For more than 50 years, Garlock Helicoflex has engineered performance metal seals and sealing systems. We have consistently been at the forefront of metal sealing in numerous industries. From seals designed for the first generation of Nuclear Power Plants to present day cryogenic space applications, our approach has been consistent...engineer the best seal for the most demanding applications. This design expertise allows us to partner with our customers to provide industry leading engineering and testing support.

Our sales and engineering staff are focused on individual markets, not territories, to maintain expertise in a specific field. If you have questions or would like to discuss a specific application, please contact us at our world headquarters in Columbia, South Carolina (USA).

Products and Services

Garlock Helicoflex®

PERFORMANCE METAL SEALS

an EnPro Industries company

Garlock Helicoflex engineers will partner with you to develop and test solutions for your toughest sealing applications whether you are in the design stage for a new project or trying to solve an existing problem.

Design for Assembly

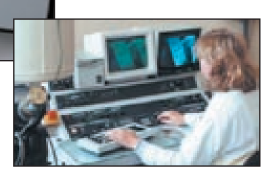
- 3D models of parts and assemblies produced in SolidWorks

ANSYS Computational Analysis

- Nonlinear mechanical behavior of metallic, elastomer and composite materials
- Contact stress evaluation
- Creep relaxation in joint assemblies
- Multi-axial fatigue
- Pressure and thermal effects

Physical Testing

- Compression load characterization
- Helium leakage
- Nitrogen leakage up to 4000 psi
- Thermal cycling from -70 to 200°C
- Seal characterization at temperatures up to 1200°C
- Cyclic durability



Garlock Helicoflex is committed to providing the highest quality metal seals and sealing systems. We provide seals for use in some of the most critical and demanding applications, including aerospace, nuclear power generation and automotive. Our quality system is monitored by our customers as well as third party auditing firms. We are certified to International Standards ISO9000:2000 and AS9100B. Our quality program also meets the requirements of 10CFR50 Appendix B. We welcome customer audits as well as source inspections.

Our staff includes multiple Certified Quality Engineers and Certified Quality Auditors, and we are committed to our Quality Policy of Total Customer Value throughout our supply chain.

We perform Liquid Penetrant Inspection and Radiographic Examination to Section V of the ASME Boiler & Pressure Vessel Code.

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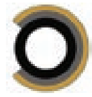
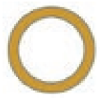
Application Information	SEAL TYPE					
						
	Helicoflex®	Delta®	O-Flex™	C-Flex™	E-Flex™ U-Flex™*	Machined Seal*
Ultra High Vacuum	●	▲▲	■	■	■	▲
Low Pressure	▲▲	●	▲	▲	▲	▲
High Pressure	▲▲	■	▲	▲▲	●	▲
Cryogenic Temperature	▲▲	▲	●	●	●	■
High Temperature	▲▲	▲	▲	▲	▲	■
Spring Back	●	●	●	▲	▲▲	■
Shaped Seals	▲	▲	▲	●	■	■
Axial Sealing	▲	■	●	▲	■	■
QDS Compatible	▲	▲	■	■	■	■
Seating Load	High	Moderate	High / Moderate	Moderate / Low	Low	High / Moderate
Leak Rate Approximation	Helium	Ultra-Helium	Helium / Bubble	Helium / Bubble	Low Bubble	Helium

* See Custom Seals Section

Application Legend	
Recommended - Excellent	▲▲
Recommended - Good	▲
Optional - Special Design	●
Not Recommended	■

Leak Legend	Approximate Leak Rates per meter of circumference
Ultra-Helium	$\leq 1 \times 10^{-11}$ std.cc/sec He
Helium	$\leq 1 \times 10^{-9}$ std.cc/sec He
Bubble	$\leq 1 \times 10^{-4}$ std.cc/sec He
Low Bubble	$\leq$ 25 cc/sec @ 50 psig Nitrogen per inch of diameter

Actual leak rate in service will depend on the following:

Seal Load: Wall Thickness or Spring Load

Surface Finish: Seal and Cavity

Surface Treatment: Coating/Plating/Jacket Material

Aerospace

Application	Section			
Fuel Nozzles	E-FLEX™	C-FLEX™	HELICOFLEX®	
Bleed Air	E-FLEX™	C-FLEX™	O-FLEX™	
Casing/Cowling	E-FLEX™			
Fuel Delivery	MS O-Rings	Boss Seal*		
V-Band Coupling	E-FLEX™	C-FLEX™	HELICOFLEX®	QDS®
Compressor Discharge	E-FLEX™	HELICOFLEX®	C-FLEX™	
Electronic Enclosures	DELTA®	HELICOFLEX®	C-FLEX™	
Gear Box	HELICOFLEX®	C-FLEX™		
Rocket Engine & Turbo Pumps	E-FLEX™	HELICOFLEX®	C-FLEX™	
MS Standards	MS Orings	C-FLEX™		
MS 33649/AS 5202/ AS 4395 Fluid Ports	Boss Seal*	C-FLEX™		

Defense

Weapons	HELICOFLEX®	C-FLEX™	O-FLEX™
Missiles	DELTA®	HELICOFLEX®	C-FLEX™
Electronic Enclosures	DELTA®	HELICOFLEX®	C-FLEX™
MS 33649/AS 5202/ AS 4395 Fluid Ports	Boss Seal*	C-FLEX™	
Military Standards	MS O-Rings	C-FLEX™	
Exhaust Systems	HELICOFLEX®	C-FLEX™	O-FLEX™
Fuel Delivery	HELICOFLEX®	C-FLEX™	DELTA®
Satellite Systems	DELTA®	HELICOFLEX®	C-FLEX™
Laser & RF Guidance Systems	DELTA®	HELICOFLEX®	

Oil & Gas - Downhole Equipment & Upstream Production

Drill Heads	HELICOFLEX®	O-FLEX™	
Valves	HELICOFLEX®	C-FLEX™	O-FLEX™
Steam Chucks	HELICOFLEX®		
Piping & Flanges	HELICOFLEX®	QDS®	
Electronic Enclosures & Packagings	DELTA®	HELICOFLEX®	C-FLEX™
Flow Control	HELICOFLEX®	C-FLEX™	
Pressure Gauges	HELICOFLEX®	C-FLEX™	
Well Head Plug	HELICOFLEX®	C-FLEX™	

Oil & Gas - Refining & Downstream Factories

Heat Exchangers	HELICOFLEX®	O-FLEX™	
Bonnet Seals	HELICOFLEX®	O-FLEX™	C-FLEX™
Valve Seats	HELICOFLEX®		
Stem Seals	HELICOFLEX®	C-FLEX™	
Piping & Flanges	HELICOFLEX®	QDS®	
Process Sampling	HELICOFLEX®	C-FLEX™	O-FLEX™
Specialty Compressors	HELICOFLEX®	C-FLEX™	O-FLEX™

Semiconductor - Front End Processing

End Point Windows	DELTA®	
Chamber Lids	DELTA®	
Exhaust Lines	QDS®	DELTA®
Injectors	DELTA®	Machined Seal*
Bulkhead Connections	DELTA®	

Semiconductor - Sub Systems

Gas Delivery System	Machined Seal*	
Mass Flow Controllers	Machined Seal*	DELTA®
Valve Manifold Box (VMB)	Machined Seal*	
Gas Isolation Box (GIB)	Machined Seal*	
Turbo Pumps	DELTA®	

* See Custom Seals Section

Semiconductor - Materials

Application	Section
Ampoules	DELTA®
Gas Canisters	DELTA®
Chemical Canisters	DELTA®

National Laboratories

RF Waveguides	DELTA®
Particle Accelerators	DELTA®
Fusion Reactors	DELTA®
Klystron Tubes	DELTA®

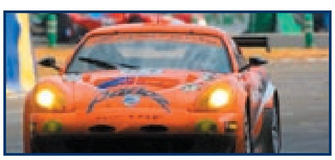
Nuclear

Pressure Vessel	HELICOFLEX®	O-FLEX™	
Spent Fuel Casks	HELICOFLEX®	O-FLEX™	
Waste Heat	HELICOFLEX®	O-FLEX™	
Primary Loop	HELICOFLEX®	O-FLEX™	QDS®
Control Valves	HELICOFLEX®	O-FLEX™	
CRD / BWR	O-FLEX™		
Pressurizer	HELICOFLEX®	O-FLEX™	

Power Gen: Land Based Turbines

Fuel Nozzles	HELICOFLEX®	C-FLEX™	E-FLEX™	
Cooling Steam	HELICOFLEX®	C-FLEX™	E-FLEX™	
Casing	E-FLEX™	HELICOFLEX®		
Fuel Delivery	MS Orings*	Boss Seal*		
V-Band Coupling	U-FLEX™*	C-FLEX™	E-FLEX™	QDS®
Compressor Discharge	HELICOFLEX®	C-FLEX™	E-FLEX™	
Electronic Enclosures	DELTA®	HELICOFLEX®	C-FLEX™	
Gear Box	HELICOFLEX®	C-FLEX™		
Rocket Engine & Turbo Pumps	E-FLEX™	HELICOFLEX®	C-FLEX™	
MS Standards	MS Orings	C-FLEX™		
Fuel Nozzle Locking Rings & Plates	Contact Applications Engineering			

High Performance Automotive

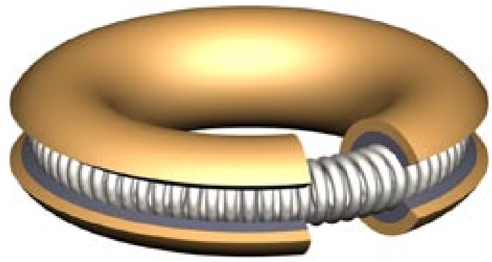


Head Gasket Replacement	HELICOFLEX®	O-FLEX™		
Cooper Ring Replacement	HELICOFLEX®	O-FLEX™		
Head to Header Interface	U-FLEX™*	C-FLEX™	HELICOFLEX®	O-FLEX™
Exhaust Systems	U-FLEX™*	C-FLEX™	HELICOFLEX®	
Turbochargers Internal and External Interfaces	U-FLEX™*	C-FLEX™	HELICOFLEX®	O-FLEX™
Stack-up Tubular Springs	O-FLEX™	C-FLEX™	U-FLEX™*	E-FLEX™
High Pressure Fuel Injection	HELICOFLEX®	O-FLEX™	C-FLEX™	
Fuel Cell High Pressure Feed	HELICOFLEX®	O-FLEX™	C-FLEX™	
Fuel Cell Exhaust Path	C-FLEX™	U-FLEX™*		
Catalytic Converter Connections	U-FLEX™*	C-FLEX™		

Plastic Injection Molding

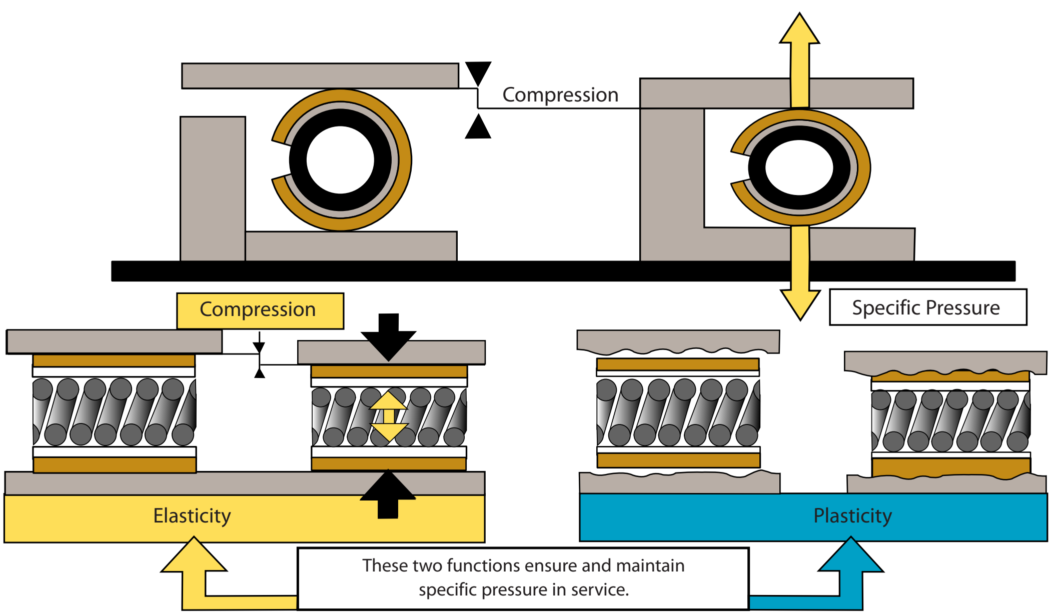
Hot Runner Components	HELICOFLEX®	O-FLEX™	C-FLEX™
Manifold Plates	HELICOFLEX®	O-FLEX™	C-FLEX™
Extruder Plates	HELICOFLEX®	O-FLEX™	C-FLEX™
Filter Packs	HELICOFLEX®	O-FLEX™	C-FLEX™
Spinnerrettes	HELICOFLEX®	O-FLEX™	C-FLEX™
Screen Changers	HELICOFLEX®	O-FLEX™	C-FLEX™
Instrumentation Ports	HELICOFLEX®	O-FLEX™	C-FLEX™

* See Custom Seals Section

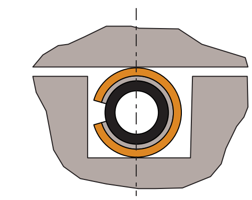


Sealing Concept

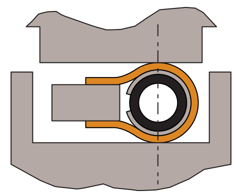
The sealing principle of the Helicoflex® family of seals is based upon the plastic deformation of a jacket of greater ductility than the flange materials. This occurs between the sealing face of a flange and an elastic core composed of a close-wound helical spring. The spring is selected to have a specific compression resistance. During compression, the resulting specific pressure forces the jacket to yield and fill the flange imperfections while ensuring positive contact with the flange sealing faces. Each coil of the helical spring acts independently and allows the seal to conform to surface irregularities on the flange surface. This combination of elasticity and plasticity makes the Helicoflex seal the best overall performing seal in the industry.



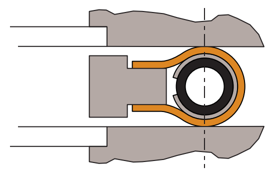
Typical Configurations



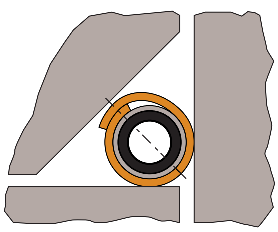
HN200
Groove Assembly



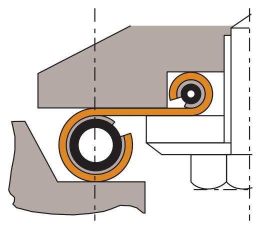
HN203
Tongue & Groove



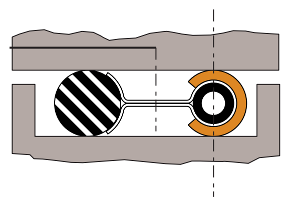
HN208
Raised face flange - ANSI B16.5



HN240
3 Face Compression



HND229
Valve Seat



HNDE290
Leak check - Insert Gas Purge

Classification of Seal Type

Cross Section Type	HN single section HNR ground spring for precise load control (Beta Spring) HNV low load (Delta Seal) HND tandem Helicoflex seals HNDE tandem Helicoflex and elastomer seals note: "L" indicates internal limiter (ex: HLDE)									
Jacket/ Lining	1 = jacket only					2 = jacket with inner lining				
Jacket Orientation	0	1	2	3	4	5	6	7	8	9
Section Orientation	0	1	2	3	4	5	6	7	8	9

Example

HN	2	0	8
Cross Section Type	# Jackets/ Lining	Jacket Orientation	Section Orientation

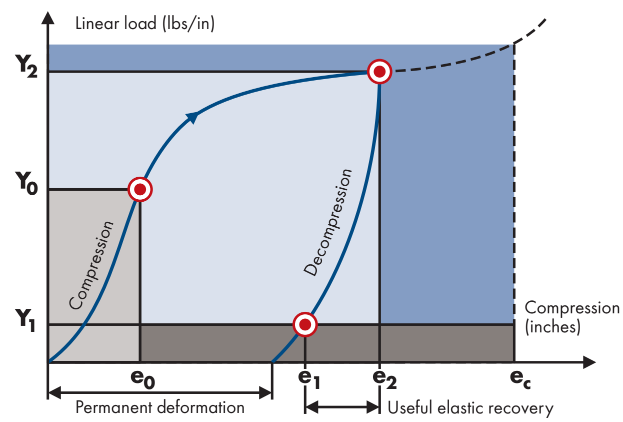
Characteristic Curve

The resilient characteristic of the Helicoflex® seal ensures useful elastic recovery during service. This elastic recovery permits the Helicoflex® seal to accommodate minor distortions in the flange assembly due to temperature and pressure cycling. For most sealing applications the Y_0 value will occur early in the compression curve and the Y_1 value will occur near the end of the decompression curve.

The compression and decompression cycle of the Helicoflex® seal is characterized by the gradual flattening of the compression curve. The decompression curve, which is distinct from the compression curve, is the result of a hysteresis effect and permanent deformation of the spring and jacket.

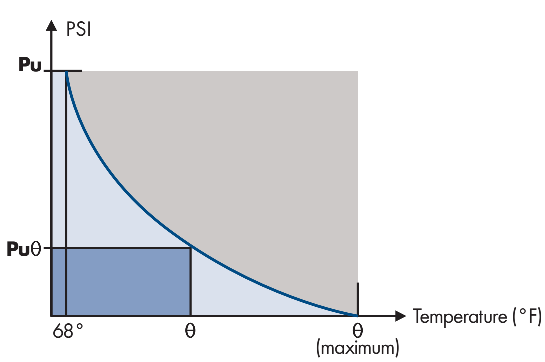
Definition of Terms

Y_0	=	load on the compression curve above which leak rate is at required level
Y_2	=	load required to reach optimum compression e2
Y_1	=	load on the decompression curve below which leak rate exceeds required level
e_2	=	optimum compression
e_c	=	compression limit beyond which there is risk of damaging the spring



The Intrinsic Power of the Seal

The intrinsic power of the Helicoflex seal reflects its ability to maintain and hold system pressure for a given temperature at Y_2 and e_2. This value is expressed as a specific pressure and is noted by the symbols Pu (room temperature) and Puθ (at operating temperature). The influence of temperature on Pu is shown in the graph below. The table on page 4 gives the values of Pu at 68°F (20°C), Pu θ at a given temperature and the maximum temperature where Pu θ = 0.



Dimensions in inches

Jacket Material	Cross Section	e_2	e_C	HELIUM SEALING Y_2 lbs/inch	Y_1 lbs/inch	Pu68°F PSI	PuΘ392°F PSI	BUBBLE SEALING Y_2 lbs/inch	Y_1 lbs/inch	Pu68°F PSI	PuΘ392°F PSI	Max Temp °F
Aluminum	0.063	0.024	0.028	857	114	7250	N/A	514	114	5075	N/A	302
	0.075	0.028	0.033	914	114	7540	N/A	571	114	5800	N/A	302
	0.087	0.028	0.035	942	114	7685	N/A	600	114	5800	N/A	356
	0.098	0.028	0.035	999	114	7975	725	657	114	6090	725	428
	0.118	0.031	0.039	1056	143	7975	1450	742	114	6525	1450	482
	0.138	0.031	0.039	1085	143	7975	2030	799	114	6815	2030	482
	0.157	0.035	0.043	1142	143	8700	2465	857	114	7250	2465	536
	0.177	0.035	0.047	1199	143	8700	2900	914	114	7540	2900	536
	0.197	0.035	0.055	1256	171	9135	3190	971	143	7975	3190	572
	0.217	0.035	0.063	1313	171	9425	3480	1028	143	8265	3480	608
	0.236	0.039	0.071	1399	200	9715	3625	1113	171	8700	3625	644
	0.276	0.039	0.087	1542	228	10150	4060	1171	200	9425	4060	644
	0.315	0.039	0.102	1656	286	10440	4640	1285	228	9860	4495	680
							PuΘ482°F				PuΘ482°F	
Silver	0.063	0.020	0.024	1142	171	9425	N/A	857	171	5800	N/A	464
	0.075	0.024	0.028	1256	171	9425	N/A	857	171	5800	N/A	464
	0.087	0.024	0.031	1313	200	10150	N/A	914	171	5800	580	536
	0.098	0.028	0.035	1370	257	10875	1160	971	228	6525	725	536
	0.118	0.031	0.039	1485	286	12325	2030	1028	257	7250	1305	572
	0.138	0.031	0.039	1599	286	13775	3190	1085	257	7975	1885	572
	0.157	0.031	0.043	1713	314	15225	3915	1142	286	8700	2320	662
	0.177	0.031	0.043	1827	343	16675	4495	1256	286	10150	2755	698
	0.197	0.031	0.051	1941	343	18125	5220	1313	286	11600	3190	698
	0.217	0.031	0.055	2056	371	19575	5800	1428	343	13050	3625	752
	0.236	0.035	0.067	2284	400	21750	6815	1542	343	15950	4350	842
	0.276	0.035	0.079	2512	457	23200	7830	1713	371	18125	5220	842
	0.315	0.035	0.094	2798	514	24650	8700	1999	400	20300	6090	932
							PuΘ572°F				PuΘ572°F	
Copper, Soft Iron, Mild Steels and Annealed Nickel	0.063	0.020	0.024	1485	228	7250	1450	1085	171	5075	725	662
	0.075	0.024	0.028	1599	286	7250	1595	1142	228	5075	870	662
	0.087	0.024	0.031	1713	343	7975	1885	1256	286	5075	1160	680
	0.098	0.028	0.035	1827	400	8700	2465	1313	343	5800	1450	716
	0.118	0.028	0.039	1999	457	9425	2900	1428	400	5800	1740	716
	0.138	0.028	0.039	2227	457	10150	3335	1542	400	6525	2175	752
	0.157	0.031	0.043	2455	514	10150	3915	1656	457	6525	2465	788
	0.177	0.031	0.043	2684	571	11600	4350	1827	457	6525	2755	842
	0.197	0.031	0.051	2912	628	12325	4785	1884	514	7250	3045	842
	0.217	0.031	0.055	3141	685	13050	5220	2056	571	7250	3335	896
	0.236	0.035	0.067	3597	799	13775	5800	2284	571	7975	3770	968
	0.276	0.035	0.079	4225	914	14500	6525	2627	628	8700	4205	968
	0.315	0.035	0.094	4911	1085	15950	7105	3026	742	9425	4640	1022
							PuΘ662°F				PuΘ662°F	
Nickel, Monel, Tantalum	0.063	0.016	0.020	1827	457	10150	1595	1142	343	5800	1015	716
	0.075	0.020	0.024	1999	457	10440	2320	1256	343	6090	1305	716
	0.087	0.020	0.028	2227	514	11020	3045	1313	400	6380	1740	788
	0.098	0.024	0.031	2512	571	11890	3915	1542	400	6815	2320	842
	0.118	0.024	0.035	2512	628	12615	4930	1713	457	7250	2900	896
	0.138	0.024	0.035	2798	685	13485	5800	1941	514	7830	3335	932
	0.157	0.028	0.039	3312	799	13920	6525	2170	571	8265	3915	1022
	0.177	0.028	0.039	4111	857	15225	7540	2398	628	8700	4350	1112
	0.197	0.028	0.043	4454	1028	15950	8265	2627	628	9425	4785	1202
	0.217	0.028	0.051	4625	1142	16675	8990	2855	685	9715	5365	1202
	0.236	0.031	0.063	N/A	N/A	N/A	N/A	3198	742	10440	5945	1202
	0.276	0.031	0.071	N/A	N/A	N/A	N/A	3712	857	11310	6525	1202
	0.315	0.031	0.083	N/A	N/A	N/A	N/A	4168	914	12035	7250	1202
							PuΘ752°F				PuΘ752°F	
Stainless Steel, Inconel, Titanium	0.063	0.016	0.020	1999	571	13050	3625	1713	457	6815	870	788
	0.075	0.020	0.024	2284	571	13195	3915	1827	457	7250	1160	788
	0.087	0.020	0.028	2570	628	13340	4205	1999	514	7540	1595	896
	0.098	0.024	0.031	2855	685	14065	4640	2170	571	8265	2175	932
	0.118	0.024	0.035	3283	742	14500	5220	2427	628	8990	2900	932
	0.138	0.024	0.035	3769	857	15080	5655	2684	742	9715	3625	1022
	0.157	0.028	0.039	4283	971	15515	6090	2969	857	10440	4350	1112
	0.177	0.028	0.039	4711	1256	15950	6525	3198	1028	11165	4930	1202
	0.197	0.028	0.043	N/A	N/A	N/A	N/A	3426	1085	11890	5365	1292
	0.217	0.028	0.051	N/A	N/A	N/A	N/A	3712	1142	12615	6090	1292
	0.236	0.031	0.063	N/A	N/A	N/A	N/A	4111	1256	13630	6815	1292
	0.276	0.031	0.071	N/A	N/A	N/A	N/A	4568	1485	14790	7540	1292
	0.315	0.031	0.083	N/A	N/A	N/A	N/A	5139	1656	15660	8410	1292

