)			
0	3	+ 0,0 / − 40	− 0,0 / + 40	+ 0,0 / − 60	− 0,0 / + 60
3	6	+ 0,0 / − 48	− 0,0 / + 48	+ 0,0 / − 75	− 0,0 / + 75
6	10	+ 0,0 / − 58	− 0,0 / + 58	+ 0,0 / − 90	− 0,0 / + 90
10	18	+ 0,0 / − 70	− 0,0 / + 70	+ 0,0 / − 110	− 0,0 / + 110
18	30	+ 0,0 / − 84	− 0,0 / + 84	+ 0,0 / − 130	− 0,0 / + 130
30	50	+ 0,0 / − 100	− 0,0 / + 100	+ 0,0 / − 160	− 0,0 / + 160
50	80	+ 0,0 / − 120	− 0,0 / + 120	+ 0,0 / − 190	− 0,0 / + 190
80	120	+ 0,0 / − 140	− 0,0 / + 140	+ 0,0 / − 220	− 0,0 / + 220
120	180	+ 0,0 / − 160	− 0,0 / + 160	+ 0,0 / − 250	− 0,0 / + 250
180	250	+ 0,0 / − 185	− 0,0 / + 185	+ 0,0 / − 290	− 0,0 / + 290
250	315	+ 0,0 / − 210	− 0,0 / + 210	+ 0,0 / − 320	− 0,0 / + 320
315	400	+ 0,0 / − 230	− 0,0 / + 230	+ 0,0 / − 360	− 0,0 / + 360
400	500	+ 0,0 / − 250	− 0,0 / + 250	+ 0,0 / − 400	− 0,0 / + 400
500	760	+ 0,0 / − 300	− 0,0 / + 300	+ 0,0 / − 500	− 0,0 / + 500
760	1050	+ 0,0 / − 400	− 0,0 / + 400	+ 0,0 / − 630	− 0,0 / + 630
1050	1425	+ 0,0 / − 500	− 0,0 / + 500	+ 0,0 / − 760	− 0,0 / + 760
1425	1940	+ 0,0 / − 630	− 0,0 / + 630	+ 0,0 / − 1000	− 0,0 / + 1000

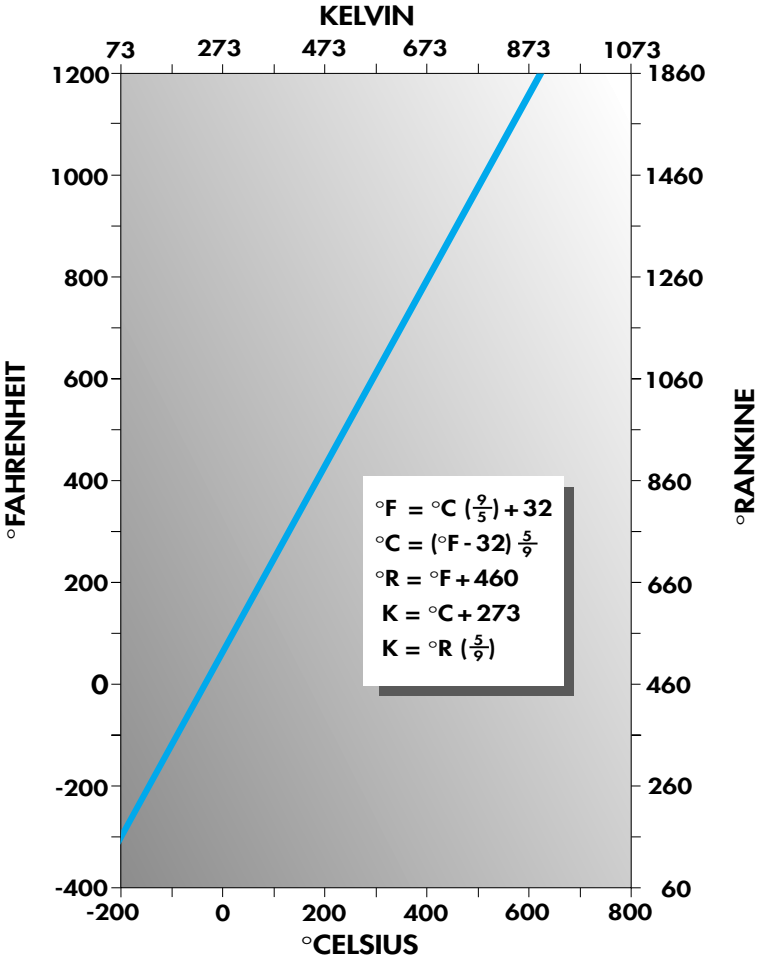
All tolerances above heavy line are in accordance with American-British-Canadian (ABC) Agreements.

Conversion Tables

Pressure

TO OBTAIN / MULTIPLY	atmosphere	bar	inches of mercury	inches of water	millimeters of mercury (Torr)	millimeters of water	kg/cm²	MPa	Newtons/ m² (Pascal)	pounds/ square inch
atmosphere by	1	1.0133	29.9210	4.0678×10^{2}	7.6000×10^{2}	1.0332×10^{4}	1.0333	1.0133×10^{-1}	1.0133×10^{5}	14.6960
bar by	9.8692×10^{-1}	1	29.5300	4.0146×10^{2}	7.5006×10^{2}	1.0197×10^{4}	1.0197	1.0000×10^{-1}	1.0000×10^{5}	14.5038
inches of mercury by	3.3421×10^{-2}	3.3864×10^{-2}	1	13.5950	25.4000	3.4532×10^{2}	0.0345	3.3864×10^{-3}	3.3864×10^{3}	4.9116×10^{-1}
inches of water by	2.4584×10^{-3}	2.4840×10^{-3}	7.3556×10^{-2}	1	1.8685	25.4000	2.5399×10^{-3}	2.4910×10^{-4}	2.4910×10^{2}	3.6128×10^{-2}
millimeters of mercury (Torr) by	1.3158×10^{-3}	1.3332×10^{-3}	3.9370×10^{-2}	5.3520×10^{-1}	1	13.5950	1.3594×10^{-3}	1.3332×10^{-4}	1.3332×10^{2}	1.9337×10^{-2}
millimeters of water by	9.6787×10^{-5}	9.8068×10^{-5}	2.8959×10^{-3}	3.9370×10^{-2}	7.3556×10^{-2}	1	1.0000×10^{-4}	9.8068×10^{-6}	9.8068	1.4223×10^{-3}
kg/cm² by	0.9678	0.9807	28.96	393.72	735.6	10000	1	9.8067×10^{-2}	98067	14.22
MPa by	9.8692	10.0000	2.9530×10^{2}	4.0146×10^{3}	7.5006×10^{3}	1.0197×10^{5}	10.1971	1	1.0000×10^{6}	1.4504×10^{2}
Newtons/m² (Pascal) by	9.8692×10^{-6}	1.0000×10^{-5}	2.9530×10^{-4}	4.0146×10^{-3}	7.5006×10^{-3}	1.0197×10^{-1}	1.0197×10^{-5}	1.0000×10^{-6}	1	1.4504×10^{-4}
pounds/ square inch by	6.8046×10^{-2}	6.8947×10^{-2}	2.0360	27.6810	51.7144	7.0310×10^{2}	7.0324×10^{-2}	6.8948×10^{-3}	6.8948×10^{3}	1

Temperature



Torque (Moment)

TO OBTAIN / MULTIPLY	N-m	kg-m	kg-cm	ft-lb	inch-lb
N-m by	1	0.1020	10.1970	0.7376	8.8509
kg-m by	9.8068	1	100.0000	7.2330	86.7942
kg-cm by	0.0981	0.0100	1	0.0723	0.8679
ft-lb by	1.3558	0.1383	13.8255	1	12.0000
inch-lb by	0.1130	0.0115	1.1522	0.0833	1

Force

TO OBTAIN / MULTIPLY	newton	kilogram	pound
newton by	1	0.1020	0.2248
kilogram by	9.8068	1	2.2046
pound by	4.4482	0.4536	1

Distributed Force (Force per unit length)

TO OBTAIN / MULTIPLY	N/mm	kg/cm	lb/in
N/mm by	1	1.0197	5.7102
kg/cm by	0.9807	1	5.5997
lb/in by	0.1751	0.1786	1

For leakage rate conversion refer to page E-10

Application Data Sheet

Please photocopy for future use!