Definition of Characteristic Values

Dj	Mean reaction diameter of the seal. (For a double section seal, $Dj = Dj_1 + Dj_2$)	________ inches
Y_2	Linear load corresponding to e_2 compression	________ lbs/inch
Y_1	Linear load on the seal to maintain sealing in service at low pressure (=Ym1)	________ lbs/inch
Pu	Intrinsic power of the seal under pressure at 68°F (20°C) when the reaction force of the seal is maintained at Y_2, regardless of the operating conditions.	________ PSI
Pu_Θ	Value of Pu at temperature Θ	________ PSI
P	Operating or proof pressure Note: if $\frac{P}{Pu \text{ or } Pu_\Theta} > 1$, the definition of the seal must be modified This ratio must never exceed 1	________ PSI
Y_{m2}	Linear tightening load on the seal at room temperature to maintain sealing under pressure. $Y_{m2} = Y_2 \frac{P}{Pu}$	________ lbs/inch
$Y_{m2\Theta}$	Value of Y_{m2} at temperature Θ. $Y_{m2\Theta} = Y_2 \frac{P}{Pu_\Theta}$	________ lbs/inch
Et	Young's modulus of bolt material at 68°F (20°C)	________ PSI
Et_s	Young's modulus of bolt material at operating temperature	________ PSI

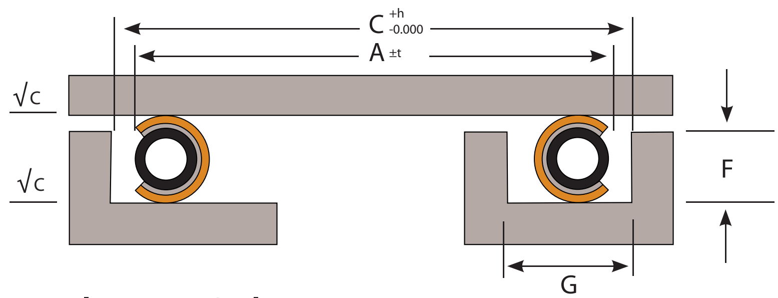
Load Calculations

Fj	Total tightening load to compress the seal to the operating point (Y_2; e_2) $Fj = \pi \times Dj \times Y_2$	________ lbs
F_F	Total hydrostatic end force $F_F = \pi/4\ Dj_1^2 \times P$ (Dj_1 = Dj in case of a single section seal)	________ lbs
Fm	Minimum total load to be maintained on the seal in service to preserve sealing, i.e. $Fm = \pi\ Dj\ Y_m$ where: Y_m = the greater of the two values: Y_{m1} or $Y_{m2\Theta}$ (see note 1 below)	________ lbs
Fs	Total load to be applied on the bolts to maintain sealing in service $Fs = F_F + F_m$	________ lbs
Fs*	Increased value of Fs to compensate for Young's modulus at temperature $Fs^* = Fs\ Et / Et_s$	________ lbs
F_B	LOAD TO BE APPLIED: If Fs* > Fj then Fb = Fs* If Fj > Fs* then Fb = Fj	________ lbs

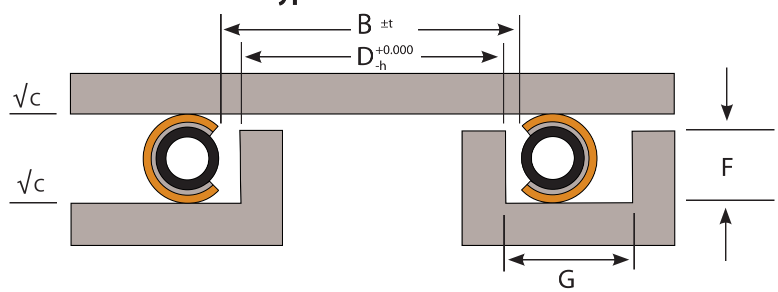
Note 1: wherever the working pressure is high and/or seal diameter is big, to such an extent that $P \cdot Dj \geq 32\ Y_m$, in order to remain on the safe side, whatever the inaccuracy on the tightening load may be, it is recommended to take the Fj value in lieu of F_m for the calculation of Fs so that $Fs = F_F + Fj$.

Note 2: this information is provided as a reference only.

Internal Pressure: Seal Type HN200



External Pressure: Seal Type HN220



Seal and Groove Sizing Calculations

The equations below can be used for basic groove calculations. Applications that have significant thermal expansion may require additional clearance. Please contact Applications Engineering for design assistance.

Determining Seal Diameter:

Internal
A = C-X

External
B = D + X

Determining Groove Diameter:

Internal
C = A + X

External
D = B – X

Tolerancing: See chart

Where:
A = Seal Outer Diameter
B = Seal Inner Diameter
C = Groove Outer Diameter
D = Groove Inner Diameter
X = Diametrical Clearance (see table)

Groove Finish √C: See groove dimensioning chart on page 7

Seal/Groove Tolerances

Seal Diameter Range	Pressure <300psi (20 bar)		Pressure ≥300 psi (20 bar)	
	Seal tolerance t	Groove tolerance h	Seal tolerance t	Groove tolerance h
0.350 to 2.000	0.005	0.005	0.004	0.004
2.001 to 12.000	0.010	0.010	0.004	0.004
12.001 to 25.000	0.010	0.010	0.006	0.006
25.001 to 48.000	0.015	0.015	0.008	0.008
48.001 to 72.000	0.020	0.015	0.010	0.008
> 72.000	Contact Applications Engineering			

Flatness

Seal Diameter Range	Amplitude	Tangential Slope	Radial Slope
0.350 to 20.000	0.008	1:1000	1:100
20.001 to 80.000	0.016	2:1000	2:100

Dimensions in inches

Shaped Seals

Groove design: Contact Applications Engineering for assistance in designing non-circular grooves.

Groove finish: Most applications will require a finish of 16-32 RMS (0.4 to 0.8 Ra μm). All machining & polishing marks must follow seal circumference.

Min. Seal Radius: The minimum seal bending radius is six times the seal cross section (CS).

Seating Load: The load (Y2) to seat the seal is approximately 30% higher due to a slightly stiffer spring design.

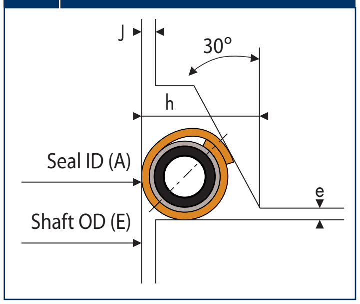
SEAL AND GROOVE DIMENSIONS

Dimensions in inches

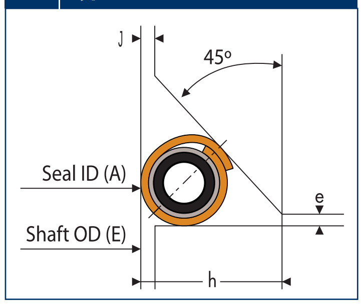
	SEAL			GROOVE				
				Pressure < 300psi	Pressure ≥ 300psi			
Jacket Material	Free Height	Installation Compression e2	Seal Diameter Range	Diametrical Clearance X	Diametrical Clearance X	Groove Depth F	Groove Width (Min.) G	Groove Finish RMS
Aluminum	0.063	0.024	0.500 to 4.000	0.024	0.012	0.039 +/- 0.003	0.111	32-125 Contact Applications Engineering for Recommendation
	0.075	0.028	0.625 to 6.000	0.028	0.012	0.047 +/- 0.003	0.131	
	0.087	0.028	0.750 to 10.000	0.028	0.012	0.059 +/- 0.003	0.143	
	0.098	0.028	0.875 to 15.000	0.028	0.012	0.070 +/- 0.003	0.154	
	0.118	0.031	1.000 to 20.000	0.031	0.012	0.087 +/- 0.004	0.180	
	0.138	0.031	1.250 to 25.000	0.031	0.020	0.107 +/- 0.004	0.200	
	0.157	0.035	1.750 to 30.000	0.035	0.020	0.122 +/- 0.004	0.227	
	0.177	0.035	2.000 to 40.000	0.035	0.020	0.142 +/- 0.004	0.247	
	0.197	0.035	3.000 to 50.000	0.035	0.020	0.162 +/- 0.004	0.267	
	0.217	0.035	4.000 to 50.000 +	0.035	0.020	0.182 +/- 0.004	0.287	
	0.236	0.039	5.000 to 50.000 +	0.039	0.020	0.197 +/- 0.005	0.314	
	0.276	0.039	6.000 to 50.000 +	0.039	0.028	0.237 +/- 0.005	0.354	
	0.315	0.039	8.000 to 50.000 +	0.039	0.028	0.276 +/- 0.005	0.393	
Silver	0.063	0.020	0.500 to 4.000	0.020	0.012	0.043 +/- 0.002	0.103	63-125 Contact Applications Engineering for Recommendation
	0.075	0.024	0.625 to 6.000	0.024	0.012	0.051 +/- 0.003	0.123	
	0.087	0.024	0.750 to 10.000	0.024	0.012	0.063 +/- 0.003	0.135	
	0.098	0.028	0.875 to 15.000	0.028	0.012	0.070 +/- 0.003	0.154	
	0.118	0.031	1.000 to 20.000	0.031	0.012	0.087 +/- 0.004	0.180	
	0.138	0.031	1.250 to 25.000	0.031	0.020	0.107 +/- 0.004	0.200	
	0.157	0.031	1.750 to 30.000	0.031	0.020	0.126 +/- 0.004	0.219	
	0.177	0.031	2.000 to 40.000	0.031	0.020	0.146 +/- 0.004	0.239	
	0.197	0.031	3.000 to 50.000	0.031	0.020	0.166 +/- 0.004	0.259	
	0.217	0.031	4.000 to 50.000 +	0.031	0.020	0.186 +/- 0.004	0.279	
	0.236	0.035	5.000 to 50.000 +	0.035	0.020	0.201 +/- 0.004	0.306	
	0.276	0.035	6.000 to 50.000 +	0.035	0.028	0.241 +/- 0.004	0.346	
	0.315	0.035	8.000 to 50.000 +	0.035	0.028	0.280 +/- 0.004	0.385	
Copper, Soft Iron, Mild Steels and Annealed Nickel	0.063	0.020	0.500 to 4.000	0.020	0.012	0.043 +/- 0.002	0.103	63-125 Contact Applications Engineering for Recommendation
	0.075	0.024	0.625 to 6.000	0.024	0.012	0.051 +/- 0.003	0.123	
	0.087	0.024	0.750 to 10.000	0.024	0.012	0.063 +/- 0.003	0.135	
	0.098	0.028	0.875 to 15.000	0.028	0.012	0.070 +/- 0.003	0.154	
	0.118	0.028	1.000 to 20.000	0.028	0.012	0.090 +/- 0.003	0.174	
	0.138	0.028	1.250 to 25.000	0.028	0.020	0.110 +/- 0.003	0.194	
	0.157	0.031	1.750 to 30.000	0.031	0.020	0.126 +/- 0.004	0.219	
	0.177	0.031	2.000 to 40.000	0.031	0.020	0.146 +/- 0.004	0.239	
	0.197	0.031	3.000 to 50.000	0.031	0.020	0.166 +/- 0.004	0.259	
	0.217	0.031	4.000 to 50.000 +	0.031	0.020	0.186 +/- 0.004	0.279	
	0.236	0.035	5.000 to 50.000 +	0.035	0.020	0.201 +/- 0.004	0.306	
	0.276	0.035	6.000 to 50.000 +	0.035	0.028	0.241 +/- 0.004	0.346	
	0.315	0.035	8.000 to 50.000 +	0.035	0.028	0.280 +/- 0.004	0.385	
Nickel, Monel, Tantalum	0.063	0.016	0.500 to 4.000	0.016	0.012	0.047 +/- 0.002	0.095	32-63 Contact Applications Engineering for Recommendation
	0.075	0.020	0.625 to 6.000	0.020	0.012	0.055 +/- 0.002	0.115	
	0.087	0.020	0.750 to 10.000	0.020	0.012	0.067 +/- 0.002	0.127	
	0.098	0.024	0.875 to 15.000	0.024	0.012	0.074 +/- 0.003	0.146	
	0.118	0.024	1.000 to 20.000	0.024	0.012	0.094 +/- 0.003	0.166	
	0.138	0.024	1.250 to 25.000	0.024	0.020	0.114 +/- 0.003	0.186	
	0.157	0.028	1.750 to 30.000	0.028	0.020	0.129 +/- 0.003	0.213	
	0.177	0.028	2.000 to 40.000	0.028	0.020	0.149 +/- 0.003	0.233	
	0.197	0.028	3.000 to 50.000	0.028	0.020	0.169 +/- 0.003	0.253	
	0.217	0.028	4.000 to 50.000 +	0.028	0.020	0.189 +/- 0.003	0.273	
	0.236	0.031	5.000 to 50.000 +	0.031	0.020	0.205 +/- 0.004	0.298	
	0.276	0.031	6.000 to 50.000 +	0.031	0.028	0.245 +/- 0.004	0.338	
	0.315	0.031	8.000 to 50.000 +	0.031	0.028	0.284 +/- 0.004	0.377	
Stainless Steel, Inconel, Titanium	0.063	0.016	0.500 to 4.000	0.016	0.012	0.047 +/- 0.002	0.095	32-63 Contact Applications Engineering for Recommendation
	0.075	0.020	0.625 to 6.000	0.020	0.012	0.055 +/- 0.002	0.115	
	0.087	0.020	0.750 to 10.000	0.020	0.012	0.067 +/- 0.002	0.127	
	0.098	0.024	0.875 to 15.000	0.024	0.012	0.074 +/- 0.003	0.146	
	0.118	0.024	1.000 to 20.000	0.024	0.012	0.094 +/- 0.003	0.166	
	0.138	0.024	1.250 to 25.000	0.024	0.020	0.114 +/- 0.003	0.186	
	0.157	0.028	1.750 to 30.000	0.028	0.020	0.129 +/- 0.003	0.213	
	0.177	0.028	2.000 to 40.000	0.028	0.020	0.149 +/- 0.003	0.233	
	0.197	0.028	3.000 to 50.000	0.028	0.020	0.169 +/- 0.003	0.253	
	0.217	0.028	4.000 to 50.000 +	0.028	0.020	0.189 +/- 0.003	0.273	
	0.236	0.031	5.000 to 50.000 +	0.031	0.020	0.205 +/- 0.004	0.298	
	0.276	0.031	6.000 to 50.000 +	0.031	0.028	0.245 +/- 0.004	0.338	
	0.315	0.031	8.000 to 50.000 +	0.031	0.028	0.284 +/- 0.004	0.377	

Three Face Compression

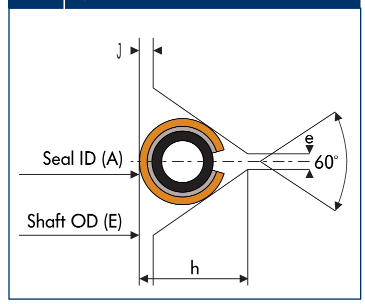
30° | Type HN140-240



45° | Type HN140-240



60° | Type HN100-200

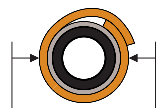


E = Shaft OD $^{+0.000}_{-0.002}$ **A = Seal ID** $^{+0.002}_{-0.000}$

CALCULATIONS	
Axial Load (Ya)	$= K \cdot Y_2$
Shaft OD (E)	= Seal ID (A)
Clearance (J)	< CS / 10
Axial Compression (e)	$= a \cdot e_2$
Cavity Finish	< 32 RMS

COEFFICIENT VALUES

Coefficient	30°	45°	60°
a	2.0	1.4	1.15
K	0.9	1.2	1.4



Cross Section
CS

"h" Values

Seal Cross Section CS	30°		45°		60°	
	Aluminum Jacket	Other Jackets	Aluminum Jacket	Other Jackets	Aluminum Jacket	Other Jackets
0.102	0.130	0.126	0.163	0.157	0.126	0.134
0.126	0.157	0.157	0.199	0.199	0.157	0.165
0.165	0.207	0.207	0.260	0.260	0.213	0.220
0.205	0.260	0.260	0.327	0.327	0.272	0.280
0.252	0.321	0.321	0.402	0.402	0.339	0.346

Dimensions in inches

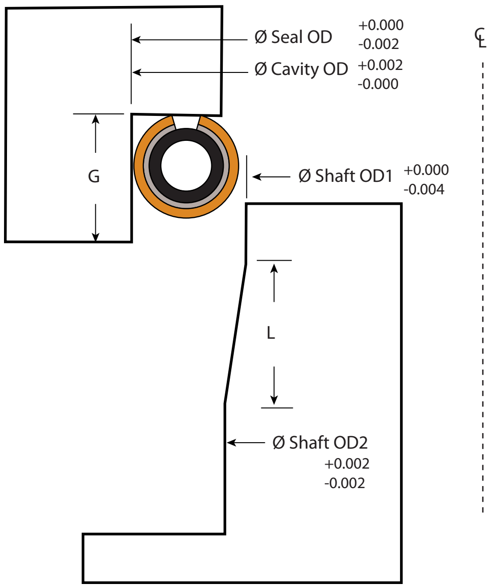
Target Sealing Criteria

The ultimate leak rate of a joint is a function of the seal design, flange design, bolting, surface finish and other factors. Helicoflex seals are designed to provide two levels of service: Helium Sealing or Bubble Sealing.

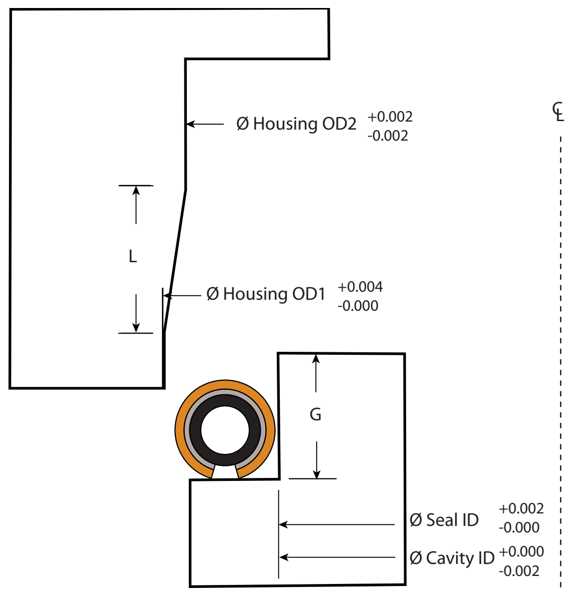
Helium Sealing: These Helicoflex seals are designed with a target Helium leak rate not to exceed $1x10^{-9}$ cc/sec. atm under a ΔP of 1 atmosphere. The ultimate leak rate will depend on the factors listed above.

Bubble Sealing: These Helicoflex seals are designed with a target air leak rate not to exceed $1x10^{-4}$ cc/sec.atm under a ΔP of 1 atmosphere.

Axial Pressure



Internal Compression



External Compression

Seal Configuration = HN110 or HN210

Aluminum			Silver			Copper			Nickel		
Cross Section CS	e_3	Ya lbs/in	Cross Section CS	e_3	Ya lbs/in	Cross Section CS	e_3	Ya lbs/in	Cross Section CS	e_3	Ya lbs/in
0.063	0.012	109	0.063	0.010	170	0.067	0.008	217	0.063	0.008	228
0.102	0.014	137	0.102	0.012	195	0.092	0.010	251	0.102	0.010	308
0.118	0.016	154	0.122	0.014	206	0.128	0.012	286	0.126	0.012	343
0.157	0.020	183	0.165	0.018	228	0.171	0.016	332	0.165	0.016	434
0.200	0.020	206	0.205	0.018	263	0.210	0.016	377	0.205	0.016	525
0.260	0.024	235	0.244	0.020	308	0.250	0.018	457	0.252	0.018	640

Dimensions in inches

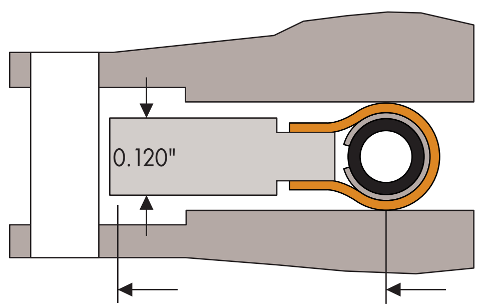
CALCULATIONS		
	Internal Compression	External Compression
G min = CS + e_3 + 0.008	Seal OD = Cavity OD	Seal ID = Cavity ID
L min = 10 x e_3	Seal ID = Seal OD - 2 CS	Seal OD = Seal ID + 2 CS
Cavity Finish: ≤ 32RMS	Shaft OD1 ≤ Seal ID	Housing OD1 ≥ Seal OD
Ya = Axial Seating Load	Shaft OD2 = Seal ID + 2e_3	Housing OD2 = SealOD - 2e_3

ANSI B16.5 Raised Face Flange

The Helicoflex® HN208 is ideally suited for standard raised face flanges. The resilient nature of the seal allows it to compensate for the extremes of high temperature and pressure where traditional spiral wounds and double jacketed seals fail. The jacket and spring combination can be modified to meet most requirements of temperature and pressure. In addition, a large selection of jacket materials ensures chemical compatibility in corrosive and caustic media.

Seal Type HN208

Jacket	Availability	Cross Section (inches)	Seating Load (lbs/in)*	Recommended Flange Finish (RMS)
Aluminum	Standard	0.160	1150	63 - 125
Silver	Standard	0.160	1725	63 - 125
Copper	Standard	0.155	2250	63 - 125
Soft Iron	Optional	0.155	2250	32 - 63
Nickel	Standard	0.150	2800	32 - 63
Monel	Optional	0.150	2800	32 - 63
Hastelloy C	Optional	0.150	3800	32 - 63
Stainless Steel	Standard	0.150	3800	32 - 63
Alloy 600	Optional	0.150	3800	32 - 63
Alloy X750	Optional	0.150	4000	32 - 63
Titanium	Optional	0.150	4000	32 - 63



Dimensions in inches

*NOTE: Seating load only! Does not allow for hydrostatic end force.

SEAL DIMENSIONS								
Nominal Diameter	Mean Diameter (d)	Seal OD (A)						
		150lb	300lb	400lb	600lb	900lb	1500lb	2500lb
1/2	0.827	1.874	2.126	2.126	2.126	2.500	2.500	2.752
3/4	1.102	2.252	2.626	2.626	2.626	2.752	2.752	3.000
1	1.417	2.626	2.874	2.874	2.874	3.122	3.122	3.374
1-1/4	1.890	3.000	3.252	3.252	3.252	3.500	3.500	4.126
1-1/2	2.283	3.374	3.752	3.752	3.752	3.874	3.874	4.626
2	2.913	4.126	4.374	4.374	4.374	5.626	5.626	5.752
2-1/2	3.425	4.874	5.126	5.126	5.126	6.500	6.500	6.626
3	4.173	5.374	5.874	5.874	5.874	6.626	6.874	7.752
3-1/2	4.685	6.374	6.500	6.500	6.374	N/A	N/A	N/A
4	5.256	6.874	7.126	7.000	7.626	8.126	8.252	9.252
5	6.378	7.752	8.500	8.374	9.500	9.752	10.000	11.000
6	7.500	8.752	9.874	9.752	10.500	11.413	11.126	12.500
8	9.567	10.996	12.126	12.000	12.626	14.126	13.874	15.252
10	11.693	13.374	14.252	14.126	15.752	17.126	17.126	18.760
12	13.858	16.126	16.626	16.500	18.000	19.626	20.500	21.626
14	15.098	17.752	19.126	19.000	19.374	20.500	22.752	N/A
16	17.205	20.252	21.252	21.126	22.252	22.626	25.252	N/A
18	19.567	21.626	23.500	23.374	24.126	25.126	27.752	N/A
20	21.575	23.874	25.752	25.500	26.874	27.500	29.752	N/A
24	25.728	28.252	30.500	30.252	31.126	32.996	35.500	N/A

Dimensions in inches

NOTE: Contact Applications Engineering for other available sizes and materials

Calculations According to Codes

	A.S.M.E. Section VIII Division I	Garlock Helicoflex
Operating load	$Wm2 = \pi.b.G.y$	$Fj = \pi.Dj.Y_2$
Hydrostatic force	$H = \pi.\dfrac{G^2}{4}.P$	$F_F = \pi.\dfrac{(Dj)^2}{4}.P$
Minimum service load	$H_P = 2.b.\pi.G.m.P$	$Fm = \pi.Dj.Ym$ $Ym = \begin{cases} Ym_1 = Y_1 \\ Ym_2 = Y_2 \dfrac{P}{Pu\Theta} \end{cases}$ Use the greater of the two
Minimum tightening load to apply on bolts	$W = \begin{cases} (1)\ W_{m2} \\ (2)\ H + Hp = W_{m1} \end{cases}$ Use the greater of the two (1) or (2)	$F_B = \begin{cases} (1)\ Fj \\ (2)\ F_F + F_m = Fs \end{cases}$ Use the greater of the two (1) or (2)

Equivalent Symbols

	A.S.M.E. Section VIII Division I
Operating load	$W_{m2} = Fj$ $b = 1$ $G = Dj$ $Y = Y_2$ ↓ $W_{m2} = \pi.Dj.Y_2$
Hydrostatic force	$H = F_F$ $G = Dj$ ↓ $H = \pi.\dfrac{(Dj)^2}{4}.P$
Minimum service load	$H_p = F_m$ $b = 1$ $G = Dj$ $2.m.P = Y_m$ $m = \dfrac{Ym}{2.P}$ ↓ $H_P = \pi.Dj.Ym$
Minimum bolt load	$W = F_B$ $W = (1)\ Fj$ $(2)\ F_F + F_m = Fs$ Use the greater of the two (1) or (2)

Note: Due to its circular section, the Helicoflex seal exhibits a "line" load instead of an "area load" typical of traditional gaskets. As a result, "m", "b" and "y" factors are not pertinent when applied to the Helicoflex seal. These equivalent equations were developed to assist flange designers with their calculations.