Advanced

FACE SEAL

Sales Engineer _____

Date _____

CUSTOMER

COMPANY _____ PHONE _____

ADDRESS _____ FAX _____

CITY _____ E-MAIL _____ ST. ____ ZIP _____

CONTACT _____ TITLE _____

OPERATING CONDITIONS

APPLICATION/EQUIPMENT _____

EXISTING SEAL _____ CUSTOMER PART NUMBER _____

CLAMPING LOAD AVAILABLE _____ SURFACE FINISH _____

❑ INTERNAL PRESSURE ❑ EXTERNAL PRESSURE

❑ STATIC ❑ CYCLIC (please fill in table below)

FREQUENCY _____

AMPLITUDE _____

FLUID MEDIUM _____ CAVITY MATERIALS _____

MAXIMUM ALLOWABLE LEAKAGE _____

ADDITIONAL INFORMATION _____

(state all units)	AT ASSEMBLY	MINIMUM	MAXIMUM	OPERATING
TEMPERATURE				
PRESSURE				
CAVITY DEPTH "F" (± tol.)				
CAVITY WIDTH "G" (± tol.)				
O.D. "D" (± tol.) internal pressure				
I.D. "D" (± tol.) external pressure				

SKETCH of APPLICATION

ENG. ACTION

QUOTATION QUANTITIES _____ ANNUAL QUANTITY POTENTIAL _____

❑ NO. DRAWINGS REQUIRED ❑ SKETCH ❑ ENGINEERING DRAWING

Application Data Sheet

Please photocopy for future use!

Advanced

AXIAL SEAL

Sales Engineer _____

Date _____

CUSTOMER

COMPANY _____ PHONE _____

ADDRESS _____ FAX _____

CITY _____ E-MAIL _____ ST. ____ ZIP _____

CONTACT _____ TITLE _____

OPERATING CONDITIONS

APPLICATION/EQUIPMENT _____

EXISTING SEAL _____ CUSTOMER PART NUMBER _____

INSERTION/FRICTION FORCE LIMITATIONS _____

❑ STATIC

❑ ROTATING
RPM _____

❑ RECIPROCATING
STROKE LENGTH _____
VELOCITY _____
CYCLE RATE _____

❑ OSCILLATORY
ROTATION _____
VELOCITY _____
CYCLE RATE _____

FLUID MEDIUM _____ CAVITY MATERIALS _____

MAXIMUM ALLOWABLE LEAKAGE _____

ADDITIONAL INFORMATION _____

(state all units)	AT ASSEMBLY	MINIMUM	MAXIMUM	OPERATING
TEMPERATURE				
PRESSURE				
CAVITY O.D. "A" (± tol.)				
CAVITY I.D. "B" (± tol.)				
CAVITY LENGTH "G" (± tol.)				

SKETCH of APPLICATION

ENG. ACTION

QUOTATION QUANTITIES _____ ANNUAL QUANTITY POTENTIAL _____

❑ NO. DRAWINGS REQUIRED ❑ SKETCH ❑ ENGINEERING DRAWING


ER0597

Additional EnerRing Styles

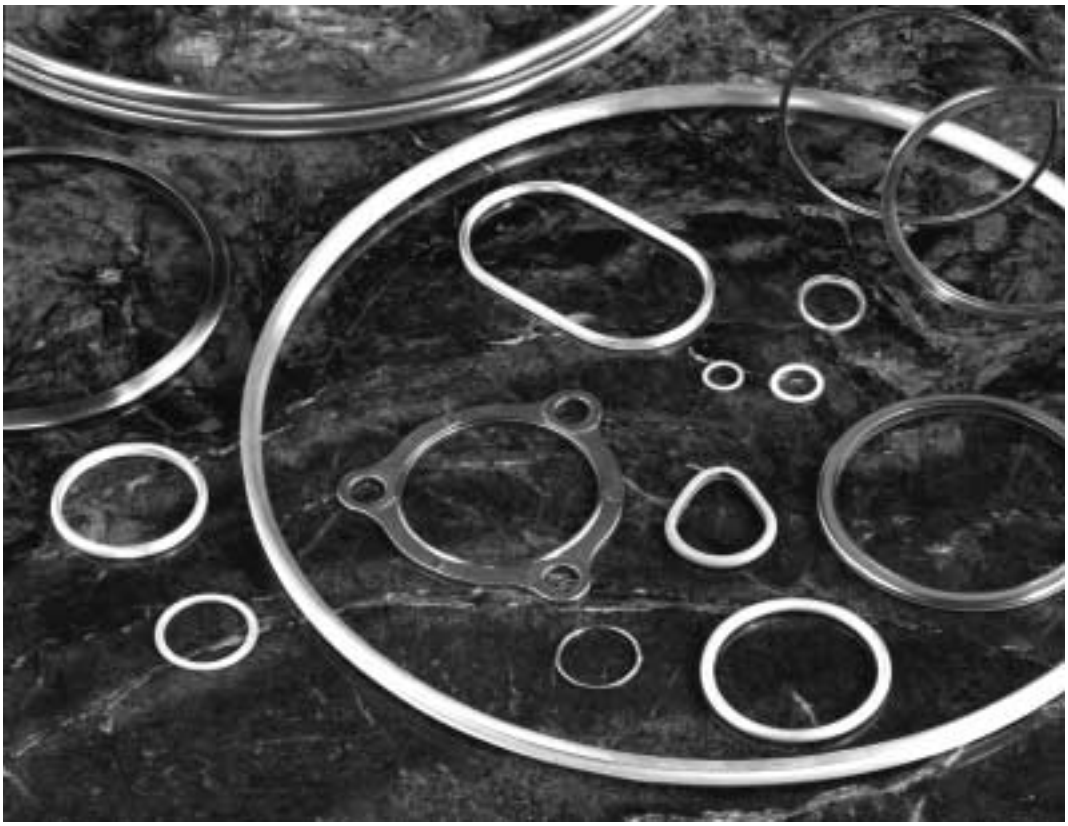
The seals shown and described in Section C of this design manual have been designed, tested, and carefully selected as our standard line of EnerRings. Using the standard EnerRings will satisfy the vast majority of applications and sealing requirements.

There are however, applications which have unique demands and we are pleased to offer our sealing expertise in developing sealing solutions for your specialized applications. Our extensive manufacturing capabilities allow us to quickly produce prototype seals which can be tested in our laboratories to verify leak rate, compressive load, and springback.

For over 40 years we have been designing and manufacturing customized seals along with our standard product line. Please advise us of your requirements by filling out a copy of the "Application Data Sheet" included as page E-24 of this design manual. Please fax this "Application Data Sheet" to your nearest Advanced Products office or distributor. Alternatively, please contact us on our World Wide Web site at http://www.advpro.com.us for online application data pages. We will respond quickly with detailed recommendations.

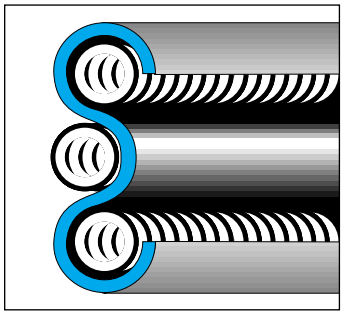
The following pages provide a brief overview of the wide range of unique seals we can offer.
These include:

- Various Formed Seals
- Precision Machined Seals
- Beaded Gaskets

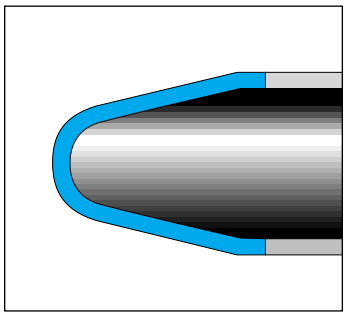


Formed Seals

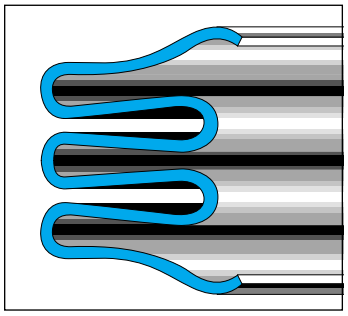
Formed seals are produced from metal strip which is formed into various cross sectional sizes and shapes to suit the needs of the application.