Garlock Helicoflex®
PERFORMANCE METAL SEALS
an EnPro Industries company

HELICOFLEX DATA SHEET

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ADDRESS: E-MAIL:

DATE:

APPLICATION: (please attach customer drawing / sketch)

Brief Description:

Annual quantities: RFQ Quantities:

Is This a New Design? ❑ Yes ❑ No Are Modifications Possible? ❑ Yes ❑ No

Drawing or Sketch Attached? ❑ Yes ❑ No What is the Seal Type? ❑ Shaped ❑ Circular

SERVICE CONDITIONS:

Media: Life Expectancy:

Working Temperature: Max/Proof Pressure: @ Temp. =

Working Pressure: Max Temperature: @ Pressure =

Pressure Direction: (Internal/External/Axial) **Target Sealing Level:** Helium: Std.cc/sec

Pressure Cycles: Flow Rate: cc/minute

Temperature Cycles: Other:

FLANGE DETAILS: (Please Provide Drawing)

Amount of Flange Movment in Service: (Inches) Radial: Axial: #Cycles:

Material: Thickness:

❑ Groove / Counter Bore: Please list dimensions in Groove Details section

❑ ANSI Raised Face Size: # Rating: Face Surface Finish: (RMS)

❑ Flange(s) with Clamping System: (ISO,KF, etc) Standard: Size:

❑ Other: Description: (Please Provide Drawing)

GROOVE DETAILS: (Please Provide Drawing)

Type (Rectangular, Dovetail, etc.):

Outer Diameter: Tolerance: Depth: Tolerance:

Inner Diameter: Tolerance: Finish (RMS) Type:

Finish Type: lathe (circular), endmill (multi-directional), other

BOLTING DETAILS: (Please Provide Drawing)

Size: Type / Grade:

Number: Bolt Circle Tapped / Through:

OTHER:

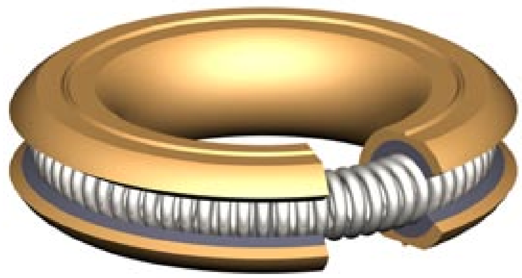
Special coating / plating specification:

Special quality / inspection specifications:

Other:

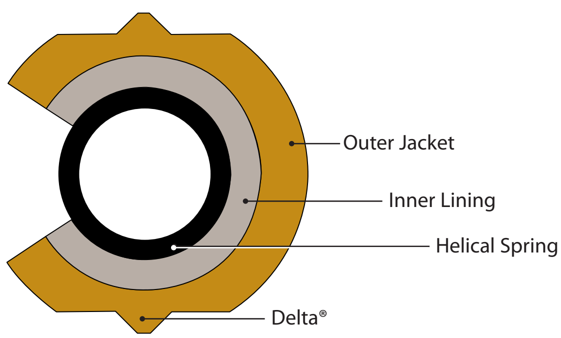
Garlock Helicoflex®
PERFORMANCE METAL SEALS
an EnPro Industries company

Sealing Concept

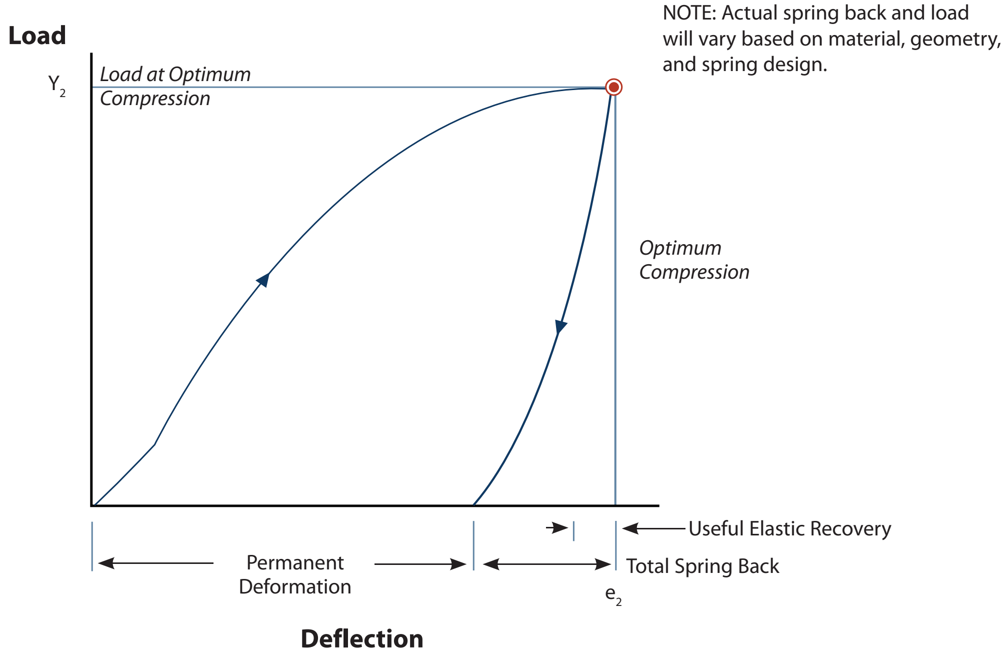


The Delta® seal is a member of the Helicoflex family of spring energized seals. The sealing principle of the Helicoflex family of seals is based upon the plastic deformation of a jacket that has greater ductility than the flange materials. This occurs between the sealing face of a flange and an elastic core composed of a close-wound helical spring. The spring is selected to have a specific compression resistance. During compression, the resulting specific pressure forces the jacket to yield and ensures positive contact with the flange sealing faces. Each coil of the helical spring acts independently and allows the seal to conform to irregularities on the flange surface.

The Delta® seal is unique in that it uses two small ridges or "Deltas" on the face of the seal. The load required to plastically deform the jacket material is greatly reduced by concentrating the compression load on the Deltas. The resulting high contact stress in the seal track makes the Delta seal an excellent choice for ultra-high vacuum applications that require ultra-low Helium leak rates. There is typically no risk of damaging the flange sealing surfaces as long as the minimum hardness requirements are maintained.



Typical Load Deflection Curve



Leak Performance

Delta seals can provide Helium leak rate performance of < 1x10-11 std.cc/sec (per meter of seal circumference). Actual leak rate will depend on seal jacket, cavity/flange finish, bolting, hardware robustness and cleanliness level.

Classification of Seal Type

Cross Section Type	HNV low load (Delta Seal)									
Jacket/ Lining	1 = jacket only					2 = jacket with inner lining				
Jacket Orientation	0	1	2	3	4	5	6	7	8	9
Section Orientation	0	1	2	3	4	5	6	7	8	9

Example

HNV	2	0	0
Cross Section Type	# Jackets/ Lining	Jacket Orientation	Section Orientation

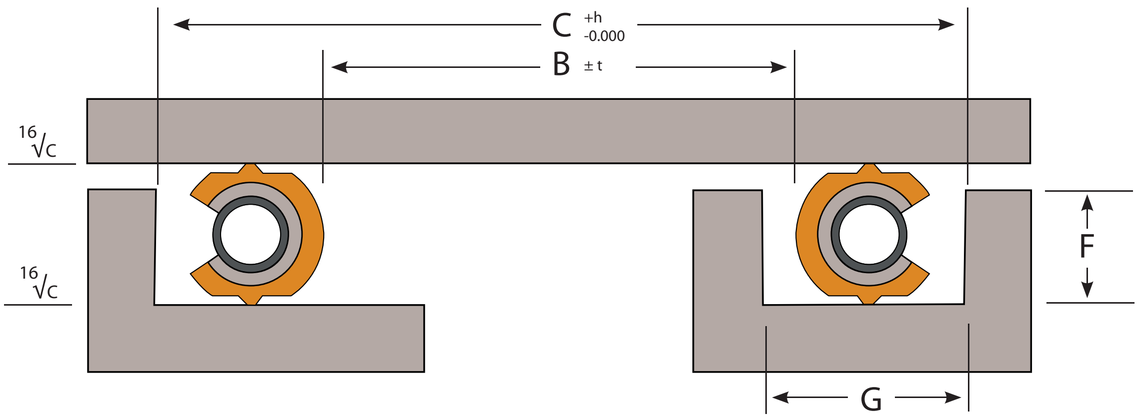
Delta® Characteristic Values

Jacket Material	Free Height	Seal Type	Installation Compression e_2	Seal Diameter	Seating Load PCI Y2	Maximum Temperature °F	°C
Aluminum	0.075	HNV100	Contact Applications Engineering				
	0.102	HNV200	0.028	0.750 to 8.000	800	428	220
	0.130	HNV200	0.031	1.000 to 16.000	800	482	250
	0.157	HNV200	0.035	2.000 to 20.000	800	536	280
	0.189	HNV200	0.035	3.000 to 30.000	800	536	280
	0.220	HNV200	0.039	4.000 to 40.000	860	608	320
	0.264	HNV200	0.043	5.000 to 50.000	860	644	340
Silver	0.067	HNV100	Contact Applications Engineering				
	0.094	HNV200	0.024	0.750 to 6.000	915	536	280
	0.122	HNV200	0.024	1.000 to 12.000	915	572	300
	0.154	HNV200	0.028	2.000 to 18.000	915	662	350
	0.185	HNV200	0.031	3.000 to 20.000	915	698	370
	0.213	HNV200	0.031	4.000 to 20.000	970	752	400
	0.256	HNV200	0.035	5.000 to 20.000	1030	842	450
Copper	0.065	HNV100	Contact Applications Engineering				
	0.092	HNV200	0.017	0.750 to 8.000	1030	716	380
	0.120	HNV200	0.021	1.000 to 16.000	1030	716	380
	0.155	HNV200	0.025	2.000 to 18.000	1030	788	420
	0.179	HNV200	0.025	3.000 to 20.000	1030	842	450
	0.210	HNV200	0.025	4.000 to 30.000	1030	896	480
	0.250	HNV200	0.029	5.000 to 30.000	1085	968	520
Nickel (Annealed)	0.065	HNV100	Contact Applications Engineering				
	0.092	HNV200	0.017	0.750 to 8.000	1030	788	420
	0.120	HNV200	0.021	1.000 to 16.000	1030	896	480
	0.155	HNV200	0.025	2.000 to 18.000	1030	1022	550
	0.179	HNV200	0.025	3.000 to 20.000	1030	1112	600
	0.210	HNV200	0.025	4.000 to 30.000	1030	1202	650
	0.250	HNV200	0.029	5.000 to 30.000	1085	1202	650
Stainless Steel	Contact Applications Engineering						

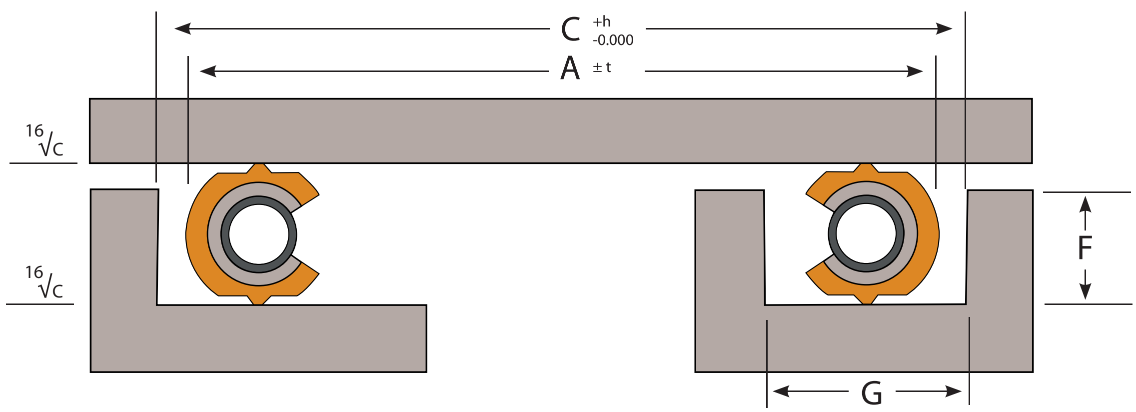
Dimensions in inches

NOTES:
1. PCI = Pounds force per circumferential inch.
2. Seating load (Y_2) is an approximation and may vary based on groove clearance, seal diameter and tolerance. Seating load is for circular seals only.
3. The customer must verify that system bolts and flanges can generate the required seating load without warping or distorting.
4. The customer must test and verify that the seal design meets customer designated performance requirements.
5. Seal type HNV100 is available as an option only. Type HNV200 is preferred due to its protective inner lining and can be expected to produce better results.
6. Contact Applications Engineering for low pressure applications.

Internal Vacuum: Seal Type HNV200



External Vacuum: Seal Type HNV220



Seal and Groove Sizing Calcuations

The equations below can be used for basic groove calculations. Applications that have significant thermal expansion may require additional clearance. Please contact Applications Engineering for design assistance.

Determining Seal Diameter:

Internal Vacuum
< 12″ B = C - X - 2 (Seal Section x 0.933)
≥ 12″ Contact Applications Engineering

External Vacuum
A = C - X

Determining Groove Diameter:

Internal Vacuum
< 12″ C = B + X + 2 (Seal Section x 0.933)
≥ 12″ Contact Applications Engineering

External Vacuum
C = A + X

Tolerancing: See chart

Where: A = Seal Outer Diameter
B = Seal Inner Diameter
C = Groove Outer Diameter
X = Diametrical Clearance

Delta® Groove Dimensions

Seal						Groove					
Jacket Material	Free Height	Seal Section	Seal Type	Seal Diameter Range	Seal Tolerance t^3	Diametical Clearance x	Seating Load PCI Y_2	Groove Tolerance h	Groove Depth F	Groove Width G (Min)	Min. Flange Hardness (Vickers)
Aluminum	0.075	0.079	HNV100	-	-	Contact Applications Engineering					
	0.102	0.106	HNV200	0.750 to 8.000	0.005	0.020	800	0.010	0.075 ± 0.002	0.150	65
	0.130	0.134	HNV200	1.000 to 16.000	0.005	0.030	800	0.010	0.099 ± 0.002	0.180	65
	0.157	0.161	HNV200	2.000 to 20.000	0.005	0.030	800	0.010	0.122 ± 0.002	0.210	65
	0.189	0.193	HNV200	3.000 to 30.000	0.005	0.035	800	0.010	0.154 ± 0.003	0.245	65
	0.220	0.228	HNV200	4.000 to 30.000	0.005	0.040	860	0.010	0.180 ± 0.003	0.280	65
	0.264	0.272	HNV200	5.000 to 30.000	0.005	0.040	860	0.010	0.220 ± 0.003	0.320	65
Silver	0.067	0.071	HNV100	-	-	Contact Applications Engineering					
	0.094	0.098	HNV200	0.750 to 6.000	0.005	0.020	915	0.010	0.070 ± 0.002	0.140	120
	0.122	0.126	HNV200	1.000 to 12.000	0.005	0.020	915	0.010	0.098 ± 0.002	0.165	120
	0.154	0.157	HNV200	2.000 to 18.000	0.005	0.025	915	0.010	0.126 ± 0.002	0.200	120
	0.185	0.189	HNV200	3.000 to 20.000	0.005	0.030	915	0.010	0.154 ± 0.003	0.235	120
	0.213	0.220	HNV200	4.000 to 20.000	0.005	0.030	970	0.010	0.180 ± 0.003	0.265	120
	0.256	0.264	HNV200	5.000 to 20.000	0.005	0.035	1030	0.010	0.220 ± 0.003	0.315	120
Copper	0.065	0.069	HNV100	-	-	Contact Applications Engineering					
	0.092	0.096	HNV200	0.750 to 8.000	0.005	0.020	1030	0.010	0.075 ± 0.001	0.130	130
	0.120	0.124	HNV200	1.000 to 16.000	0.005	0.020	1030	0.010	0.098 ± 0.002	0.160	130
	0.155	0.159	HNV200	2.000 to 18.000	0.005	0.025	1030	0.010	0.130 ± 0.002	0.200	130
	0.179	0.183	HNV200	3.000 too 20.000	0.005	0.025	1030	0.010	0.154 ± 0.002	0.225	130
	0.210	0.218	HNV200	4.000 to 30.000	0.005	0.025	1030	0.010	0.185 ± 0.002	0.255	130
	0.250	0.257	HNV200	5.000 to 30.000	0.005	0.030	1085	0.010	0.220 ± 0.003	0.300	130
Nickel (Annealed)	0.065	0.069	HNV100	-	-	Contact Applications Engineering					
	0.092	0.096	HNV200	0.750 to 8.000	0.005	0.020	1030	0.010	0.075 ± 0.001	0.130	220
	0.120	0.124	HNV200	1.000 to 16.000	0.005	0.020	1030	0.010	0.098 ± 0.002	0.160	220
	0.155	0.159	HNV200	2.000 to 18.000	0.005	0.025	1030	0.010	0.130 ± 0.003	0.200	220
	0.179	0.183	HNV200	3.000 to 20.000	0.005	0.025	1030	0.010	0.154 ± 0.002	0.225	220
	0.210	0.218	HNV200	4.000 to 30.000	0.005	0.025	1030	0.010	0.185 ± 0.002	0.255	220
	0.250	0.257	HNV200	5.000 to 30.000	0.005	0.030	1085	0.010	0.220 ± 0.003	0.300	220
Stainless Steel	Contact Applications Engineering					Contact Applications Engineering					

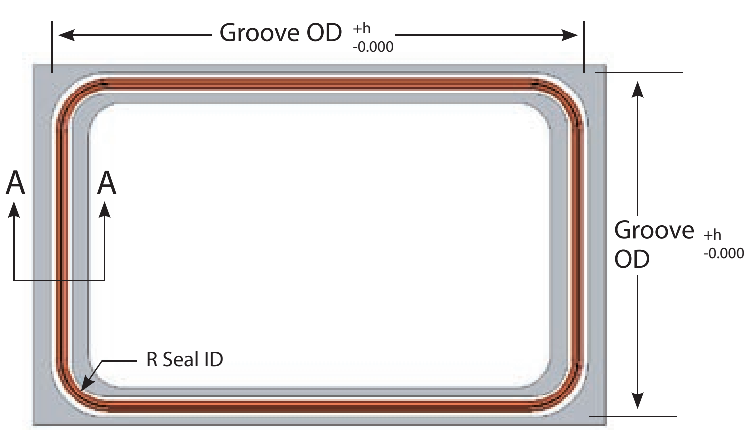
NOTES:
1. Contact Applications Engineering for additional sizes.
2. Seal type HNV100 is available as an option only. Type HNV200 is preferred due to its protective inner lining and can be expected to produce better results.
3. Seal diameters ≥ 12″ may require special tolerancing. Contact Applications Engineering for design assistance.

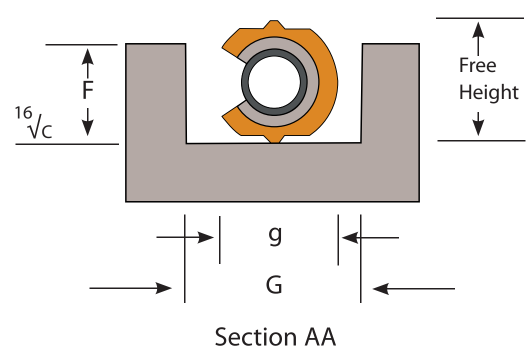
Shaped Seal: Delta® Groove Dimensions

Seal								Groove			
Jacket Material	Free Height	Seal Section g	Seal Type	Installation Compression e_2	Seating Load PCI Y_2	Seal Tolerance t	Bend Radius ID R (Min)	Groove Tolerance h	Groove Depth F	Groove Width G (Min)	Min. Flange Hardness (Vickers)
Aluminum	0.075	0.079	HNV100	Contact Applications Engineering				Contact Applications Engineering			
	0.102	0.106	HNV200	0.028	1200	Fit Template	0.750	0.010	0.075 ± 0.002	0.170	65
	0.130	0.134	HNV200	0.031	1050	Fit Template	1.000	0.010	0.099 ± 0.002	0.200	65
	0.157	0.161	HNV200	0.035	1050	Fit Template	1.125	0.010	0.122 ± 0.002	0.230	65
	0.189	0.194	HNV200	0.035	1050	Fit Template	1.375	0.010	0.154 ± 0.003	0.265	65
	0.220	0.228	HNV200	0.039	1170	Fit Template	1.500	0.010	0.180 ± 0.003	0.300	65
	0.264	0.272	HNV200	0.043	1200	Fit Template	1.750	0.010	0.220 ± 0.003	0.340	65
Silver	0.067	0.071	HNV100	Contact Applications Engineering				Contact Applications Engineering			
	0.094	0.098	HNV200	0.024	1050	Fit Template	0.625	0.010	0.070 ± 0.002	0.160	120
	0.122	0.126	HNV200	0.024	1150	Fit Template	0.875	0.010	0.098 ± 0.002	0.185	120
	0.154	0.157	HNV200	0.028	1100	Fit Template	1.000	0.010	0.126 ± 0.002	0.220	120
	0.185	0.189	HNV200	0.031	1100	Fit Template	1.250	0.010	0.154 ± 0.003	0.225	120
Copper	0.065	0.069	HNV100	Contact Applications Engineering				Contact Applications Engineering			
	0.092	0.096	HNV200	0.017	1100	Fit Template	0.625	0.010	0.075 ± 0.001	0.150	130
	0.120	0.124	HNV200	0.021	1350	Fit Template	0.875	0.010	0.098 ± 0.002	0.180	130
	0.155	0.159	HNV200	0.025	1275	Fit Template	1.000	0.010	0.130 ± 0.002	0.220	130
	0.179	0.183	HNV200	0.025	1275	Fit Template	1.125	0.010	0.154 ± 0.002	0.245	130
Nickel (Annealed)	0.065	0.069	HNV100	Contact Applications Engineering				Contact Applications Engineering			
	0.092	0.096	HNV200	0.017	1100	Fit Template	0.625	0.010	0.075 ± 0.001	0.150	220
	0.120	0.124	HNV200	0.021	1350	Fit Template	0.875	0.010	0.098 ± 0.002	0.180	220
	0.155	0.159	HNV200	0.025	1275	Fit Template	1.000	0.010	0.130 ± 0.003	0.220	220
	0.179	0.183	HNV200	0.025	1275	Fit Template	1.125	0.010	0.154 ± 0.002	0.245	220
Stainless Steel	Contact Applications Engineering										

NOTES:

1. PCI = Pounds force per circumferential inch.
2. Seating Load (Y_2) is an approximation and may vary based on groove clearance, seal diameter and tolerance. Load values may be slightly higher in corner radii.
3. Seal type HNV100 is available as an option only. Type HNV200 is preferred due to its protective inner lining and can be expected to produce better results.
4. Seal Tolerance: Seal is manufactured to fit customer supplied/purchased groove template.
5. All machining and polishing marks must follow seal circumference.





Garlock Helicoflex®
PERFORMANCE METAL SEALS
an EnPro Industries company

HELICOFLEX DATA SHEET

Tel: 800-233-1722 Fax: 803-783-4279
E-Mail: sales@helicoflex.com

COMPANY: PHONE:
CONTACT: FAX:
ADDRESS: E-MAIL:
DATE:

APPLICATION: (please attach customer drawing / sketch)

Brief Description:

Annual quantities: RFQ Quantities:

Is This a New Design? ❑ Yes ❑ No Are Modifications Possible? ❑ Yes ❑ No

Drawing or Sketch Attached? ❑ Yes ❑ No What is the Seal Type? ❑ Shaped ❑ Circular

SERVICE CONDITIONS:

Media: Life Expectancy:

Working Temperature: Max/Proof Pressure: @ Temp. =

Working Pressure: Max Temperature: @ Pressure =

Pressure Direction: (Internal/External/Axial)

Target Sealing Level: Helium: Std.cc/sec

Pressure Cycles: Flow Rate: cc/minute

Temperature Cycles: Other:

FLANGE DETAILS: (Please Provide Drawing)

Amount of Flange Movment in Service: (Inches) Radial: Axial: #Cycles:

Material: Thickness:

❑ Groove / Counter Bore: Please list dimensions in Groove Details section

❑ ANSI Raised Face Size: # Rating: Face Surface Finish: (RMS)

❑ Flange(s) with Clamping System: (ISO,KF, etc) Standard: Size:

❑ Other: Description: (Please Provide Drawing)

GROOVE DETAILS: (Please Provide Drawing)

Type (Rectangular, Dovetail, etc.):

Outer Diameter: Tolerance: Depth: Tolerance:

Inner Diameter: Tolerance: Finish (RMS) Type:

Finish Type: lathe (circular), endmill (multi-directional), other

BOLTING DETAILS: (Please Provide Drawing)

Size: Type / Grade:

Number: Bolt Circle Tapped / Through:

OTHER:

Special coating / plating specification:

Special quality / inspection specifications:

Other:

The technical data contained herein is by way of example and should not be relied on for any specific application. Garlock Helicoflex will be pleased to provide specific technical data or specifications with respect to any customer's particular applications. Use of the technical data or specifications contained herein without the express written approval of Garlock Helicoflex is at user's risk and Garlock Helicoflex expressly disclaims responsibility for such use and the situations which may result therefrom.