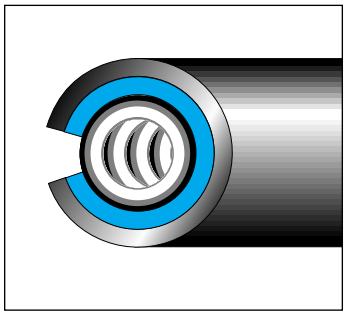
The **"Serpentine Seal"** is designed for deep cavities where radial cavity width is limited and use of a large cross section standard seal is not possible. These seals are based on the Spring Energized C-Ring design and provide high springback, high seating loads, and low leakage rates.



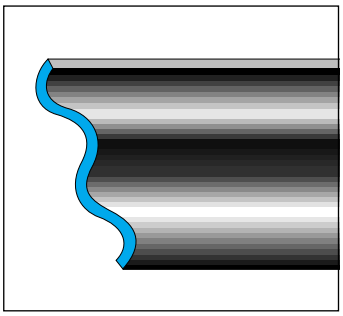
The **"Formed V-Ring"** is a low load, versatile seal which can be manufactured for a wide range of cavity sizes and depths. It is a relatively inexpensive seal with excellent springback.



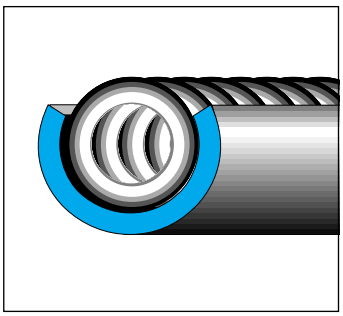
The customized **E-Ring** can be designed with a large number and variety of convolutions. These seals provide exceptional springback when flange separation is of primary concern.



The **"Double Jacket Seal"** is very similar to the standard Spring Energized C-Ring. Instead of the electroplated ductile finish, these seals are wrapped with a layer of soft metal strip such as silver or aluminum. Plated seals are generally preferred over these seals as the electroplated finish is completely bonded to the base metal and is less vulnerable to damage. Additionally, the open side of the double jacket seal must face away from the system pressure as leakage between the two jackets could result in rupture of the thin outer jacket.



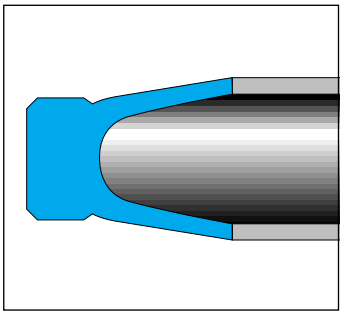
The **"High Flex Axial Seal"** is a low pressure seal which is more tolerant to shaft eccentricity than the standard axial C-Ring. Due to its flexibility it is not suitable for pressures greater than 100 psi (0,7 MPa).



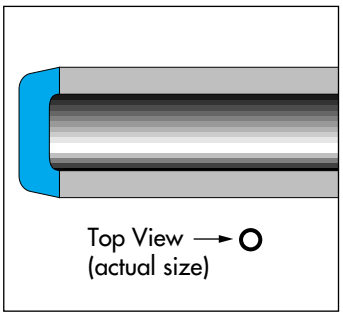
The **Spring Energized Axial C-Ring** is very similar to the standard, non-spring energized axial C-Ring. However, due to the additional sealing stress created by the spring, it is capable of sealing higher reversing pressures.

Precision Machined Seals

The following seals are examples of the type of seals that are produced in our machine shop. They are machined to very tight tolerances and are available in sizes that are smaller than formed seals.



The **"Machined V-Ring"** is a popular seal intended for use in precision flanges with surfaces finishes of 4-16 µ inch (0,1-0,4 µ m) R_a. The "heel" end is designed to serve as a compression limiter allowing the seal to be used without a groove.

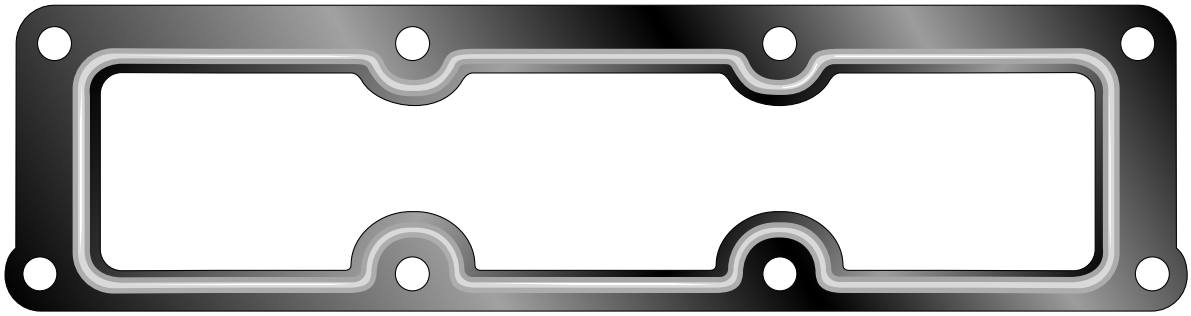


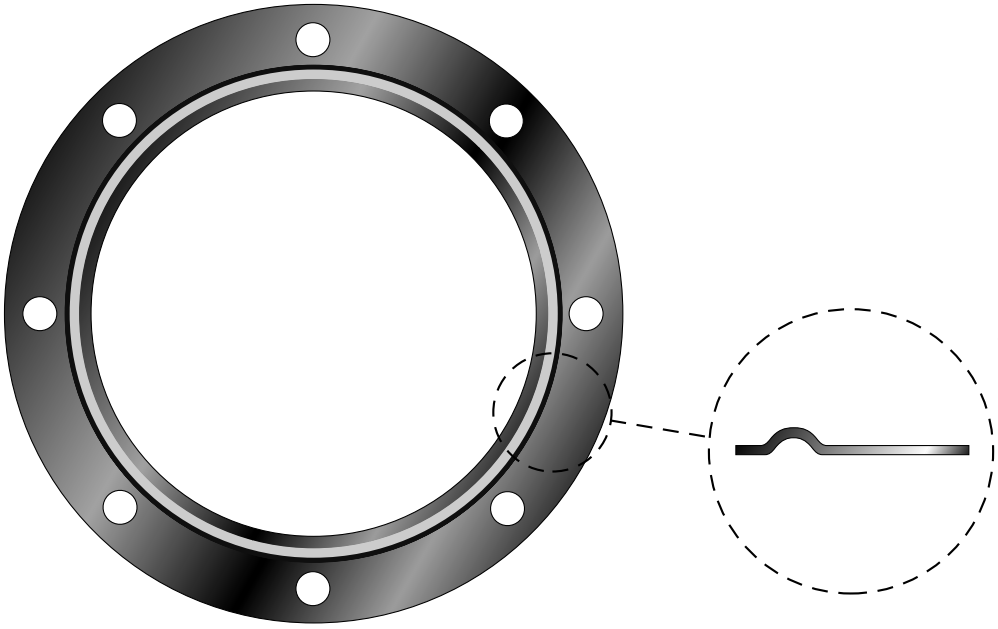
The **"Ultra Small Seal"** was designed to fulfill the need for a very small face seal. It functions similarly to the standard C-Ring face seal but can be machined as small as 0.120 inch (3,05 mm) O.D. where formed seal manufacture is not possible.

Beaded Gaskets

Beaded gaskets are inexpensively laser cut or stamped from metal sheet. They are then embossed with a ridge, or "bead" which acts as the sealing surface of the gasket. The seals can be cut to virtually any shape and include bolt holes to facilitate installation. As the mating flanges are bolted together the raised bead of the gasket produces a higher sealing stress than a plain flat gasket.

Two typical beaded gaskets are shown below. Simply fax a copy of your flange drawing to your nearest Advanced Products office or distributor and we will design a beaded gasket for you.





Cross Sectional view showing raised bead.