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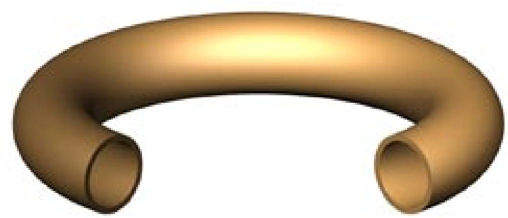
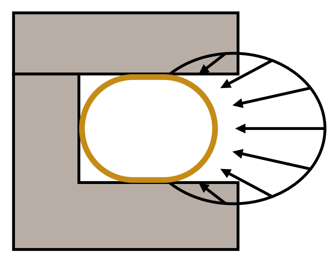
Sealing Concept



O-Flex™ Metal O-Rings are designed to provide a sealing option for high pressure/temperature applications that require minimal spring back. The O-Flex™ is made from high strength metal tubing that is coiled, cut and welded to size. It is available in standard cross section increments of 1/32". The O-Flex™ seating load can be adjusted to the application by varying the cross section and tubing wall thickness. Typical applications include Performance Engines, Plastic Extrusion/Molding, Military Specifications, Aerospace and Chemical Processing.

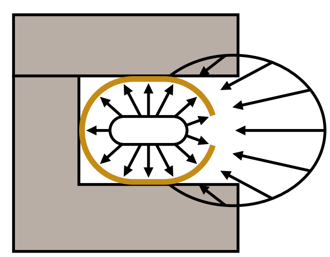
O-Flex™ Types

Basic



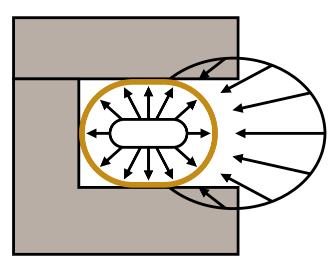
The basic O-Flex™ is designed for low to moderate pressure applications as high pressure may collapse the exposed tubing wall.

Self Energizing



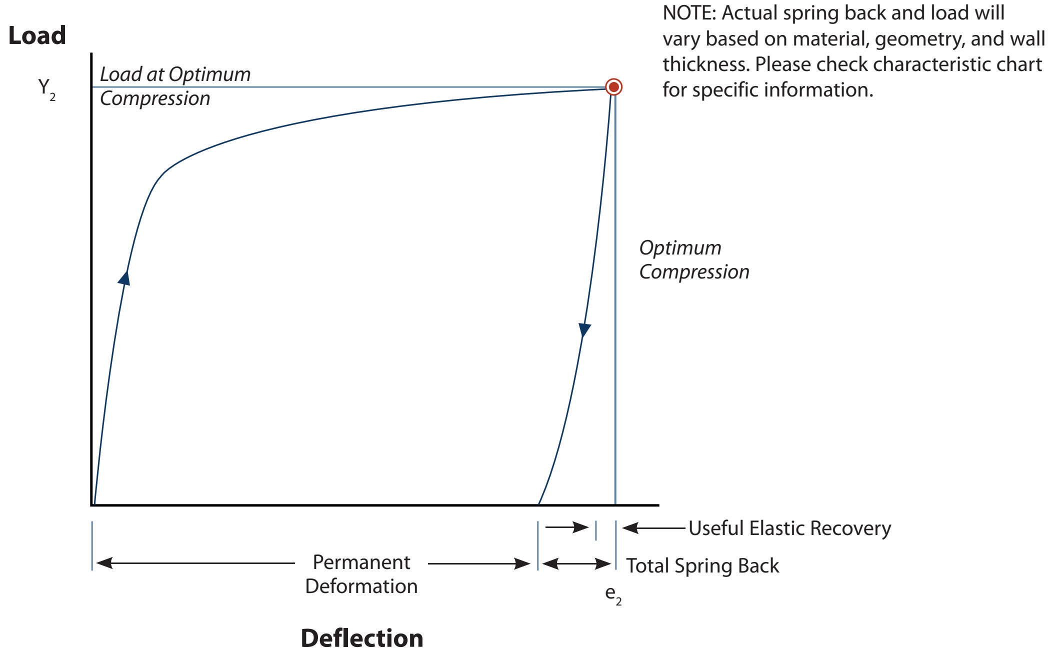
The Self-Energizing O-Flex™ is designed for high pressure applications. Small holes are drilled in the tubing wall exposed to the system pressure. These holes create an energizing effect by allowing the pressure to enter the O-Flex™. As a result, the pressure inside the seal increases with the system pressure and minimizes the possibility of collapsing the exposed tubing wall.

Pressure Filled



The Pressure Filled O-Flex™ is designed for Performance Engine applications that require sealing at elevated pressure and temperature in a high cycling environment. The O-Flex™ is filled with an inert gas that increases in pressure proportional to increases in system temperature. This results in an energizing effect that partially offsets the loss of material strength in service.

O-Flex™ Characteristic Curve



Material Selection

Material	Status	Temperature	Heat Treatment
SS 321	Standard	T < 700ºF	NA
Alloy 600	Standard	T < 1,000ºF	NA
Alloy X750	Standard	T < 1,100ºF	NA
Alloy 718	Optional	T < 1,200ºF	NA
Other	Contact Applications Engineering		

Plating/Coating Selection

Plating/Coating	Status	Standard Thickness	Temperature	Groove Finish*
PTFE	Optional	.001/.003	T < 500ºF	16 - 32 RMS
Silver	Standard	.001/.002	T < 800ºF	16 - 63 RMS
Silver w/ Gold strike	Optional	.001/.002	T < 1,200ºF	16 - 63 RMS
Nickel	Standard	.001/.002	T < 1,600ºF	16 - 32 RMS
None	-	-	-	< 16 RMS
Other	Contact Applications Engineering			

Dimensions in inches

* Groove finish must follow seal circumference (lathe turned finish).
Contact Applications Engineering for non-standard thicknesses.

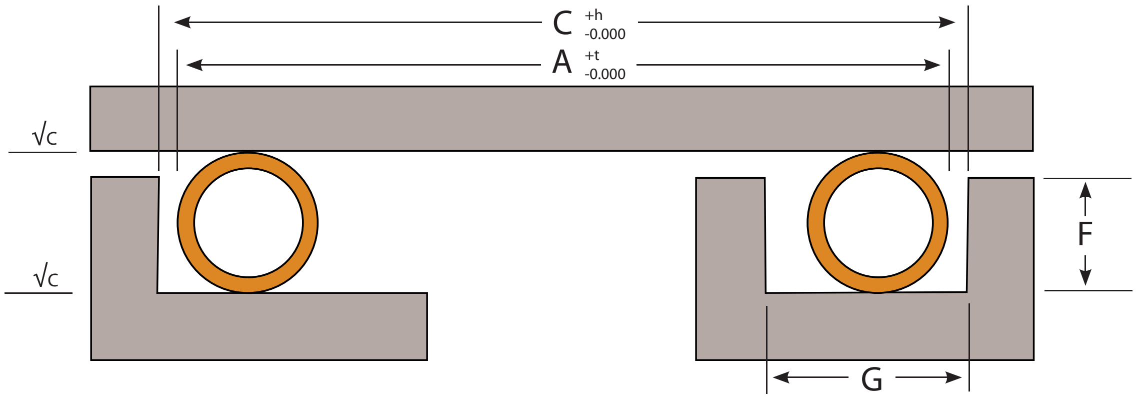
O-Flex™ Characteristic Values

Free Height	Compression e_2	Seal Diameter Range	Material Thickness	Thin (T) Medium (M) Heavy (H)	CHARACTERISTIC VALUES AT 70ºF: SS 321 Seating Load (PCI) Y_2	Alloy 600 Seating Load (PCI) Y_2	Alloy X-750 Seating Load (PCI) Y_2
0.032	0.006	0.500 to 4.000	0.006	T	457	503	594
			0.010	M	1028	1131	1336
			-	H	-	-	-
0.063	0.012	0.500 to 10.000	0.010	T	571	628	742
			0.012	M	799	879	1039
			0.014	H	1256	1382	1633
0.094	0.020	1.000 to 20.000	0.010	T	343	377	446
			0.012	M	514	565	668
			0.018	H	1313	1444	1707
0.125	0.026	2.000 to 40.000	0.010	T	343	377	446
			0.020	M	1142	1256	1485
			0.025	H	2056	2262	2673
0.156	0.031	3.000 to 50.000	-	T	-	-	-
			0.020	M	857	943	1114
			0.025	H	1428	1571	1856
0.188	0.039	4.000 to 60.000	-	T	-	-	-
			0.020	M	657	723	854
			0.032	H	2113	2324	2747
0.250	0.051	5.000 to 80.000	0.025	T	799	879	1039
			0.032	M	1370	1507	1781
			0.049	H	3026	3329	3934

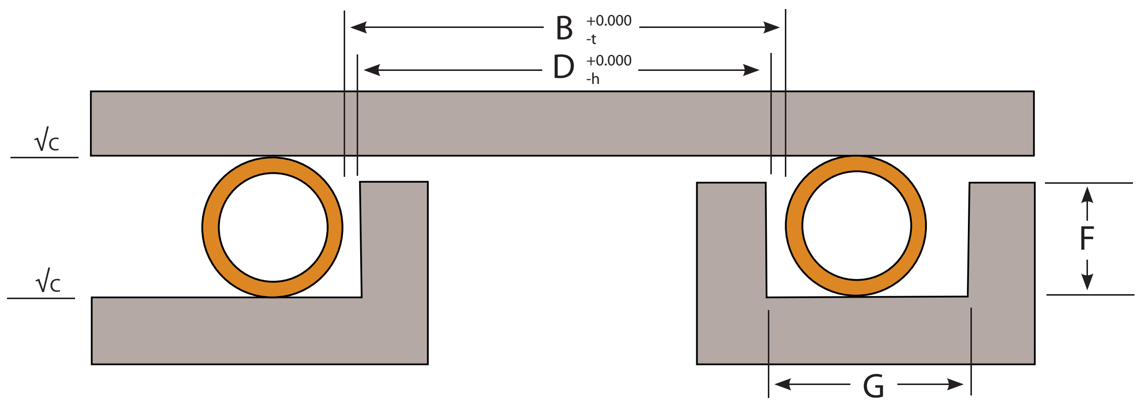
Dimensions in inches

NOTES:
1. PCI = Pounds force per circumferential inch
2. Seating Load (Y_2) is an approximation and may vary based on groove clearance, seal diameter, tolerance and plating thickness. It does not allow for system pressure requirements and should be verified for each application and seal size.
3. The customer must verify that system bolts and flanges can generate the required seating load without warping or distorting.
4. The customer must test and verify that the seal design meets customer designated performance requirements.

Internal Pressure



External Pressure



Seal and Groove Sizing Calculations

The equations below can be used for basic groove calculations. Applications that have significant thermal expansion may require additional clearance. Please contact Applications Engineering for design assistance.

Determining Seal Diameter:

Internal
A = C-X-2Pmax

External
B = D + X + 2Pmax

Determining Groove Diameter:

Internal
C = A + X + 2Pmax

External
D = B – X – 2Pmax

Tolerancing: See chart

Where:	A =	Seal Outer Diameter
	B =	Seal Inner Diameter
	C =	Groove Outer Diameter
	D =	Groove Inner Diameter
	Pmax =	Maximum Plating or Coating Thickness
	X =	Diametrical Clearance

Groove Finish √c: See Plating/Coating Section

Seal and Groove Dimensions

SEAL			GROOVE			
Free Height	Seal Diameter Range	Seal Tolerance t	Diametrical Clearance x	Groove Tolerance h	Groove Depth F	Groove Width (Min.) G
0.032	0.500 to 4.000	0.005	0.006	0.004	0.026 ±0.001	0.055
0.063	0.500 to 10.000	0.005	0.006	0.004	0.051 ±0.001	0.090
0.094	1.000 to 20.000	0.005	0.008	0.004	0.073 ±0.002	0.125
0.125	2.000 to 40.000	0.005	0.008	0.004	0.099 ±0.002	0.160
0.157	3.000 to 50.000	0.005	0.014	0.006	0.125 ±0.002	0.200
0.188	4.000 to 50.000	0.005	0.014	0.006	0.149 ±0.002	0.250
0.250	5.000 to 50.000	0.008	0.019	0.008	0.199 ±0.002	0.350

Dimensions in inches

NOTE: Contact Applications Engineering for additional sizes.

Aerospace Industry

Racing Industry

Tube Coatings	Tube Diameter	S.steel 321			Alloy 600			Alloy X750		
	Wall Thickness	T	M	H	T	M	H	T	M	H
Non Plated	0.032″	■	■	●	■	■	●	■	●	●
	0.063″	■	■	■	■	■	●	■	■	●
	0.094″	■	■	■	■	■	●	■	■	●
	0.125″	■	■	●	■	■	●	■	■	●
	0.156″	■	■	●	■	■	●	■	■	●
	0.188″	■	■	●	■	■	●	■	■	●
	0.250″	■	●	●	■	●	●	■	●	●
	Wall Thickness	T	M	H	T	M	H	T	M	H
PTFE	0.032″	●	▲	▲		▲	▲	●	▲	▲
	0.063″	●	▲	▲		▲	▲	●	▲	▲
	0.094″	●	●	▲		●	▲	●	●	▲
	0.125″	●	▲	▲		▲	▲	●	▲	▲
	0.156″	■	▲	▲	■	▲	▲	■	▲	▲
	0.188″	■	●	▲	■	●	▲	●	●	▲
	0.250″	▲	▲	▲	▲	▲	▲	▲	▲	▲
	Wall Thickness	T	M	H	T	M	H	T	M	H
Silver	0.032″	●	●	▲	●	●	▲	●	●	▲
	0.063″	●	●	▲	●	●	▲	●	●	▲
	0.094″	■	●	▲	■	●	▲	●	●	▲
	0.125″	■	●	▲	■	●	▲	●	●	▲
	0.156″	■	●	▲	■	●	▲	■	●	▲
	0.188″	■	●	▲	■	●	▲	■	●	▲
	0.250″	●	●	▲	●	●	▲	●	●	▲
	Wall Thickness	T	M	H	T	M	H	T	M	H
Nickel	0.032″	■	●	●	■	●	●	■	●	●
	0.063″	■	■	●	■	●	●	■	●	●
	0.094″	■	■	●	■	■	●	■	■	●
	0.125″	■	●	●	■	●	●	■	●	●
	0.156″	■	●	●	■	●	●	■	●	●
	0.188″	■	■	●	■	■	●	■	●	●
	0.250″	■	●	●	●	●	●	●	●	▲

Legend

■ : Q > 1.32 x 10^{-5} std.cc/sec He

● : 1.32 x 10^{-9} < Q < 1.32 x 10^{-5} std.cc/sec He

▲ : Q <1.32 x 10^{-9} std.cc/sec He

Q : Approximate leak rate per meter of circumference

T: Thin

M: Medium

H: Heavy



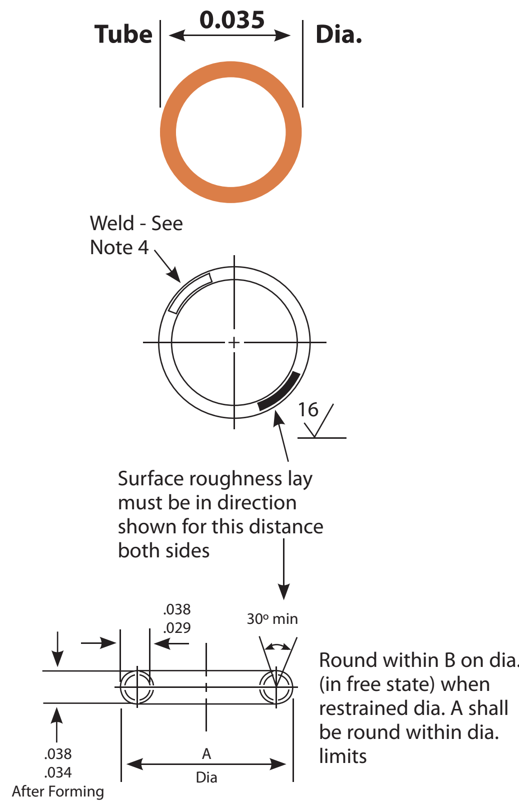
O-Flex™ Seals for Military Standards

Tube 0.035 Diameter

Military Standard

MS 9141 Gasket, metal O-ring, .035 tube x .006 wall, cres
MS 9371 Gasket, metal O-ring, .035 tube x .006 wall, cres, silver plated

1. Ring shall be flat within B.
2. *Preferred sizes.
3. Material: Corrosion and heat resistant steel tubing AMS 5570 or AMS 5576.
4. Finish weld flush with tube OD. Smooth blend within .125 of Weld. Dimensions at blend shall not be more than .003 below adjacent surfaces.
5. Finish: Silver plate AMS 2410 .0010-.0015 thick. Dimensions to be met before plating. Contact points permissible on ID of ring: (MS 9371 only)
6. Surface roughness: AS 291/ANSI B46.1
7. Manufacturing specification: AMS 7325
8. Identification: Mark MS part number and manufacturer's identification on container.
9. Dimensions in inches.
10. Do not use unassigned part numbers.
11. Contact Applications Engineering for design requirements.



Add to MS Number	A +.005 -.000	B	Add to MS Number	A +.005 -.000	B
-03	.250 †	.020	-15	.750*	.020
-04	.281 †	.020	-16	.812	.020
-05	.312 †	.020	-17	.875*	.020
-06	.344 †	.020	-18	.938	.020
-07	.375 †	.020	-19	1.000*	.020
-08	.406 †	.020	-20	1.125	.020
-09	.438 †	.020	-21	1.250	.020
-10	.469 †	.020	-22	1.375	.020
-11	.500	.020	-23	1.500*	.020
-12	.562	.020	-24	1.625	.020
-13	.625*	.020	-25	1.750*	.020
-14	.688	.020	-26	1.875	.020
			-27	2.000*	0.20

Dimensions in inches

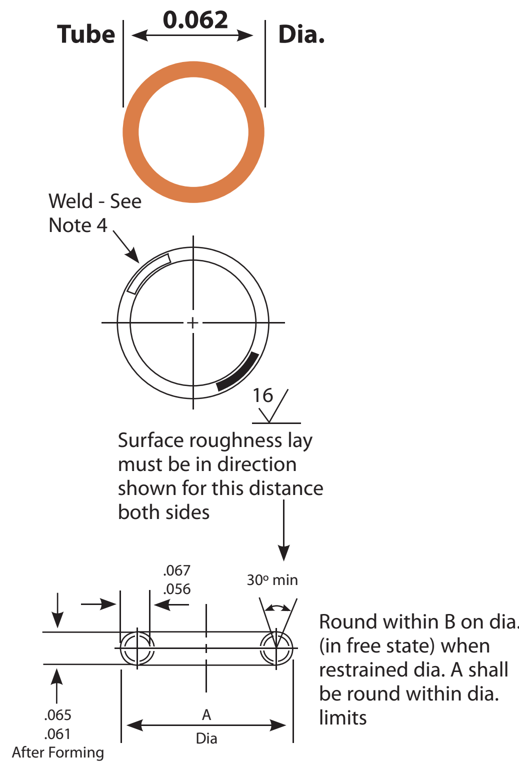
† Contact Applications Engineering for these sizes.

Tube 0.062 Diameter

Military Standard

MS 9142 Gasket, metal O-ring, .062 tube x .006 wall, cres
MS 9202 Gasket, metal O-ring, .062 tube x .010 wall, cres
MS 9372 Gasket, metal O-ring, .062 tube x .006 wall, cres, silver plated
MS 9373 Gasket, metal O-ring, .062 tube x .010 wall, cres, silver plated

1. Ring shall be flat within B.
2. *Preferred sizes.
3. Material: Corrosion and heat resistant steel tubing AMS 5570 or AMS 5576.
4. Finish weld flush with tube OD. Smooth blend within .125 of Weld. Dimensions at blend shall not be more than .004 below adjacent surfaces.
5. Finish: Silver plate AMS 2410 .0010-.0015 thick. Dimensions to be met before plating. Contact points permissible on ID of ring: (MS 9372, MS 9373 only)
6. Surface roughness: AS 291/ANSI B46.1
7. Manufacturing specification: AMS 7325
8. Identification: Mark MS part number and manufacturer's identification on container.
9. Dimensions in inches.
10. Do not use unassigned part numbers.
11. Contact Applications Engineering for design requirements.

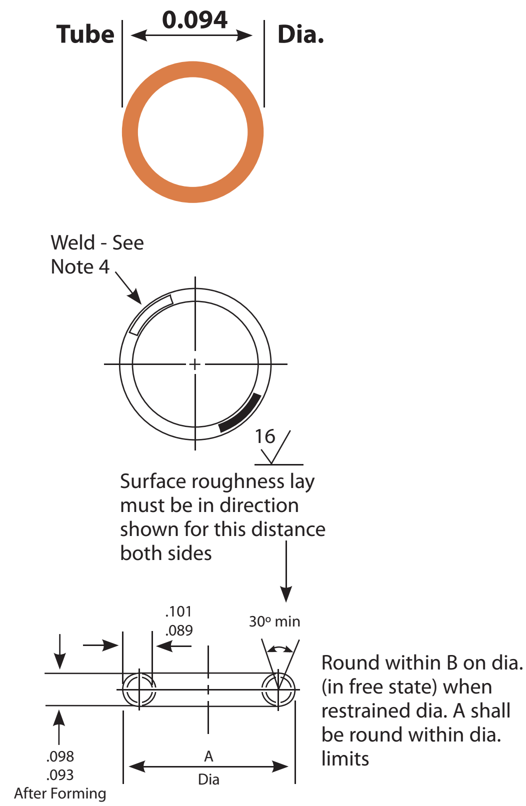


NOTE: MS 9142 and MS 9372 available only from dash 013 through dash 099.

Add to MS Number	A +.005 -.000	B	Add to MS Number	A +.005 -.000	B	Add to MS Number	A +.005 -.000	B	Add to MS Number	A +.005 -.000	B
-013	.438*	.030	-037	1.188	.030	-061	2.625	.060	-103	5.250	.090
-014	.469	.030	-038	1.219	.030	-062	2.688	.060	-105	5.375	.090
-015	.500*	.030	-039	1.250*	.030	-063	2.750*	.060	-107	5.500	.090
-016	.531	.030	-040	1.312	.030	-064	2.812	.060	-109	5.625	.090
-017	.562*	.030	-041	1.375*	.030	-065	2.875	.060	-111	5.750	.090
-018	.594	.030	-042	1.438	.030	-066	2.938	.060	-113	5.875	.090
-019	.625*	.030	-043	1.500*	.030	-067	3.000*	.060	-115	6.000*	.090
-020	.656	.030	-044	1.562	.030	-069	3.125	.060	-117	6.125	.090
-021	.688*	.030	-045	1.625*	.030	-071	3.250	.060	-119	6.250	.090
-022	.719	.030	-046	1.688	.030	-073	3.375	.060	-121	6.375	.090
-023	.750*	.030	-047	1.750*	.030	-075	3.500*	.060	-123	6.500	.090
-024	.781	.030	-048	1.812	.030	-077	3.625	.060	-125	6.625	.090
-025	.812	.030	-049	1.875	.030	-079	3.750	.060	-127	6.750	.090
-026	.844	.030	-050	1.938	.030	-081	3.875	.060	-129	6.875	.090
-027	.875*	.030	-051	2.000*	.030	-083	4.000*	.060	-131	7.000*	.090
-028	.906	.030	-052	2.062	.030	-085	4.125	.060	-133	7.125	.090
-029	.938	.030	-053	2.125	.030	-087	4.250	.060	-135	7.250	.090
-030	.969	.030	-054	2.188	.030	-089	4.375	.060	-137	7.375	.090
-031	1.000*	.030	-055	2.250*	.030	-091	4.500*	.060	-139	7.500	.090
-032	1.031	.030	-056	2.312	.030	-093	4.625	.060	-141	7.625	.090
-033	1.062	.030	-057	2.375	.030	-095	4.750	.060	-143	7.750	.090
-034	1.094	.030	-058	2.438	.030	-097	4.875	.060	-145	7.875	.090
-035	1.125*	.030	-059	2.500*	.030	-099	5.000*	.060	-147	8.000*	.090
-036	1.156	.030	-060	2.562	.060	-101	5.125	.090			

Dimensions in inches

Tube 0.094 Diameter



Military Standard

MS 9203 Gasket, metal O-ring, .094 tube x .006 wall, cres
MS 9204 Gasket, metal O-ring, .094 tube x .010 wall, cres
MS 9374 Gasket, metal O-ring, .094 tube x .006 wall, cres, silver plated
MS 9375 Gasket, metal O-ring, .094 tube x .010 wall, cres, silver plated

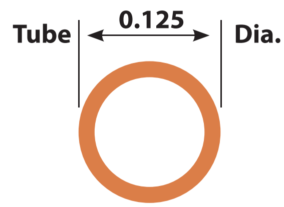
1. Ring shall be flat within B.
2. *Preferred sizes.
3. Material: Corrosion and heat resistant steel tubing AMS 5570 or AMS 5576.
4. Finish weld flush with tube OD. Smooth blend within .125 of Weld. Dimensions at blend shall not be more than .004 below adjacent surfaces.
5. Finish: Silver plate AMS 2410 .0010-.0015 thick. Dimensions to be met before plating. Contact points permissible on ID of ring: (MS 9374, MS 9375 only)
6. Surface roughness: AS 291/ANSI B46.1
7. Manufacturing specification: AMS 7325
8. Identification: Mark MS part number and manufacturer's identification on container.
9. Dimensions in inches.
10. Do not use unassigned part numbers.
11. Contact Applications Engineering for design requirements.

NOTE: MS 9374 and MS 9375 available only through dash 195

Add to MS Number	A +.005 -.000	B	Add to MS Number	A +.005 -.000	B	Add to MS Number	A +.005 -.000	B	Add to MS Number	A +.005 -.000	B
-010	1.000*	.030	-038	2.188	.030	-065	3.875	.060	-143	8.750	.090
-012	1.031	.030	-039	2.250*	.030	-066	3.938	.060	-147	9.000*	.090
-013	1.062	.030	-040	2.312	.030	-067	4.000*	.060	-151	9.250	.090
-014	1.094	.030	-041	2.375	.030	-069	4.125	.060	-155	9.500	.090
-015	1.125*	.030	-042	2.438	.030	-071	4.250	.060	-159	9.750	.090
-016	1.156	.030	-043	2.500*	.030	-073	4.375	.060	-163	10.000*	.090
-017	1.188	.030	-044	2.562	.060	-075	4.500*	.060	-167	10.250	.125
-018	1.219	.030	-045	2.625	.060	-077	4.625	.060	-171	10.500	.125
-019	1.250*	.030	-046	2.688	.060	-079	4.750	.060	-175	10.750	.125
-020	1.281	.030	-047	2.750*	.060	-081	4.875	.060	-179	11.000*	.125
-021	1.312	.030	-048	2.812	.060	-083	5.000*	.060	-183	11.250	.125
-022	1.344	.030	-049	2.875	.060	-085	5.125	.090	-187	11.500	.125
-023	1.375*	.030	-050	2.938	.060	-087	5.250	.090	-191	11.750	.125
-024	1.406	.030	-051	3.000	.060	-089	5.375	.090	-195	12.000*	.125
-025	1.438	.030	-052	3.062	.060	-091	5.500*	.090	-203	12.500	.150
-026	1.469	.030	-053	3.125	.060	-095	5.750	.090	-211	13.000	.150
-027	1.500*	.030	-054	3.188	.060	-099	6.000*	.090	-219	13.500	.150
-028	1.562	.030	-055	3.250	.060	-103	6.250	.090	-227	14.000	.150
-029	1.625	.030	-056	3.312	.060	-107	6.500	.090			
-030	1.688	.030	-057	3.375	.060	-111	6.750	.090			
-031	1.750*	.030	-058	3.438	.060	-115	7.000*	.090			
-032	1.812	.030	-059	3.500*	.060	-119	7.250	.090			
-033	1.875	.030	-060	3.562	.060	-123	7.500	.090			
-034	1.938	.030	-061	3.625	.060	-127	7.750	.090			
-035	2.000*	.030	-062	3.688	.060	-131	8.000*	.090			
-036	2.062	.030	-063	3.750	.060	-135	8.250	.090			
-037	2.125	.030	-064	3.812	.060	-139	8.500	.090			

Dimensions in inches

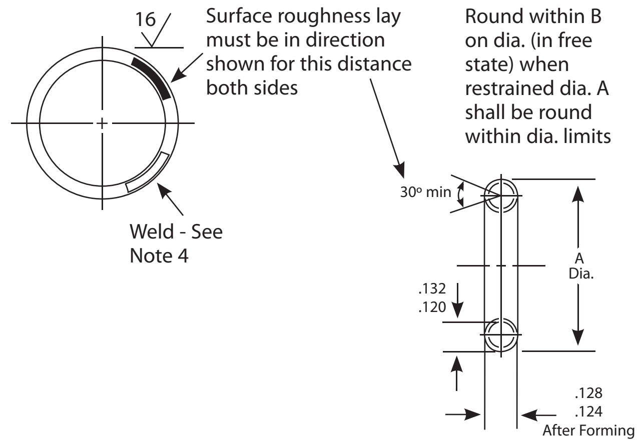
Tube 0.125 Diameter



Military Standard

MS 9205 Gasket, metal O-ring, .125 tube x .010 wall, cres
MS 9376 Gasket, metal O-ring, .125 tube x .010 wall, cres, silver plated

1. Ring shall be flat within B.
2. *Preferred sizes.
3. Material: Corrosion and heat resistant steel tubing AMS 5570 or AMS 5576. Tube size .124-.127 dia., wall thick. .009-.011.
4. Finish weld flush with tube OD. Smooth blend within .125 of Weld. Dimensions at blend shall not be more than .004 below adjacent surfaces.
5. Finish: Silver plate AMS 2410 .0010-.0015 thick. Dimensions to be met before plating. Contact points permissible on ID of ring: (MS 9376 only)
6. Surface roughness: AS 291/ANSI B46.1
7. Manufacturing specification: AMS 7325
8. Identification: Mark MS part number and manufacturer's identification on container.
9. Dimensions in inches.
10. Do not use unassigned part numbers.
11. Contact Applications Engineering for design requirements.



NOTE: MS 9376 available only through dash 170

Add to MS Number	A +.005 -.000	B	Add to MS Number	A +.005 -.000	B	Add to MS Number	A +.005 -.000	B	Add to MS Number	A +.005 -.000	B	Add to MS Number	A +.005 -.000	B
-010	2.000*	.030	-049	4.438	.060	-102	7.750	.090	-238	16.250	.200	-490	32.000*	.500
-011	2.062	.030	-050	4.500*	.060	-104	7.875	.090	-242	16.500	.200	-498	32.500	.500
-012	2.125	.030	-051	4.562	.060	-106	8.000*	.090	-246	16.750	.200	-506	33.000	.500
-013	2.188	.030	-052	4.625	.060	-108	8.125	.090	-250	17.000	.200	-514	33.500	.500
-014	2.250*	.030	-053	4.688	.060	-110	8.250	.090	-254	17.250	.200	-522	34.000	.500
-015	2.312	.030	-054	4.750	.060	-112	8.375	.090	-258	17.500	.200	-530	34.500	.500
-016	2.375	.030	-055	4.812	.060	-114	8.500	.090	-262	17.750	.200	-538	35.000	.500
-017	2.438	.030	-056	4.875	.060	-116	8.625	.090	-266	18.000*	.200	-546	35.500	.500
-018	2.500*	.030	-057	4.938	.060	-118	8.750	.090	-270	18.250	.200	-554	36.000*	.500
-019	2.562	.060	-058	5.000*	.060	-120	8.875	.090	-274	18.500	.200	-562	36.500	.500
-020	2.625	.060	-059	5.062	.090	-122	9.000*	.090	-278	18.750	.200	-570	37.000	.500
-021	2.688	.060	-060	5.125	.090	-126	9.250	.090	-282	19.000	.200	-578	37.500	.500
-022	2.750*	.060	-061	5.188	.090	-130	9.500	.090	-286	19.250	.250	-586	38.000	.500
-023	2.812	.060	-062	5.250	.090	-134	9.750	.090	-290	19.500	.250	-594	38.500	.500
-024	2.875	.060	-063	5.312	.090	-138	10.000*	.090	-294	19.750	.250	-602	39.000	.500
-025	2.938	.060	-064	5.375	.090	-142	10.250	.125	-298	20.000*	.250	-610	39.500	.500
-026	3.000*	.060	-065	5.438	.090	-146	10.500	.125	-306	20.500	.250	-618	40.000*	1.000
-027	3.062	.060	-066	5.500*	.090	-150	10.750	.125	-314	21.000	.250	-634	41.000	1.000
-028	3.125	.060	-067	5.562	.090	-154	11.000*	.125	-322	21.500	.250	-650	42.000	1.000
-029	3.188	.060	-068	5.625	.090	-158	11.250	.125	-330	22.000*	.250	-666	43.000	1.000
-030	3.250	.060	-069	5.688	.090	-162	11.500	.125	-338	22.500	.500	-682	44.000	1.000
-031	3.312	.060	-070	5.750	.090	-166	11.750	.125	-346	23.000	.500	-698	45.000*	1.000
-032	3.375	.060	-071	5.812	.090	-170	12.000*	.125	-354	23.500	.500	-714	46.000	1.000
-033	3.438	.060	-072	5.875	.090	-174	12.250	.150	-362	24.000*	.500	-730	47.000	1.000
-034	3.500*	.060	-073	5.938	.090	-178	12.500	.150	-370	24.500	.500	-746	48.000	1.000
-035	3.562	.060	-074	6.000*	.090	-182	12.750	.150	-378	25.000	.500	-762	49.000	1.000
-036	3.625	.060	-076	6.125	.090	-186	13.000	.150	-386	25.500	.500	-778	50.000*	1.000
-037	3.688	.060	-078	6.250	.090	-190	13.250	.150	-394	26.000	.500			
-038	3.750	.060	-080	6.375	.090	-194	13.500	.150	-402	26.500	.500			
-039	3.812	.060	-082	6.500	.090	-198	13.750	.150	-410	27.000	.500			
-040	3.875	.060	-084	6.625	.090	-202	14.000*	.150	-418	27.500	.500			
-041	3.938	.060	-086	6.750	.090	-206	14.250	.175	-426	28.000*	.500			
-042	4.000*	.060	-088	6.875	.090	-210	14.500	.175	-434	28.500	.500			
-043	4.062	.060	-090	7.000*	.090	-214	14.750	.175	-442	29.000	.500			
-044	4.125	.060	-092	7.125	.090	-218	15.000	.175	-450	29.500	.500			
-045	4.188	.060	-094	7.250	.090	-222	15.250	.175	-458	30.000	.500			
-046	4.250	.060	-096	7.375	.090	-226	15.500	.175	-466	30.500	.500			
-047	4.312	.060	-098	7.500	.090	-230	15.750	.175	-474	31.000	.500			
-048	4.375	.060	-100	7.625	.090	-234	16.000*	.175	-482	31.500	.500			

Dimensions in inches

Garlock Helicoflex®
PERFORMANCE METAL SEALS
an EnPro Industries company

HELICOFLEX DATA SHEET

Tel: 800-233-1722 Fax: 803-783-4279
E-Mail: sales@helicoflex.com

COMPANY:	PHONE:
CONTACT:	FAX:
ADDRESS:	E-MAIL:
	DATE:

APPLICATION: (please attach customer drawing / sketch)

Brief Description:

Annual quantities: RFQ Quantities:

Is This a New Design? ❑ Yes ❑ No | Are Modifications Possible? ❑ Yes ❑ No

Drawing or Sketch Attached? ❑ Yes ❑ No | What is the Seal Type? ❑ Shaped ❑ Circular

SERVICE CONDITIONS:

Media:	Life Expectancy:
Working Temperature:	Max/Proof Pressure: @ Temp. =
Working Pressure:	Max Temperature: @ Pressure =
Pressure Direction: (Internal/External/Axial)	**Target Sealing Level:** Helium: Std.cc/sec
Pressure Cycles:	Flow Rate: cc/minute
Temperature Cycles:	Other:

FLANGE DETAILS: (Please Provide Drawing)

Amount of Flange Movment in Service: (Inches) Radial: Axial: #Cycles:

Material: Thickness:

❑ Groove / Counter Bore: Please list dimensions in Groove Details section

❑ ANSI Raised Face Size: # Rating: Face Surface Finish: (RMS)

❑ Flange(s) with Clamping System: (ISO,KF, etc) Standard: Size:

❑ Other: Description: (Please Provide Drawing)

GROOVE DETAILS: (Please Provide Drawing)

Type (Rectangular, Dovetail, etc.):

Outer Diameter: Tolerance:	Depth: Tolerance:
Inner Diameter: Tolerance:	Finish (RMS) Type:
	Finish Type: lathe (circular), endmill (multi-directional), other

BOLTING DETAILS: (Please Provide Drawing)

Size:	Type / Grade:
Number: Bolt Circle	Tapped / Through:

OTHER:

Special coating / plating specification:

Special quality / inspection specifications:

Other:

Garlock Helicoflex®
PERFORMANCE METAL SEALS
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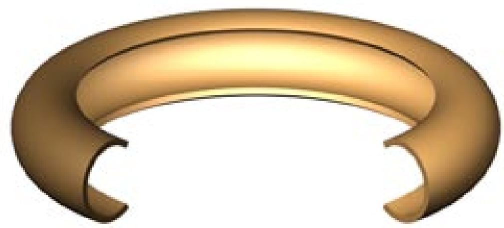
Sealing Concept



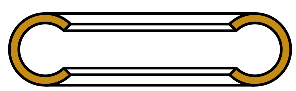
The sealing concept of C-Flex™ metal C-rings is based on the elastic deformation of a metal "C" substrate which, during the compression cycle, gives a contact point on each sealing surface.

The substrate characteristics determine the compressive load of the seal. This load combined with an accurate compression rate results in a specific pressure which is directly related to the sealing level obtained. A certain specific pressure is necessary to make the seal flow into the flange imperfections. In service, this load is supplemented by the system pressure. A softer surface treatment is available to increase the plasticity of the seal and reduce the specific pressure necessary to reach the desired sealing level.

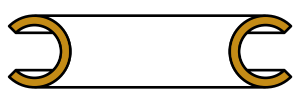
C-FLEX™ Types

The opening of the C-Flex™ seal is typically oriented toward the system pressure. In service, the system pressure "energizes" the seal providing supplemental load. This energizing effect increases in direct proportion to increases in differential system pressure. Below are typical seal orientations:

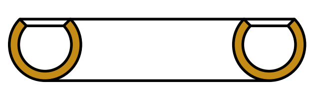
Internal Pressure



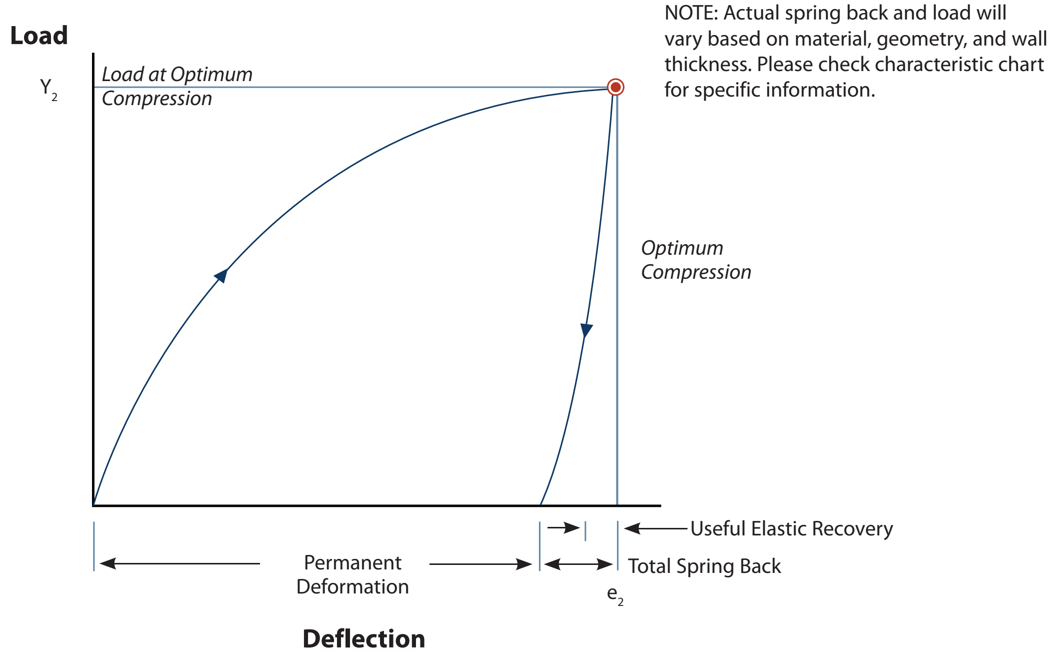
External Pressure



Axial Pressure



C-Flex™ Characteristic Curve



Material Selection

Material	Status	Temperature	Heat Treatment
Alloy X750	Standard	T < 1,100ºF	Solution heat treat and precipitation harden per AMS 5598
Alloy 718	Optional	T < 1,200ºF	Solution heat treat and precipitation harden per AMS 5596
Other	Contact Applications Engineering		

Plating/Coating Selection

Plating/Coating	Status	Standard Thickness	Temperature	Groove Finish*
PTFE	Optional	.001/.003	T < 500ºF	16 - 32 RMS
Silver	Standard	.001/.002	T < 800ºF	16 - 63 RMS
Silver w/ Gold strike	Optional	.001/.002	T < 1,200ºF	16 - 63 RMS
Nickel	Standard	.001/.002	T < 1,600ºF	16 - 32 RMS
None	-	-	-	< 16 RMS
Other	Contact Applications Engineering			

* Groove finish must follow seal circumference (lathe turned finish)

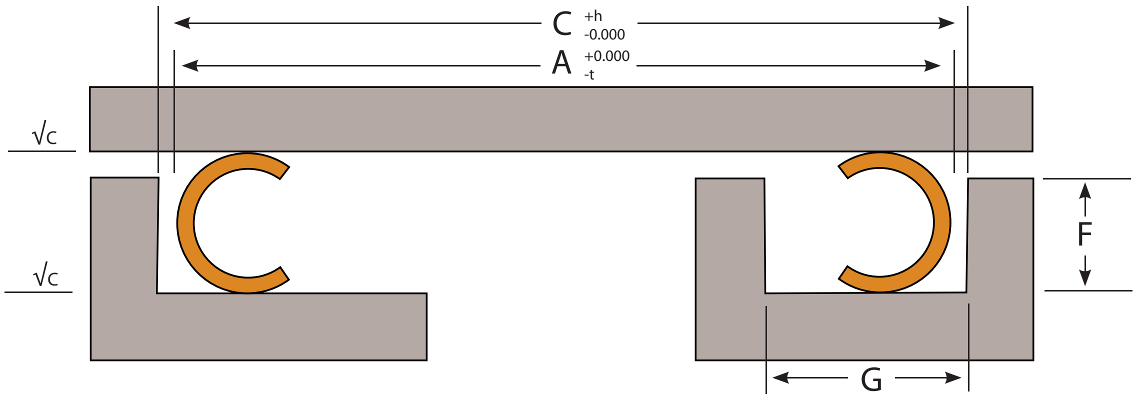
C-Flex™ Characteristic Values

Free Height	Installation Compression e_2	Seal Diameter Range	Material Thickness	Thin (T) Medium (M) Heavy (H)	CHARACTERISTIC VALUES AT 70ºF — Alloy X-750 Seating Load (PCI) Y_2	CHARACTERISTIC VALUES AT 70ºF — Alloy 718 Seating Load (PCI) Y_2
0.047	0.006	0.250 to 4.000	0.006	T	95	110
			-	M	-	-
			0.008	H	210	245
0.063	0.012	0.500 to 10.000	0.008	T	85	100
			-	M	-	-
			0.010	H	260	300
0.094	0.020	1.000 to 20.000	0.010	T	140	165
			-	M	-	-
			0.015	H	400	460
0.125	0.026	2.000 to 40.000	0.010	T	130	150
			0.015	M	240	280
			0.020	H	570	660
0.156	0.032	3.000 to 50.000	0.015	T	200	230
			-	M	-	-
			0.025	H	600	690
0.188	0.039	4.000 to 60.000	0.020	T	350	410
			-	M	-	-
			-	H	-	-
0.250	0.051	5.000 to 80.000	0.025	T	315	365
			-	M	-	-
			-	H	-	-

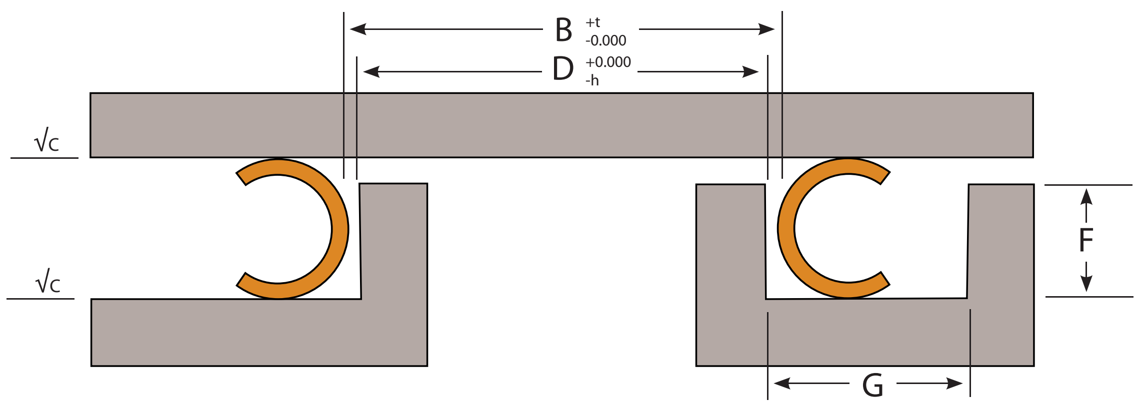
Dimensions in inches

NOTES:
1. PCI = Pounds force per circumferential inch
2. Seating Load (Y_2) is an approximation and may vary based on groove clearance, seal diameter, tolerance and plating thickness. It does not allow for system pressure requirements and should be verified for each application and seal size.
3. The customer must verify that system bolts and flanges can generate the required seating load without warping or distorting.
4. The customer must test and verify that the seal design meets customer designated performance requirements.

Internal Pressure



External Pressure



Seal and Groove Sizing Calculations

The equations below can be used for basic groove calculations. Applications that have significant thermal expansion may require additional clearance. Please contact Applications Engineering for design assistance.

Determining Seal Diameter:

Internal
A = C-X-2Pmax

External
B = D + X + 2Pmax

Determining Groove Diameter:

Internal
C = A + X + 2Pmax

External
D = B – X – 2Pmax

Tolerancing: See chart

Where:	A =	Seal Outer Diameter
	B =	Seal Inner Diameter
	C =	Groove Outer Diameter
	D =	Groove Inner Diameter
	Pmax =	Maximum Plating or Coating Thickness
	X =	Diametrical Clearance

Groove Finish √c: See Plating/Coating Section

Seal and Groove Dimensions

SEAL		GROOVE		
Free Height	Seal Diameter Range	Diametrical Clearance x	Groove Depth F	Groove Width (Min.) G
0.047	0.250 to 4.000	0.006	0.038 ±0.001	0.055
0.063	0.300 to 6.000	0.007	0.050 ±0.001	0.075
0.094	0.400 to 16.000	0.008	0.074 ±0.002	0.105
0.125	1.000 to 25.000	0.012	0.100 ±0.002	0.135
0.157	1.250 to 30.000	0.016	0.127 ±0.002	0.170
0.188	2.000 to 40.000	0.018	0.151 ±0.002	0.200
0.250	4.000 to 50.000	0.020	0.200 ±0.003	0.260

Dimensions in inches

NOTE: Contact Applications Engineering for additional sizes.

Tolerances

Seal Diameter Range	Seal Tolerance t	Groove Tolerance h
0.250 to 0.999	0.002	0.001
1.000 to 1.999	0.002	0.002
2.000 to 2.999	0.003	0.003
3.000 to 3.999	0.003	0.003
4.000 to 4.999	0.004	0.004
5.000 to 6.999	0.006	0.006
7.000 to 9.999	0.007	0.007
10.000 to 14.999	0.012	0.012
15.000 to 19.999	0.015	0.015
20.000 +	Contact Applications Engineering	

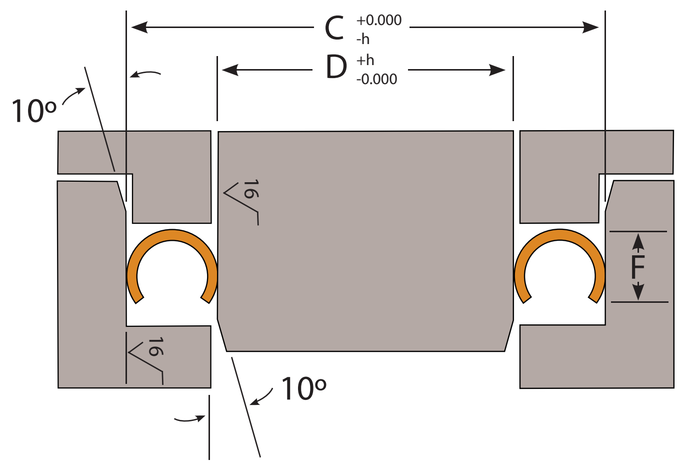
Dimensions in inches

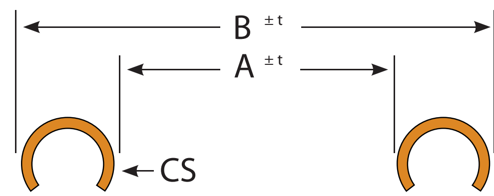
Shaped Seals

C-Flex™ seals can be made in a variety of shapes and sizes. Typical Internal and External pressure seals can be formed into racetrack, square, triangular and rectangular shapes. Contact Applications Engineering for more information regarding shaped seal capabilities.

Minimum Corner Radii for Shaped C-Flex™ Seals						
Cross Section	0.063	0.094	0.125	0.157	0.188	0.250
Minimum Inner Radius	0.375	0.565	1.000	2.000	3.000	4.000

Dimensions in inches





SEAL						CAVITY DIMENSIONS				
Cross Section CS	Material Thickness (Prior to Forming)	Seal ID Range	Axial Length (Max. Ref)	Axial Load PCI	Seal Tolerance t	Cavity OD C	Cavity ID D	Cavity Tolerance h	Cavity Depth F (Min)	Cavity OD/ID Eccentricity (Max.)
0.063	0.008	0.375 to 1.249	0.050	110	0.001	B - 0.003	A + 0.003	0.001	0.075	0.0005
	0.008	1.250 to 2.500	0.050	110	0.001	B - 0.004	A + 0.004	0.001	0.075	0.0005
	0.010	0.375 to 1.249	0.050	130	0.001	B - 0.003	A + 0.003	0.001	0.075	0.0005
	0.010	1.250 to 2.500	0.050	130	0.001	B - 0.004	A + 0.004	0.001	0.075	0.0005
0.094	0.010	0.500 to 1.249	0.075	80	0.001	B - 0.003	A + 0.003	0.001	0.105	0.0010
	0.010	1.250 to 3.000	0.075	80	0.001	B - 0.004	A + 0.004	0.001	0.105	0.0010
	0.015	0.500 to 1.249	0.075	190	0.001	B - 0.003	A + 0.003	0.001	0.105	0.0010
	0.015	1.250 to 3.000	0.075	190	0.001	B - 0.004	A + 0.004	0.001	0.105	0.0010
0.125	0.015	0.750 to 2.499	0.100	165	0.001	B - 0.003	A + 0.003	0.001	0.135	0.0010
	0.015	2.500 to 8.000	0.100	165	0.002	B - 0.006	A + 0.006	0.002	0.135	0.0010
	0.020	0.750 to 2.499	0.100	210	0.001	B - 0.003	A + 0.003	0.001	0.135	0.0010
	0.020	2.500 to 8.000	0.100	210	0.002	B - 0.006	A + 0.006	0.002	0.135	0.0010
0.157	0.015	2.000 to 5.999	0.125	240	0.002	B - 0.006	A + 0.006	0.002	0.170	0.0015
	0.015	6.000 to 10.000	0.125	240	0.002	B - 0.007	A + 0.007	0.002	0.170	0.0015
	0.025	2.000 to 5.999	0.125	360	0.002	B - 0.006	A + 0.006	0.002	0.170	0.0015
	0.025	6.000 to 10.000	0.125	360	0.002	B - 0.007	A + 0.007	0.002	0.170	0.0015
0.188	0.020	3.000 to 5.999	0.150	280	0.002	B - 0.007	A + 0.007	0.002	0.200	0.0015
	0.020	6.000 to 10.000	0.150	280	0.002	B - 0.008	A + 0.008	0.002	0.200	0.0015
0.250	0.025	4.000 to 6.499	0.200	360	0.002	B - 0.008	A + 0.008	0.002	0.260	0.0015
	0.025	6.500 to 10.000	0.200	360	0.002	B - 0.009	A + 0.009	0.002	0.260	0.0015

Dimensions in inches

NOTES:
1. PCI = Pounds force per circumferencial inch
2. Axial load is an approximate value. Actual value will vary based on diameter, interferences, friction coefficients, finish, platings, lubrication, etc.
3. Load values are for Alloy 718 at 70ºF

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PERFORMANCE METAL SEALS
an EnPro Industries company

HELICOFLEX DATA SHEET

Tel: 800-233-1722 Fax: 803-783-4279
E-Mail: sales@helicoflex.com

COMPANY: ____________ PHONE: ____________
CONTACT: ____________ FAX: ____________
ADDRESS: ____________ E-MAIL: ____________
DATE: ____________

APPLICATION: (please attach customer drawing / sketch)

Brief Description: ____________

Annual quantities: ____________ RFQ Quantities: ____________

Is This a New Design? ❑ Yes ❑ No
Are Modifications Possible? ❑ Yes ❑ No
Drawing or Sketch Attached? ❑ Yes ❑ No
What is the Seal Type? ❑ Shaped ❑ Circular

SERVICE CONDITIONS:

Media: ____________
Life Expectancy: ____________
Working Temperature: ____________
Max/Proof Pressure: ________ @ Temp. = ________
Working Pressure: ____________
Max Temperature: ________ @ Pressure = ________
Pressure Direction: ____________
(Internal/External/Axial)
Pressure Cycles: ____________
Temperature Cycles: ____________

Target Sealing Level:
Helium: ________ Std.cc/sec
Flow Rate: ________ cc/minute
Other: ________

FLANGE DETAILS: (Please Provide Drawing)

Amount of Flange Movment in Service: (Inches) Radial: ________ Axial: ________ #Cycles: ________

Material: ____________ Thickness: ____________

❑ Groove / Counter Bore: Please list dimensions in Groove Details section
❑ ANSI Raised Face Size: ________ # Rating: ________ Face Surface Finish: ________ (RMS)
❑ Flange(s) with Clamping System: (ISO,KF, etc) Standard: ________ Size: ________
❑ Other: Description: ____________ (Please Provide Drawing)

GROOVE DETAILS: (Please Provide Drawing)

Type (Rectangular, Dovetail, etc.): ____________

Outer Diameter: ________ Tolerance: ________
Inner Diameter: ________ Tolerance: ________
Depth: ________ Tolerance: ________
Finish (RMS) ________ Type: ________
Finish Type: lathe (circular), endmill (multi-directional), other

BOLTING DETAILS: (Please Provide Drawing)

Size: ________
Number: ________ Bolt Circle ________
Type / Grade: ____________
Tapped / Through: ____________

OTHER:

Special coating / plating specification:

Special quality / inspection specifications:

Other:

Garlock Helicoflex®
PERFORMANCE METAL SEALS
an EnPro Industries company

Sealing Concept

E-Flex™ Metal E-rings are designed to have low load, high spring back performance for high pressure/temperature applications. In service, the E-Flex™ is pressure energized by the system which increases the contact stress and further minimizes leakage. The E-Flex™ geometry can be designed to meet the requirements for each unique application and can be manufactured in a wide range of sizes. Typical markets for E-Flex™ seals include Aerospace, Land Based Turbines, and Automotive.

E-Flex™ Types

E-Flex™

The standard E-Flex™ design exhibits improved spring back and reduced load compared to C-Rings.

Super E-Flex™

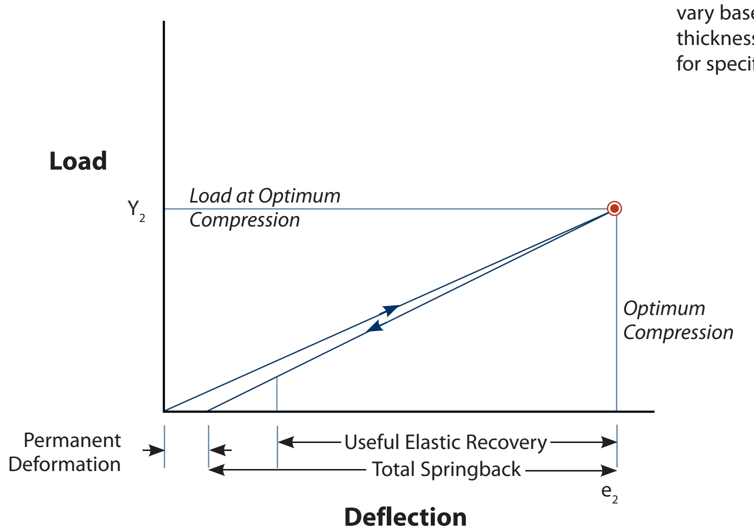
The Super E-Flex™ is designed to have less stress during installation. These seals typically have less load than the traditional E-Flex™ seals and have nearly 100% spring back at room temperature.

Multi-convolution

These seals are designed with extra convolutions and special geometry for applications that require maximum spring back in service.

E-Flex™ Characteristic Curve

NOTE: Actual spring back and load will vary based on material, geometry, and wall thickness. Please check characteristic chart for specific information.



Material Selection

Material	Status	Temperature	Heat Treatment
Alloy X750	Optional	T < 1,100°F	Solution heat treat and precipitation harden per AMS5598
Alloy 718	Standard	T < 1,200°F	Solution heat treat and precipitation harden per AMS5596
Waspaloy	Optional	T < 1,350°F	Solution heat treat, stabilize and precipitation harden per AMS5544

Coatings and Platings

Type	Description
Tribological Coating	An HVOC tribaloy coating ideal for applications exhibiting high wear patterns.
Silver Plating	Not recommended for most applications. The E-Flex seal does not generate enough load to plastically deform the silver plating.
Custom	Please contact Applications Engineering for special or custom coating requests.

E-Flex™ Characteristics For Alloy 718 Material At 70°F

E-Flex™ Type	Free Height	Material Thickness	Seal Diameter	Seating Load (PCI) Y_2	Installation Springback	Installation Compression e_2
E-FLEX™	0.075	0.006	0.625 6.000	42 28	0.009 0.011	0.013
	0.098	0.008	0.625 8.000	104 64	0.013 0.014	0.021
	0.102	0.010	0.625 8.000	92 56	0.011 0.013	0.015
	0.132	0.008	1.250 24.000	32 16	0.013 0.014	0.014
	0.132	0.015	1.250 24.000	50 28	0.013 0.014	0.014
	0.218	0.015	3.375 40.000	93 78	0.026 0.031	0.037
	0.243	0.010	6.000 40.000	12 11	0.072 0.073	0.073
	0.295	0.020	6.000 60.000	83 69	0.046 0.047	0.048
	0.375	0.020	8.000 60.000	55 44	0.062 0.062	0.062
Super E-FLEX™	0.108	0.0095	0.950 40.000	38 28	0.015 0.021	0.021
	0.140	0.010	1.750 40.000	24 14	0.022 0.022	0.022
	0.140	0.012	1.750 40.000	41 24	0.021 0.022	0.022
Multiple Convolution E-FLEX™	0.209	0.007	25.000	30	0.040	0.048
	0.230	0.008	25.000	30	0.065	0.065
	0.243	0.010	25.000	46	0.046	0.057
	0.263	0.006	25.000	29	0.062	0.068
	0.286	0.010	25.000	25	0.061	0.061
	0.300	0.010	25.000	55	0.041	0.055

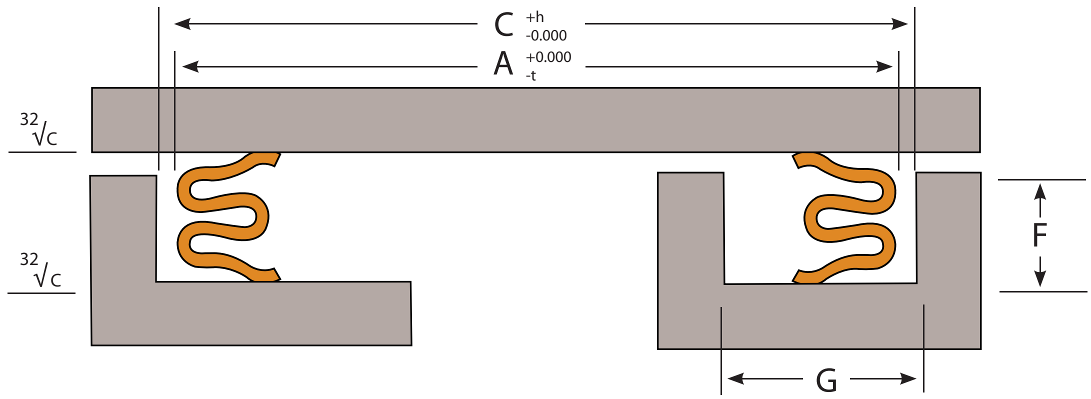
Dimensions in inches

NOTES:

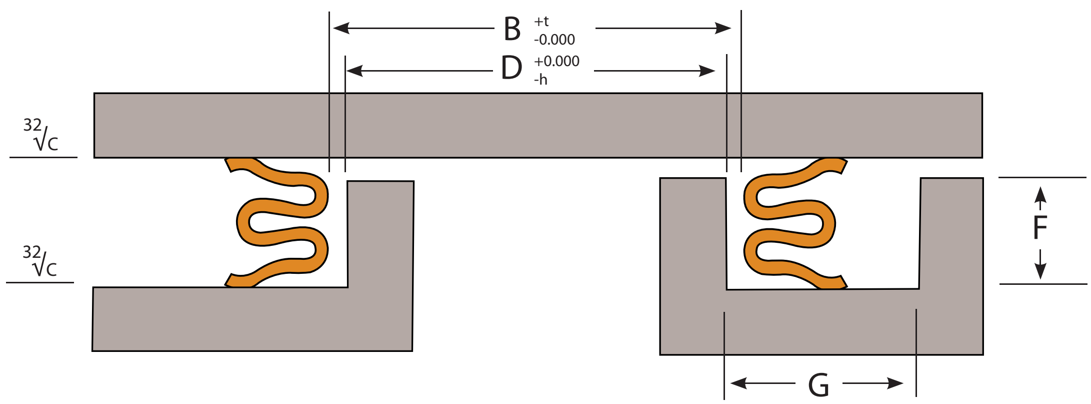
1. PCI = Pounds force per circumferential inch
2. Seating load (Y_2) is an approximation and may vary based on groove clearance, seal diameter, tolerance and coating thickness. It does not allow for system pressure requirements and should be verified for each application and seal size.
3. The customer must verify that system bolts and flanges can generate the required seating load without warping or distorting.
4. The customer must test and verify that the seal design meets customer designated performance requirements.

Other materials: Please contact Applications Engineering.
Anti-Wear Coatings: Please contact Applications Engineering.

Internal Pressure



External Pressure



Seal and Groove Sizing Calcuations

The equations below can be used for basic groove calculations. Applications that have significant thermal expansion may require additional clearance. Please contact Applications Engineering for design assistance.

Determining Seal Diameter:

Internal
A = C-X-2Pmax

External
B = D + X + 2Pmax

Determining Groove Diameter:

Internal
C = A + X + 2Pmax

External
D = B – X – 2Pmax

Tolerancing: See chart

Where:
A = Seal Outer Diameter
B = Seal Inner Diameter
C = Groove Outer Diameter
D = Groove Inner Diameter
Pmax = Maximum Plating or Coating Thickness
x = Diametrical clearance

SEAL					GROOVE DIMENSIONS				
E-Flex™ Type	Free Height	Material Thickness (Prior to Forming)	Radial Width (Max. Ref.)	Internal A Diameter Range	External B Diameter Range	Diametrical Clearance x	Groove Depth F	Groove Width (Min) G Int. Press.	Groove Width (Min) G Ext. Press.
E-FLEX™	0.075	0.006	0.066	1.360 to 6.000	1.200 to 6.000	0.003	0.062 ± 0.001	0.090	0.090
	0.098	0.008	0.083	2.000 to 10.000	1.200 to 10.000	0.003	0.077 ± 0.002	0.110	0.110
	0.102	0.010	0.091	2.000 to 10.000	1.200 to 10.000	0.003	0.087 ± 0.001	0.115	0.115
	0.132	0.008	0.120	1.360 to 13.000	2.500 to 13.000	0.003	0.118 ± 0.002	0.145	0.145
	0.132	0.015	0.120	1.360 to 13.000	2.500 to 13.000	0.003	0.118 ± 0.002	0.145	0.145
	0.218	0.015	0.190	2.600 to 13.000	2.600 to 13.000	0.005	0.181 ± 0.002	0.210	0.220
	0.243	0.010	0.260	6.000 to 40.000	6.000 to 40.000	0.005	0.170 ± 0.003	0.300	0.320
	0.295	0.020	0.266	6.000 to 60.000	6.000 to 60.000	0.005	0.247 ± 0.003	0.315	0.335
	0.375	0.020	0.340	8.000 to 60.000	8.000 to 60.000	0.005	0.313 ± 0.003	0.405	0.425
Super E-FLEX™	0.108	0.0095	0.145	2.000 to 13.000	2.500 to 13.000	0.003	0.087 ± 0.002	0.170	0.180
	0.140	0.010	0.194	2.500 to 13.000	2.500 to 13.000	0.005	0.118 ± 0.002	0.220	0.250
	0.140	0.012	0.194	2.500 to 13.000	2.500 to 13.000	0.005	0.118 ± 0.002	0.220	0.250
Multiple Convolution E-FLEX™	0.209	0.007	0.116	10.000 to 40.000	10.000 to 40.000	0.003	0.199 / 0.166	0.180	0.180
	0.230	0.008	0.184	10.000 to 40.000	10.000 to 40.000	0.003	0.210 / 0.170	0.255	0.255
	0.243	0.010	0.150	10.000 to 60.000	10.000 to 60.000	0.003	0.231 / 0.191	0.220	0.220
	0.263	0.006	0.150	10.000 to 40.000	10.000 to 40.000	0.003	0.248 / 0.200	0.220	0.220
	0.286	0.010	0.200	10.000 to 40.000	10.000 to 40.000	0.003	0.270 / 0.230	0.270	0.270
	0.300	0.010	0.150	10.000 to 60.000	10.000 to 60.000	0.003	0.285 / 0.245	0.220	0.220

Dimensions in inches

NOTE: Contact Applications Engineering for additional sizes.

Tolerances

	E-FLEX™		Super E-FLEX™		Multiple Convolution E-FLEX™	
Seal Diameter Range	Groove Tolerance "h"	Seal Tolerance "t"	Groove Tolerance "h"	Seal Tolerance "t"	Groove Tolerance "h"	Seal Tolerance "t"
1.000 to 1.999	0.002	0.003	0.002	0.004	-	-
2.000 to 2.999	0.002	0.004	0.003	0.006	-	-
3.000 to 3.999	0.003	0.005	0.004	0.008	-	-
4.000 to 4.999	0.003	0.006	0.004	0.008	-	-
5.000 to 5.999	0.003	0.006	0.005	0.010	-	-
6.000 to 6.999	0.004	0.007	0.006	0.012	-	-
7.000 to 7.999	0.004	0.008	0.007	0.014	-	-
8.000 to 8.999	0.005	0.009	0.008	0.016	-	-
9.000 to 9.999	0.005	0.010	0.009	0.018	-	-
10.000 to 10.99	0.005	0.010	0.010	0.020	0.005	0.010
11.000 to 11.999	0.006	0.011	0.010	0.020	0.006	0.011
12.000 to 12.999	0.006	0.012	0.010	0.020	0.006	0.012
13.000 to 13.999	0.007	0.013	0.010	0.020	0.007	0.013
14.000 +	Contact Applications Engineering					

Dimensions in inches

Part Number	AS1895/7 Reference	Duct Size	SEAL DIMENSIONS			
			OD	ID (Ref)	Out of Roundness of Outer Diameter	Free Height
E-800128 -100	AS1895/7 -100	1.00	1.249 1.245	0.958	0.040 0.020	0.113 0.103
E-800128 -125	AS1895/7 -125	1.25	1.499 1.495	1.208	0.040 0.020	0.113 0.103
E-800128 -150	AS1895/7 -150	1.50	1.749 1.745	1.458	0.040 0.020	0.113 0.103
E-800128 -175	AS1895/7 -175	1.75	1.999 1.995	1.708	0.040 0.020	0.113 0.103
E-800128 -200	AS1895/7 -200	2.00	2.249 2.245	1.958	0.040 0.020	0.113 0.103
E-800128 -225	AS1895/7 -225	2.25	2.499 2.493	2.208	0.040 0.020	0.113 0.103
E-800128 -250	AS1895/7 -250	2.50	2.749 2.743	2.458	0.040 0.020	0.113 0.103
E-800128 -275	AS1895/7 -275	2.75	2.999 2.993	2.708	0.040 0.020	0.113 0.103
E-800128 -300	AS1895/7 -300	3.00	3.249 3.243	2.958	0.040 0.020	0.113 0.103
E-800128 -325	AS1895/7 -325	3.25	3.499 3.491	3.208	0.040 0.020	0.113 0.103
E-800128 -350	AS1895/7 -350	3.50	3.749 3.741	3.458	0.050 0.030	0.113 0.103
E-800128 -400	AS1895/7 -400	4.00	4.249 4.241	3.958	0.050 0.030	0.113 0.103
E-800128 -450	AS1895/7 -450	4.50	4.749 4.739	4.458	0.050 0.030	0.113 0.103
E-800128 -500	AS1895/7 -500	5.00	5.249 5.239	4.958	0.060 0.040	0.113 0.103
E-800128 -550	AS1895/7 -550	5.50	5.749 5.737	5.458	0.060 0.040	0.113 0.103
E-800128 -600	AS1895/7 -600	6.00	6.249 6.237	5.958	0.060 0.040	0.113 0.103
E-800128 -650	AS1895/7 -650	6.50	6.749 6.735	6.458	0.065 0.045	0.113 0.103
E-800128 -700	AS1895/7 -700	7.00	7.249 7.235	6.958	0.065 0.045	0.113 0.103
E-800128 -750	AS1895/7 -750	7.50	7.749 7.733	7.458	0.065 0.045	0.113 0.103

NOTE: Material: Alloy 718 per AMS 5596
Heat Treatment: Solution heat treated and precipitation hardened per AMS 5596 in inert atmosphere.

Garlock Helicoflex®
PERFORMANCE METAL SEALS
an EnPro Industries company

HELICOFLEX DATA SHEET

Tel: 800-233-1722 Fax: 803-783-4279
E-Mail: sales@helicoflex.com

COMPANY: | PHONE:
CONTACT: | FAX:
ADDRESS: | E-MAIL:
DATE:

APPLICATION: (please attach customer drawing / sketch)

Brief Description:

Annual quantities: | RFQ Quantities:

Is This a New Design? ❏ Yes ❏ No | Are Modifications Possible? ❏ Yes ❏ No

Drawing or Sketch Attached? ❏ Yes ❏ No | What is the Seal Type? ❏ Shaped ❏ Circular

SERVICE CONDITIONS:

Media: | Life Expectancy:

Working Temperature: | Max/Proof Pressure: @ Temp. =

Working Pressure: | Max Temperature: @ Pressure =

Pressure Direction: (Internal/External/Axial) | **Target Sealing Level:** Helium: Std.cc/sec

Pressure Cycles: | Flow Rate: cc/minute

Temperature Cycles: | Other:

FLANGE DETAILS: (Please Provide Drawing)

Amount of Flange Movment in Service: (Inches) Radial: Axial: #Cycles:

Material: Thickness:

❏ Groove / Counter Bore: Please list dimensions in Groove Details section

❏ ANSI Raised Face Size: # Rating: Face Surface Finish: (RMS)

❏ Flange(s) with Clamping System: (ISO,KF, etc) Standard: Size:

❏ Other: Description: (Please Provide Drawing)

GROOVE DETAILS: (Please Provide Drawing)

Type (Rectangular, Dovetail, etc.):

Outer Diameter: Tolerance: | Depth: Tolerance:

Inner Diameter: Tolerance: | Finish (RMS) Type:

Finish Type: lathe (circular), endmill (multi-directional), other

Size: | Type / Grade:

Number: Bolt Circle | Tapped / Through:

OTHER:

Special coating / plating specification:

Special quality / inspection specifications:

Other:

The technical data contained herein is by way of example and should not be relied on for any specific application. Garlock Helicoflex will be pleased to provide specific technical data or specifications with respect to any customer's particular applications. Use of the technical data or specifications contained herein without the express written approval of Garlock Helicoflex is at user's risk and Garlock Helicoflex expressly disclaims responsibility for such use and the situations which may result therefrom.

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Garlock Helicoflex is constantly involved in engineering and development. Accordingly, Garlock Helicoflex reserves the right to modify, at any time, the technology and product specifications contained herein.

Garlock Helicoflex®
PERFORMANCE METAL SEALS
an EnPro Industries company

Sealing Concept

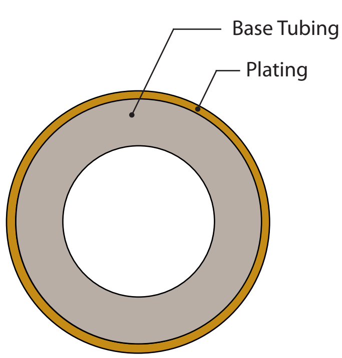
Garlock Helicoflex is the world's leading manufacturer of Nuclear Reactor Pressure Vessel (RPV) Closure Head Seals. In addition, Garlock Helicoflex sealing technology is used extensively as primary seals on spent fuel storage and transportation casks.

O-FLEX™ Metal O-Rings

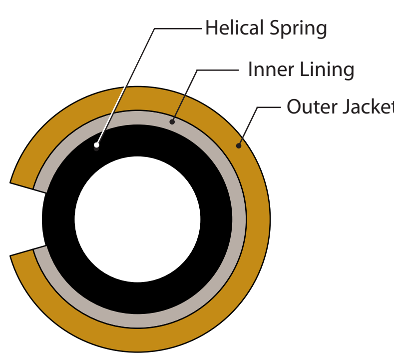
The O-Flex™ is manufactured of Alloy 718 or Stainless Steel 304 tubing. Alloy 718 is the most common and preferred material because it offers optimum strength, spring back and resistance to radiation and corrosion. The base tubing is plated with pure (99.95%) silver. This combination of elastic core (tubing) with deformable plastic layer (silver) provides durable sealing for traditional Nuclear Reactor Pressure Vessels.

HELICOFLEX® Spring Energized Seals

The Helicoflex® seal is a high performance, flexible, metal seal that has exceptional compression and elastic recovery properties. The Helicoflex seal is composed of a close-wound helical spring surrounded by two metal jackets. The spring is selected to have a specific compression resistance. During compression, the resulting specific pressure forces the jacket to yield and fill the flange imperfections while ensuring positive contact with the flange sealing faces. Each coil of the helical spring acts independently and allows the seal to conform to surface irregularities on the flange surface. This combination of elasticity and plasticity makes the Helicoflex seal the best choice for ageing reactors.



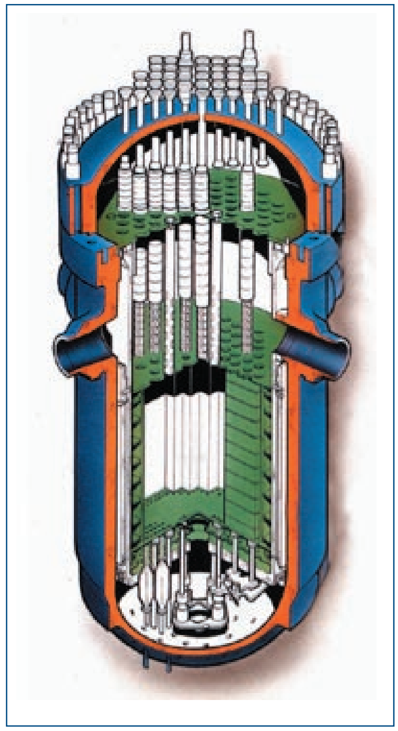
NRPV
O-FLEX™



NRPV
HELICOFLEX®

NUCLEAR
Nuclear Reactor Pressure Vessel Seals

TYPICAL SEAL APPLICATIONS



RPV Closure Head Seals

These seals are the primary seal for the reactor pressure vessel. Typically, the seals are used in tandem with an inner and outer seal for redundancy. The seals are positioned in the reactor pressure vessel head with clips and screws for easy installation and assembly.

Control Rod Drive (CRD) Seals

PTFE coated O-Flex™ seals for CRD mechanisms.

Spent Fuel Casks

Primary seals for casks used in the storage and transportation of spent fuel assemblies.

Other Applications

Steam Turbines
Primary Loop
Valves
Waste Heat Systems
Steam Pressurizer

Reactor Types

BWR – All Types
PWR – All Types
Gas Cooled
Navy Nuclear

QA System Assessment

ISO 9001:2000
Title 10 CFR 50 Appendix B
ANSI / ASME N45.2
Favorable Audits by NUPIC Members
ANSI / ASME NQA-1
KTA 1401

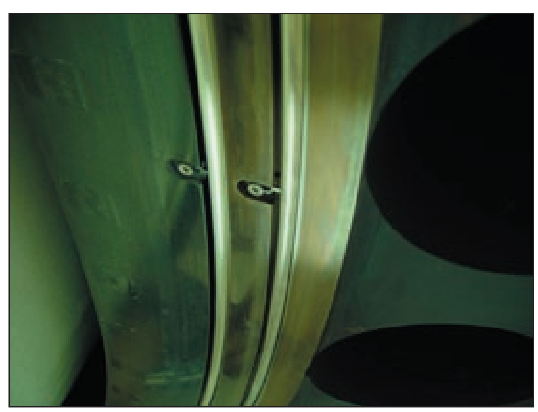
General Services

- Global leader for more than 50 years in nuclear RPV seal design and manufacturing. References available.
- RPV seal design and manufacturing for most PWR Nuclear Power Plants (NPP) and all BWR NPPs worldwide and to major NSSS worldwide. References available.
- Spent fuel cask seal design to all major spent fuel (transportation and storage) casks manufacturers worldwide. References available.
- Individual RPV seal design and recommendations for newly built PWR and BWR units.
- Seal and retainer design improvements to meet today's industries requirements of tight outage itineraries and ALARA requirements.
- Qualified and experienced on-site field services to evaluate the cause of numerous RPV seal problems, i.e. for RPV seal leakages, etc.
- Nuclear seal qualification services for new applications.
- Quality Assurance program based on the requirements of 10 CFR 50 Appendix B, ASME, N45.2, ASME Boiler and Pressure Vessel Codes V and IX, NUPIC audited.
- 3rd party evaluation available for on-site laser scan & repair of mating surfaces, reactor pressure vessel flange, and pressure vessel closure head grooves.
- NPP field staff training available, i.e. handling, installation, removal of RPV seals.
- Airfreight packaging and crating and airfreight arrangement for quick response transportation (airfreight capability limitation given by seal design).

Garlock Helicoflex Emergency Response

- Emergency response for outage. Spare RPV seals available on demand.
- 24/7 emergency service phone (803) 695-3553 (U.S.A.)
- 24 - 36 hour worldwide emergency site service available, on request.

RPV Closure Lid



RPV O-Flex™ Seals with installation clips

(Photos courtesy of AREVA)

Nuclear RPV Closure Head Seals

RPV O-FLEX™ — ALLOY 718 BASE TUBING

Free Height	Wall Thickness	Recommended Diameter Range	Seating Load (PCI) Y_2*	Installation Compression e_2	Installation Compression %	Total Springback (Min.)
0.375	0.038	40 to 180		0.030	8%	0.009
				0.037	10%	0.009
				0.045	12%	0.009
			2500	**0.060**	**16%**	**0.009**
				0.064	17%	0.009
0.500	0.050	120 to >180		0.040	8%	0.015
				0.050	10%	0.015
				0.060	12%	0.015
			2500	**0.080**	**16%**	**0.015**
				0.085	17%	0.015
0.625	0.063	120 to >180		0.050	8%	0.017
				0.062	10%	0.017
				0.075	12%	0.017
			4000	**0.100**	**16%**	**0.017**
				0.106	17%	0.017

Dimensions in inches

NOTE: Recommended compression % for NRPV O-FLEX is 16%
* PCI = Pounds force per Circumferential Inch

RPV Helicoflex: HN200 — HIGH TEMPERATURE ALLOY SPRING

Free Height	Wall Thickness	Recommended Diameter Range	Seating Load (PCI) Y2*	Installation Compression e2	Installation Compression %	Total Springback (Min.)
0.520	N/A	40 to >180	4000	0.052	10%	0.017

Dimensions in inches

RPV Closure Head Seals are typically held in the pressure vessel head with specially designed clips. Garlock Helicoflex recommends a clip be located at a minimum every 30″ of seal circumference. This will ensure that the seal is securely held in place.

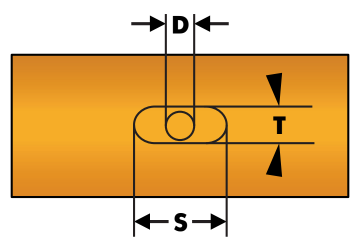
Type I

This clip can only be used with the traditional O-Flex RPV seal. This clip is designed to penetrate either a slot (most common) or a hole in ID of the O-Flex™.

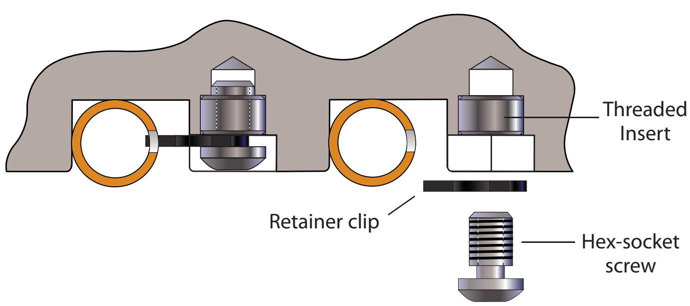
Type I Clip (O-FLEX Only)

Free Height	Wall Thickness	Slot Length S	Slot Width T	Hole Diameter D
0.375	0.038	0.281	0.125	0.070
0.500	0.050	0.375	0.205	0.093
0.625	0.063	0.438	0.256	0.125

Dimensions in inches



NOTE: Type I clip can be used with a slot or hole (depending on ring design)

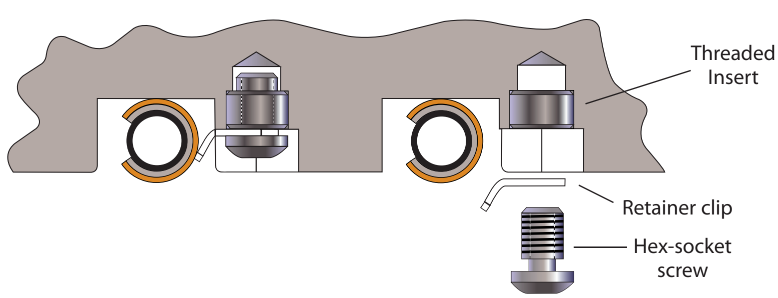


O-FLEX Diameter	Number of Slots
up to 72″	4
72″ to 144″	8
144″ to 200″	12
200″ +	16 or 24

Dimensions in inches

Type II

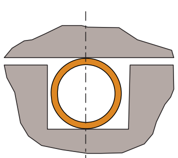
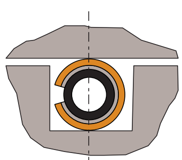
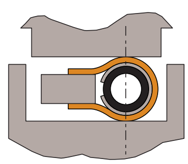
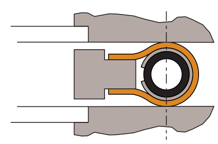
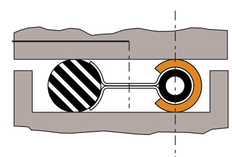
This style clip can be used with either the O-Flex™ or the Helicoflex® RPV seals. It is designed to hold the seal to the outer circumference of the groove without having to penetrate the ring through a slot. This makes seal installation easier since the seal does not require special alignment.



Garlock Helicoflex metal seals offer the performance and flexibility to meet stringent spent fuel cask requirements. The Helicoflex seal in particular can be made in a wide variety of geometries and shapes to meet the demanding requirements of cask designers. Typical seal types are listed below. Please contact Applications Engineering to discuss your cask requirements.

Typical Cask Seal Locations:
Cask Lid Closures
Fill Ports
Drain Ports

Typical Configurations

O-FLEX™	HELICOFLEX®			
	HN200 Groove assembly	**HN203** Tongue & Groove	**HN208** Raised face flanges - ANSI B16.5	**HNDE290** Leak check- inert gas purge
				

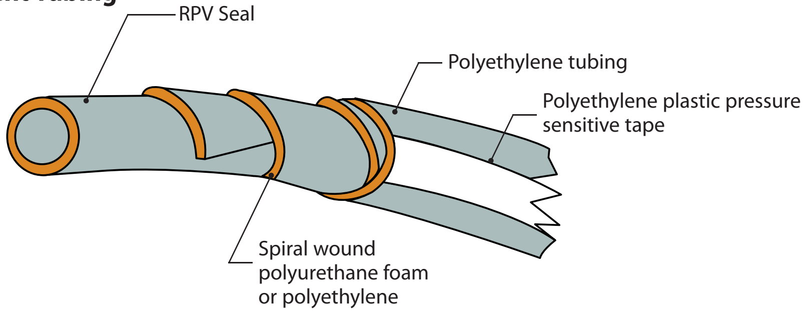
TN-40 Dry Storage Cask

TN-32 Dry Storage Cask

RPV Closure Head Seal Packaging

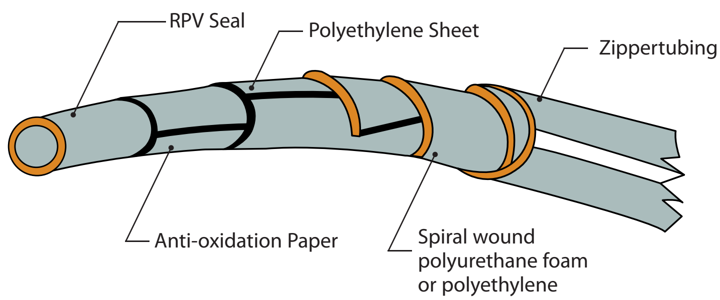
Garlock Helicoflex offers two styles of protective packaging for RPV seals:

Regular "Casement Tubing"



Zipper Lock Tubing Packaging

This is a packaging upgrade that was developed using ALARA minded principles. This packaging is designed to be removed quickly and therefore reduce radiation exposure time during unpacking and installation.



Shipping

Individually wrapped seals are securely packaged in wooden crates. Special provisions are made for extra protection during overseas shipments. Typically, the crate is transported by way of a specialized drop deck freight carrier. However, some crates may be custom designed for specialty ocean or air freight carriers.

Garlock Helicoflex®
PERFORMANCE METAL SEALS
an EnPro Industries company

HELICOFLEX DATA SHEET

Tel: 800-233-1722 Fax: 803-783-4279
E-Mail: sales@helicoflex.com

COMPANY:	PHONE:
CONTACT:	FAX:
ADDRESS:	E-MAIL:
	DATE:

APPLICATION: (please attach customer drawing / sketch)

Brief Description:

Annual quantities: | RFQ Quantities:

Is This a New Design? ❏ Yes ❏ No | Are Modifications Possible? ❏ Yes ❏ No

Drawing or Sketch Attached? ❏ Yes ❏ No | What is the Seal Type? ❏ Shaped ❏ Circular

SERVICE CONDITIONS:

Media: | Life Expectancy:

Working Temperature: | Max/Proof Pressure: @ Temp. =

Working Pressure: | Max Temperature: @ Pressure =

Pressure Direction: (Internal/External/Axial) | **Target Sealing Level:** Helium: Std.cc/sec

Pressure Cycles: | Flow Rate: cc/minute

Temperature Cycles: | Other:

FLANGE DETAILS: (Please Provide Drawing)

Amount of Flange Movment in Service: (Inches) Radial: Axial: #Cycles:

Material: Thickness:

❏ Groove / Counter Bore: Please list dimensions in Groove Details section

❏ ANSI Raised Face Size: # Rating: Face Surface Finish: (RMS)

❏ Flange(s) with Clamping System: (ISO,KF, etc) Standard: Size:

❏ Other: Description: (Please Provide Drawing)

GROOVE DETAILS: (Please Provide Drawing)

Type (Rectangular, Dovetail, etc.):

Outer Diameter: Tolerance: | Depth: Tolerance:

Inner Diameter: Tolerance: | Finish (RMS) Type:

Finish Type: lathe (circular), endmill (multi-directional), other

BOLTING DETAILS: (Please Provide Drawing)

Size: | Type / Grade:

Number: Bolt Circle | Tapped / Through:

OTHER:

Special coating / plating specification:

Special quality / inspection specifications:

Other:

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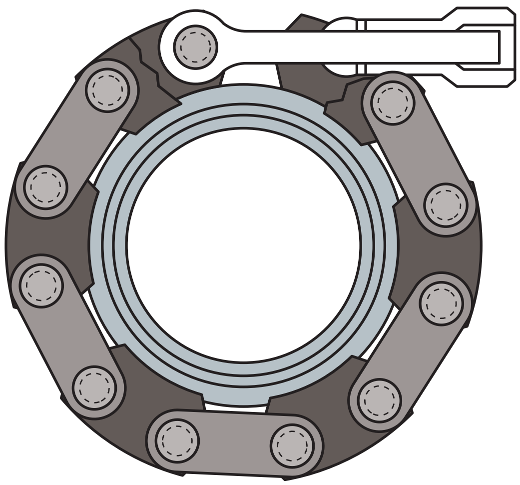
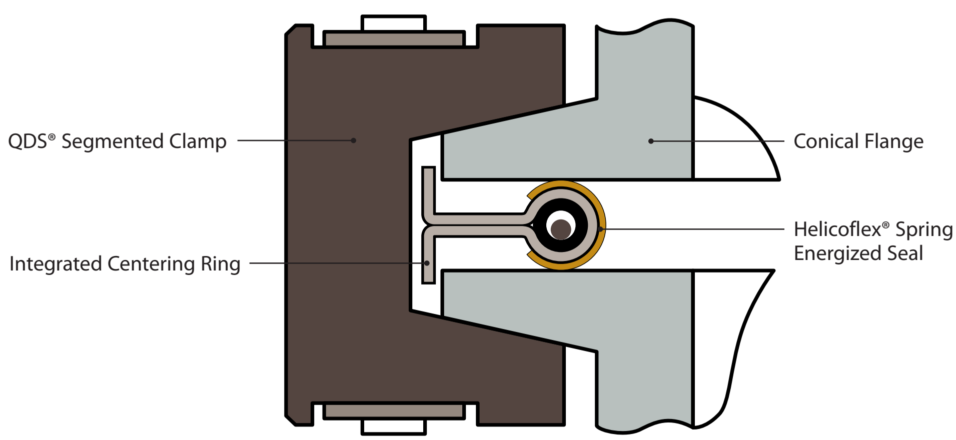
Sealing Concept

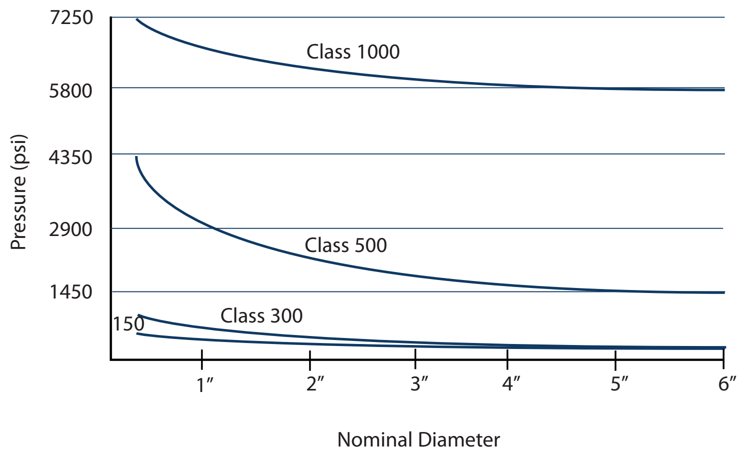
The Quick Disconnect System (QDS®) is designed to be assembled and disassembled quickly while offering space saving features. A typical QDS® requires less space than a traditional bolted assembly and can be easier to install, especially in tight locations where access to bolts and screws may be difficult. This feature is especially beneficial in radioactive environments where personnel exposure is an issue. The QDS® is available for both standard ISO-KF sizes and similar custom sizes for low and medium pressure applications.





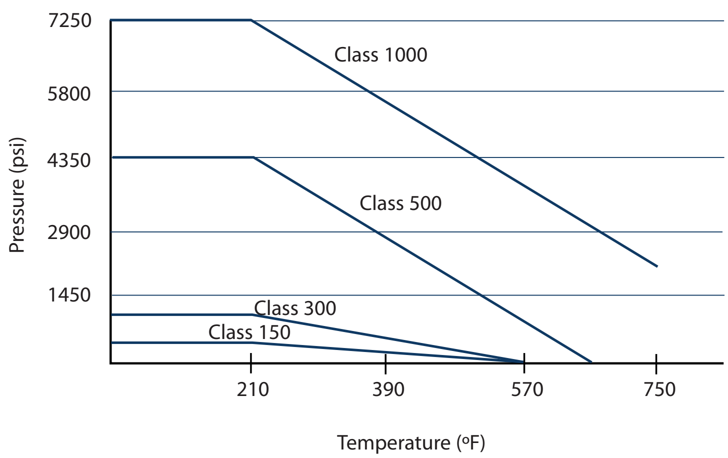
Quick Disconnect System
(Section View)

Pressure Limits x Nominal Diameter (70ºF)



NOTE: Hydraulic Pressure

Pressure Limits x Operating Temperature



* Reference only. Must be adjusted for nominal diameter.

QDS® Seal-Clamp Compatibility

	Jacket Material	Class 150	Class 300	Class 500	Class 1000
Helicoflex® HL290P	Aluminum	O	O	O	O
	Silver	X	O	O	O
	Copper	X	X	O	O
	Nickel	X	X	O	O
	Stainless Steel	X	X	O	O
Delta® HLV290P	Aluminum	O	O	O	O
	Silver	X	O	O	O
	Copper	X	X	O	O
	Nickel	X	X	O	O
	Stainless Steel	X	X	O	O

Clamps

Reference Number			
300 **Class*** 150 300 500	**A** **Link Size**	**55** **Flange OD** (mm)	**NM** **Non-Magnetic** (Optional) This is a special option for applications that require reduced magnetic permeability

Flanges

Reference Number			Weld Stub Description		
300 **Class*** 150 300 500	**KF** **Flange Type** KF Class 300/500 L Standard ISO Class 150	**55** **Flange OD** (mm)	**1-½** **Pipe/Tube OD** (Class 300/500)	**Sch 10** **Pipe Schedule** Tube thickness (Class 300/500)	**Short** **Stub Length** (Class 300/500)

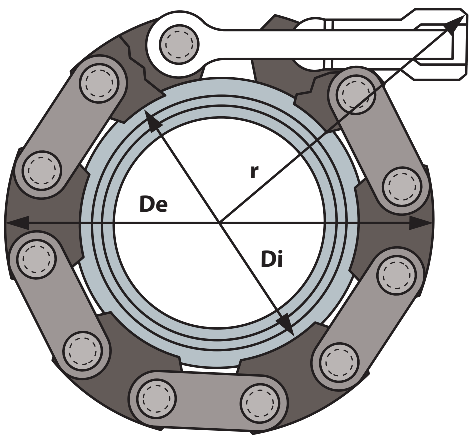
Example:
300KF55 1.5" Sch 10, short
Class 300
Type KF
Flange OD = 55mm
Pipe OD = 1.5"
Pipe Schedule = 10
Stub Length = Short (1.181")

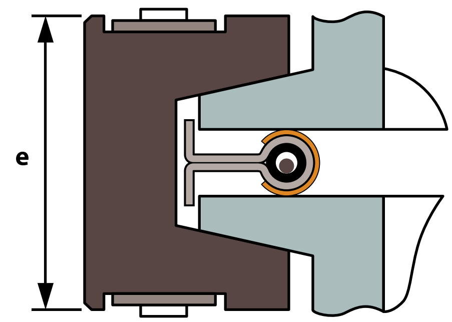
Blind Flanges:
Blind Flanges may be specified by placing a "T" in front of the Reference Number

Example: T300KF55

* The class type is based on load capability expressed in N/mm and is NOT related to the pound ratings for ANSI B16.5 flanges.

Clamps: ISO KF





Light: Class 150

Material:
- Aluminum links
- Non-magnetic side-plates
- Non-magnetic stainless steel screws

Technical Data:
- Clamping load: 150 N/mm (860 lb/in)
- Temperature: 392ºF (200ºC) max.

The selection is made according to the ISO Nominal Diameter reference

CLAMP DIMENSIONS

ISO KF Nominal Diameter	Part Number	De in	De mm	Di in	Di mm	r in	r mm	e in	e mm	max pressure psi	max pressure bars	max torque in.lb	max torque Nm
10/16	150 L 30	2.284	58	0.827	21	2.402	61	0.906	23	290	20	35.0	4
20/25	150 L 40	2.795	71	1.181	30	2.284	58	0.906	23	174	12	62.0	7
32/40	150 L 55	3.346	85	1.772	45	2.559	65	0.906	23	145	10	80.0	9
50	150 L 75	4.016	102	2.559	65	2.796	71	0.906	23	73	5	89.0	10

NOTE: ISO nominal diameter is sometimes denoted as NW or QF

Heavy: Class 300

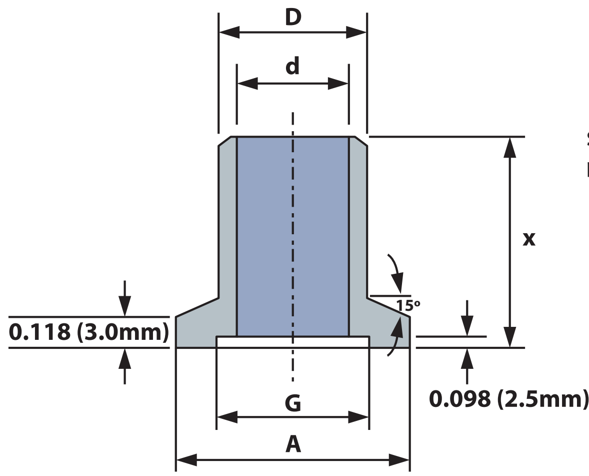
Material:
- Stainless Steel links
- Stainless Steel side-plates
- Steel screw (stainless steel on request)

Technical Data:
- Clamping load: 300 N/mm (1715 lb/in)
- Temperature: 572ºF (300ºC) max.

CLAMP DIMENSIONS

ISO KF Nominal Diameter	Part Number	De in	De mm	Di in	Di mm	r in	r mm	e in	e mm	max pressure psi	max pressure bars	max torque in.lb	max torque Nm
10/16	300 L 30	2.362	60	0.787	20	2.165	55	1.260	32	870	60	53	6
20/25	300 L 40	2.756	70	1.181	30	2.284	58	1.260	32	580	40	89	10
32/40	300 L 55	3.307	84	1.772	45	2.441	62	1.260	32	580	40	124	14
50	300 L 75	3.937	100	2.559	65	2.756	70	1.260	32	290	20	159	18

Flanges: ISO KF

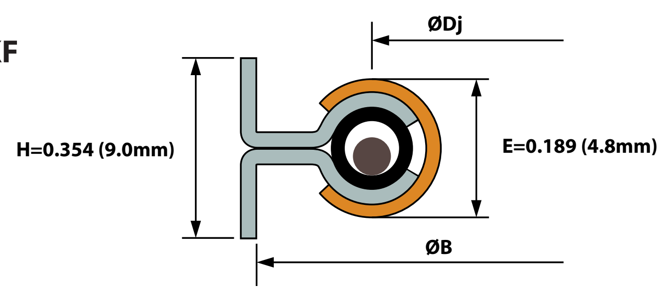


Standard ISO KF Flange per ISO 2861

FLANGE DIMENSIONS														
ISO KF Nominal Diameter	A		D		d		G		X-short		X-long		Flange ref. number
	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	
10	1.181	30	0.551	14	0.394	10	0.480	12.2	0.787	20	1.969	50	150 KF 30 ND 10
16	1.181	30	0.780	19.8	0.630	16	0.677	17.2	0.787	20	1.969	50	150 KF 30 ND 16
20	1.575	40	0.984	25	0.827	21	0.874	22.2	0.984	25	1.969	50	150 KF 40 ND 20
25	1.575	40	1.102	28	0.945	24	1.032	26.2	0.984	25	1.969	50	150 KF 40 ND 25
32	2.165	55	1.496	38	1.260	32	1.346	34.2	1.181	30	2.362	60	150 KF 55 ND 32
40	2.165	55	1.732	44	1.575	40	1.622	41.2	1.181	30	2.362	60	150 KF 55 ND 40
50	2.953	75	2.244	57	1.969	50	2.055	52.2	1.181	30	2.362	60	150 KF 75 ND 50

NOTE: Flange class 150 NF E 29-724/ISO 2861

Seals: ISO KF

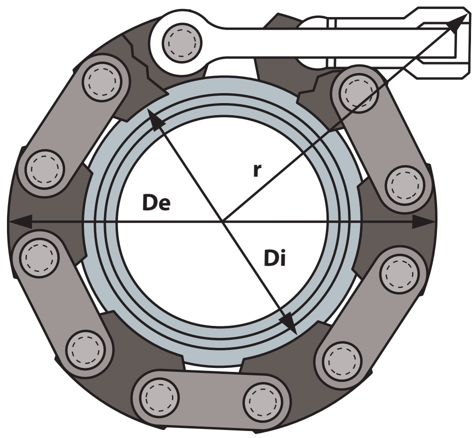


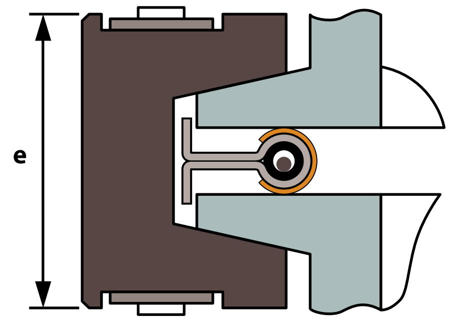
Helicoflex Spring Energized Seal Type: HL290P

SEAL DIMENSIONS - ALUMINUM JACKET					
ISO KF Nominal Diameter	ØDj		ØB		Seal Type
	in	mm	in	mm	
10/16	0.866	22.0	1.185	30.1	HL290P-4.8Al ND 16
20/25	1.268	32.2	1.579	40.1	HL290P-4.8Al ND 25
32/40	1.878	47.7	2.169	55.1	HL290P-4.8Al ND 40
50	2.449	62.2	2.957	75.1	HL290P-4.8Al ND 50

Other jacket materials available upon request.

Clamps: Class 300



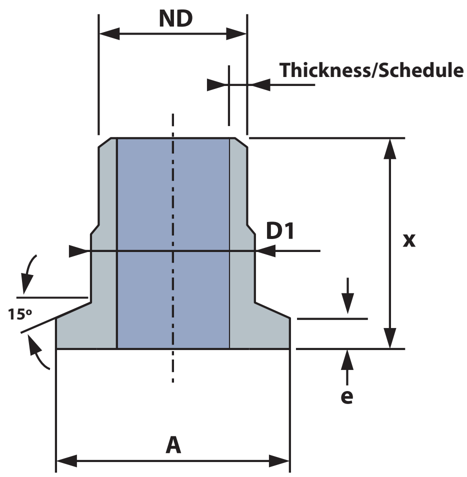


Material:
- Stainless Steel links
- Stainless Steel side-plates
- Steel screw (stainless steel on request)

Technical Data:
- Clamping load: 300 N/mm (1715 lb/in)
- Temperature: 572ºF (300ºC) max.

Clamp Reference	Tube OD (Max)		Clamp Dimensions								Pressure (Max)	Torque (Max)
			De		Di		r		e			
	in	mm	in	mm	in	mm	in	mm	in	mm	psi	ft.lb
300 A 30	0.709	18	2.362	60	0.787	20	2.165	55	1.260	32	870	4
300 A 40	1.102	28	2.756	70	1.181	30	2.283	58	1.260	32	580	7
300 A 55	1.693	43	3.307	84	1.772	45	2.441	62	1.260	32	580	10
300 A 75	2.441	62	3.937	100	2.559	65	2.756	70	1.260	32	290	13
300 B 92	2.992	76	5.512	140	3.150	80	4.134	105	1.614	41	290	37
300 B 114	3.780	96	6.299	160	4.016	102	4.528	115	1.614	41	261	37
300 B 134	4.567	116	7.087	180	4.803	122	4.921	125	1.614	41	232	37
300 C 167	5.748	146	9.055	230	6.024	153	6.142	156	2.087	53	232	89
300 C 201	7.087	180	10.630	270	7.362	187	6.890	175	2.087	53	203	89
300 C 252	9.055	230	12.598	320	9.370	238	7.677	195	2.087	53	174	89
300 D 304	10.945	278	14.961	380	11.260	286	9.055	230	2.756	70	174	133
300 D 356	12.992	330	17.087	434	13.307	338	10.236	260	2.756	70	145	133
300 D 387	14.173	360	18.110	460	14.528	369	10.827	275	2.756	70	116	133
300 D 438	16.142	410	20.079	510	16.535	420	11.811	300	2.756	70	58	133

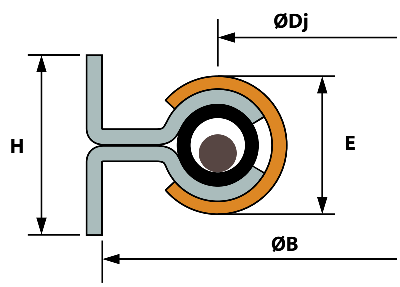
Flanges: Class 300



ND = Nominal Diameter

Clamp Reference	Flange Dimensions						Flange Reference
	A		D1		e		
	in	mm	in	mm	in	mm	
300 A 30	1.181	30	0.709	18	0.157	4.0	300 KF 30
300 A 40	1.575	40	1.102	28	0.157	4.0	300 KF 40
300 A 55	2.165	55	1.693	43	0.157	4.0	300 KF 55
300 A 75	2.953	75	2.480	63	0.157	4.0	300 KF 75
300 B 92	3.622	92	3.071	78	0.248	6.3	300 KF 92
300 B 114	4.488	114	3.937	100	0.248	6.3	300 KF 114
300 B 134	5.276	134	4.724	120	0.248	6.3	300 KF 134
300 C 167	6.575	167	5.906	150	0.327	8.3	300 KF 167
300 C 201	7.913	201	7.244	184	0.327	8.3	300 KF 201
300 C 252	9.921	252	9.252	235	0.327	8.3	300 KF 252
300 D 304	11.969	304	11.102	282	0.445	11.3	300 KF 304
300 D 356	14.016	356	13.150	334	0.445	11.3	300 KF 356
300 D 387	15.236	387	14.370	365	0.445	11.3	300 KF 387
300 D 438	17.244	438	16.378	416	0.445	11.3	300 KF 438

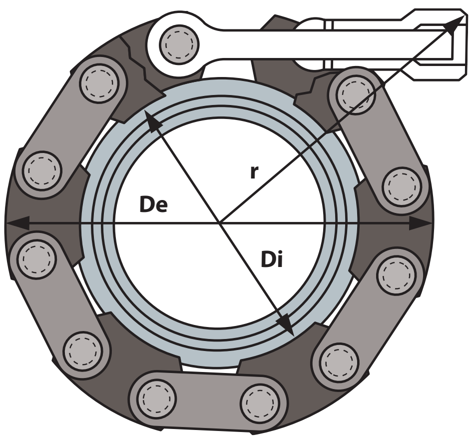
Seals: Class 300

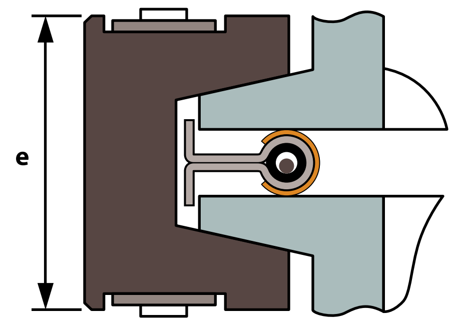


Helicoflex Spring Energized Seal Type: HL290P

Clamp Reference	Clamp Dimensions								Seal Reference
	ØB		ØDj		E		H		
	in	mm	in	mm	in	mm	in	mm	
300 A 30	1.185	30.1	0.866	22.0	0.110	2.8	0.315	8	HL290P - 2.8 x 30
300 A 40	1.579	40.1	1.268	32.2	0.110	2.8	0.315	8	HL290P - 2.8 x 40
300 A 55	2.169	55.1	1.878	47.7	0.110	2.8	0.315	8	HL290P - 2.8 x 55
300 A 75	2.957	75.1	2.449	62.2	0.110	2.8	0.315	8	HL290P - 2.8 x 75
300 B 92	3.626	92.1	3.268	83.0	0.189	4.8	0.354	9	HL290P - 4.8 x 92
300 B 114	4.492	114.1	4.055	103.0	0.189	4.8	0.354	9	HL290P - 4.8 x 114
300 B 134	5.280	134.1	4.764	121.0	0.189	4.8	0.354	9	HL290P - 4.8 x 134
300 C 167	6.579	167.1	6.063	154.0	0.189	4.8	0.472	12	HL290P - 4.8 x 167
300 C 201	7.917	201.1	7.283	185.0	0.189	4.8	0.472	12	HL290P - 4.8 x 201
300 C 252	9.925	252.1	9.291	236.0	0.189	4.8	0.472	12	HL290P - 4.8 x 252
300 D 304	11.972	304.1	11.339	288.0	0.189	4.8	0.551	14	HL290P - 4.8 x 304
300 D 356	14.020	356.1	13.268	337.0	0.189	4.8	0.551	14	HL290P - 4.8 x 356
300 D 387	15.240	387.1	14.488	368.0	0.189	4.8	0.551	14	HL290P - 4.8 x 387
300 D 438	17.248	438.1	16.496	419.0	0.189	4.8	0.551	14	HL290P - 4.8 x 438

Clamps: Class 500



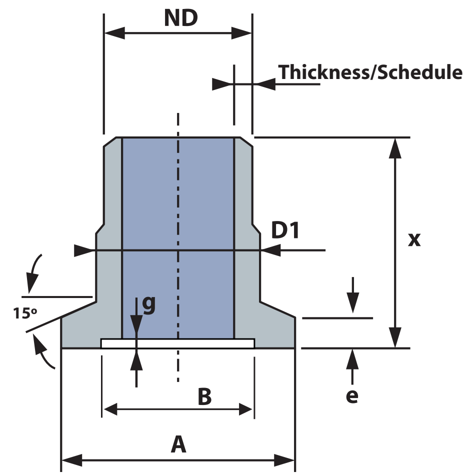


Material:
- Stainless Steel links
- Stainless Steel side-plates
- Steel screw

Technical Data:
- Clamping load: 500 N/mm (2855 lb/in)
- Temperature: 662ºF (350ºC) max.

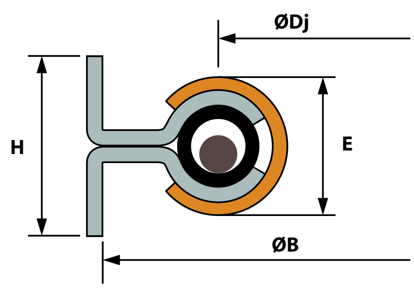
Clamp Reference	Tube OD (Max)		Clamp Dimensions								Pressure (Max) psi	Torque (Max) ft.lb
			De		Di		r		e			
	in	mm	in	mm	in	mm	in	mm	in	mm		
500 A 30	0.709	18	2.362	60	0.787	20	2.165	55	1.260	32	4350	13
500 A 40	1.102	28	2.756	70	1.181	30	2.283	58	1.260	32	2900	13
500 A 55	1.693	43	3.307	84	1.772	45	2.441	62	1.260	32	2610	13
500 B 75	2.402	61	4.803	122	2.480	63	4.134	105	1.614	41	2610	37
500 B 92	2.992	76	5.512	140	3.150	80	4.134	105	1.614	41	2030	37
500 B 114	3.780	96	6.299	160	4.016	102	4.528	115	1.614	41	1450	37
500 C 134	4.528	115	7.559	192	4.724	120	5.709	145	2.087	53	1450	89
500 C 167	5.669	144	9.055	230	6.024	153	6.142	156	2.087	53	1160	89
500 D 201	6.693	170	11.181	284	7.205	183	6.890	175	2.756	70	1160	133
500 D 252	8.661	220	13.071	332	9.213	234	8.386	213	2.756	70	1015	133
500 D 304	10.787	274	14.961	380	11.260	286	9.055	230	2.756	70	870	133
500 E 356	12.756	324	17.126	435	13.150	334	10.433	265	3.307	84	870	184
500 E 387	14.016	356	18.701	475	14.370	365	11.024	280	3.307	84	580	184
500 E 438	16.024	407	20.472	520	16.378	416	12.205	310	3.307	84	290	184

Flanges: Class 500



Clamp Reference	Clamp Dimensions: A in	A mm	B in	B mm	D1 in	D1 mm	g in	g mm	e in	e mm	Flange Reference
500 A 30	1.181	30	0.992	25.2	0.709	18	0.031	0.8	0.189	4.8	500 KF 30
500 A 40	1.575	40	1.394	35.4	1.102	28	0.031	0.8	0.189	4.8	500 KF 40
500 A 55	2.165	55	2.004	50.9	1.693	43	0.031	0.8	0.189	4..8	500 KF 55
500 B 75	2.953	75	2.575	65.4	2.402	61	0.035	0.9	0.311	7.9	500 KF 75
500 B 92	3.622	92	3.413	86.7	3.071	78	0.035	0.9	0.311	7.9	500 KF 92
500 B 114	4.488	114	4.201	106.7	3.937	100	0.035	0.9	0.311	7.9	500 KF 114
500 C 134	5.276	134	4.909	124.7	4.646	118	0.035	0.9	0.390	9.9	500 KF 134
500 C 167	6.575	167	6.209	157.7	5.906	150	0.035	0.9	0.390	9.9	500 KF 167
500 D 201	7.913	201	7.429	188.7	7.087	180	0.035	0.9	0.508	12.9	500 KF 201
500 D 252	9.921	252	9.437	239.7	9.094	231	0.035	0.9	0.508	12.9	500 KF 252
500 D 304	11.969	304	11.484	291.7	11.102	282	0.035	0.9	0.508	12.9	500 KF 304
500 E 356	14.016	356	13.413	340.7	12.992	330	0.035	0.9	0.665	16.9	500 KF 356
500 E 387	15.236	387	14.634	371.7	14.213	361	0.035	0.9	0.665	16.9	500 KF 387
500 E 438	17.244	438	16.642	422.7	16.220	412	0.035	0.9	0.665	16.9	500 KF 438

Seals: Class 500



Clamp Reference	Clamp Dimensions: ØB in	ØB mm	ØDj in	ØDj mm	E in	E mm	H in	H mm	Seal Reference
500 A 30	1.185	30.1	0.866	22.0	0.110	2.8	0.315	8	HL290P - 2.8 x 30
500 A 40	1.579	40.1	1.268	32.2	0.110	2.8	0.315	8	HL290P - 2.8 x 40
500 A 55	2.169	55.1	1.878	47.7	0.110	2.8	0.315	8	HL290P - 2.8 x 55
500 B 75	2.957	75.1	2.449	62.2	0.126	3.2	0.354	9	HL290P - 3.2 x 75
500 B 92	3.626	92.1	3.268	83.0	0.126	3.2	0.354	9	HL290P - 3.2 x 92
500 B 114	4.492	114.1	4.055	103.0	0.126	3.2	0.354	9	HL290P - 3.2 x 114
500 C 134	5.280	134.1	4.764	121.0	0.126	3.2	0.472	12	HL290P - 3.2 x 134
500 C 167	6.579	167.1	6.063	154.0	0.126	3.2	0.472	12	HL290P - 3.2 x 167
500 D 201	7.917	201.1	7.283	185.0	0.126	3.2	0.551	14	HL290P - 3.2 x 201
500 D 252	9.925	252.1	9.291	236.0	0.126	3.2	0.551	14	HL290P - 3.2 x 252
500 D 304	11.972	304.1	11.339	288.0	0.126	3.2	0.551	14	HL290P - 3.2 x 304
500 E 356	14.020	356.1	13.268	337.0	0.126	3.2	0.630	16	HL290P - 3.2 x 356
500 E 387	15.240	387.1	14.488	368.0	0.126	3.2	0.630	16	HL290P - 3.2 x 387
500 E 438	17.248	438.1	16.496	419.0	0.126	3.2	0.630	16	HL290P - 3.2 x 438

Standard Schedule Pipe Sizes

Nom Pipe Size (in)	Pipe OD (Max)		Schedule 5S				Schedule 10S			
			Thickness		ID		Thickness		ID	
	in	mm	in	mm	in	mm	in	mm	in	mm
1/8	0.405	10.29					0.049	1.24	0.307	7.81
1/4	0.540	13.72					0.065	1.65	0.410	10.42
1/2	0.840	21.34	0.065	1.65	0.710	18.04	0.083	2.11	0.674	17.12
3/4	1.050	26.67	0.065	1.65	0.918	23.31	0.083	2.11	0.884	22.45
1	1.315	33.40	0.065	1.65	1.185	30.10	0.109	2.77	1.097	27.86
1-1/2	1.900	48.26	0.065	1.65	1.770	44.96	0.109	2.77	1.682	42.72
2	2.375	60.33	0.065	1.65	2.245	57.03	0.109	2.77	2.157	54.79
2-1/2	2.875	73.03	0.083	2.10	2.710	68.83	0.120	3.05	2.635	66.93
3	3.500	88.90	0.083	2.10	3.335	84.70	0.120	3.05	3.260	82.80
4	4.500	114.30	0.083	2.10	4.335	110.10	0.120	3.05	4.260	108.20
5	5.563	141.30	0.109	2.77	5.463	138.76	0.134	3.40	5.295	134.50
6	6.625	168.28	0.109	2.77	6.407	162.74	0.134	3.40	6.357	161.48
8	8.625	219.08	0.109	2.77	8.407	213.54	0.148	3.76	8.329	211.56
10	10.750	273.05	0.134	3.40	10.482	266.25	0.165	4.19	10.420	264.67
12	12.750	323.85	0.156	3.96	12.438	315.93	0.180	4.57	12.390	314.71
14	14.000	355.60	0.156	3.96	13.688	347.68	0.188	4.78	13.624	346.04
16	16.000	406.40	0.165	4.19	15.670	398.02	0.188	4.78	15.624	396.84

Nom Pipe Size (in)	Pipe OD (Max)		Schedule 40S				Schedule 80S			
			Thickness		ID		Thickness		ID	
	in	mm	in	mm	in	mm	in	mm	in	mm
1/8	0.405	10.29	0.068	1.73	0.269	6.83	0.095	2.41	0.215	5.47
1/4	0.540	13.72	0.088	2.24	0.364	9.24	0.119	3.02	0.302	7.68
1/2	0.840	21.34	0.109	2.77	0.622	15.80	0.147	3.73	0.546	13.88
3/4	1.050	26.67	0.113	2.87	0.824	20.93	0.154	3.91	0.742	18.85
1	1.315	33.40	0.133	3.38	1.049	26.64	0.179	4.55	0.957	24.30
1-1/2	1.900	48.26	0.145	3.68	1.610	40.90	0.200	5.08	1.500	38.10
2	2.375	60.33	0.154	3.91	2.067	52.51	0.218	5.54	1.939	49.25
2-1/2	2.875	73.03	0.203	5.16	2.469	62.71	0.276	7.01	2.323	59.01
3	3.500	88.90	0.216	5.49	3.068	77.92	0.300	7.62	2.900	73.66
4	4.500	114.30	0.237	6.02	4.026	102.26	0.337	8.56	3.826	97.18
5	5.563	141.30	0.258	6.55	5.047	128.20	0.376	9.53	4.813	122.24
6	6.625	168.28	0.280	7.11	6.065	154.06	0.432	10.97	5.761	146.34
8	8.625	219.08	0.322	8.18	7.981	202.72	0.500	12.70	7.625	193.68
10	10.750	273.05	0.365	9.27	10.020	254.51	0.500	12.70	9.750	247.65
12	12.750	323.85	0.375	9.52	12.000	304.81	0.500	12.70	11.750	298.45
14	14.000	355.60	0.375	9.52	13.250	336.56	0.500	12.70	13.004	330.30
16	16.000	406.40	0.375	9.52	15.250	387.36	0.500	12.70	15.000	381.00

ISO Standard Tubing

Tube OD		Light				Medium				Heavy			
		Thickness		ID		Thickness		ID		Thickness		ID	
in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm
0.236	6.00	0.039	1.00	0.157	4.00								
0.315	8.00	0.039	1.00	0.236	6.00								
0.394	10.00	0.039	1.00	0.315	8.00								
0.472	12.00	0.039	1.00	0.394	10.00	0.059	1.50	0.354	9.00				
0.551	14.00	0.039	1.00	0.472	12.00	0.059	1.50	0.433	11.00	0.079	2.00	0.394	10.00
0.630	16.00	0.039	1.00	0.551	14.00	0.059	1.50	0.669	17.00	0.079	2.00	0.472	12.00
0.787	20.00	0.039	1.00	0.709	18.00	0.059	1.50	0.866	22.00	0.079	2.00	0.630	16.00
0.984	25.00	0.039	1.00	0.906	23.00	0.059	1.50	0.866	22.00	0.079	2.00	0.827	21.00
1.102	28.00	0.039	1.00	1.024	26.00	0.059	1.50	0.984	25.00	0.079	2.00	0.945	24.00
1.496	38.00	0.039	1.00	1.417	36.00	0.063	1.60	1.370	34.80	0.079	2.00	1.339	34.00
1.752	44.50	0.059	1.50	1.634	41.50	0.079	2.00	1.594	40.50	0.102	2.60	1.547	39.30
2.244	57.00	0.059	1.50	2.126	54.00	0.079	2.00	2.087	53.00	0.102	2.60	2.039	51.80
2.996	76.10	0.063	1.60	2.870	72.90	0.091	2.30	2.815	71.50	0.114	2.90	2.768	70.30

Weld Stub Lengths

Flange Reference				Stub Length (X)					
				short		long		extra long	
Class			Suffix	in	mm	in	mm	in	mm
150	300	500	KF 30	0.787	20	1.969	50	3.937	100
150	300	500	KF 40	0.984	25	1.969	50	3.937	100
150	300	500	KF 55	1.181	30	2.362	60	4.724	120
150	300	500	KF 75	1.181	30	2.362	60	4.724	120
N/A	300	500	KF 92	1.181	30	2.362	60	4.724	120
N/A	300	500	KF 114	1.772	45	3.150	80	6.299	160
N/A	300	500	KF 134	1.969	50	3.543	90	7.874	200
N/A	300	500	KF 167	1.969	50	3.543	90	7.874	200
N/A	300	500	KF 201	1.969	50	3.937	100	7.874	200
N/A	300	500	KF 252	1.969	50	3.937	100	7.874	200
N/A	300	500	KF 304	1.969	50	3.937	100	7.874	200
N/A	300	500	KF 356	2.362	60	4.724	120	9.449	240
N/A	300	500	KF 387	2.362	60	4.724	120	9.449	240
N/A	300	500	KF 438	2.362	60	4.724	120	9.449	240

QDS Class 1000

The Class 1000 series is a heavy duty clamp and flange assembly designed for medium to high pressure. The flange and seal assembly can be modified to accept a variety of seal configurations. Please contact Applications Engineering for more information.

Remote Handling

The QDS® clamp and seal can be fitted with special handling features such as custom cross bolts and seal tabs for easy installation and removal with remote handling equipment. These custom QDS® assemblies are ideal for radioactive environments where personnel exposure must be reduced or eliminated.   Please contact Applications Engineering for more information.

Garlock Helicoflex®
PERFORMANCE METAL SEALS
an EnPro Industries company

QDS DATA SHEET

Tel: 800-233-1722 Fax: 803-783-4279
E-Mail: sales@helicoflex.com

COMPANY: ______ PHONE: ______
CONTACT: ______ FAX: ______
ADDRESS: ______ E-MAIL: ______
DATE: ______

APPLICATION

Brief Description: ______________________________

Is This a New Design? ❑ Yes ❑ No
Are Modifications Possible? ❑ Yes ❑ No
Drawing or Sketch Attached? ❑ Yes ❑ No

SERVICE CONDITIONS

Working Pressure: ______________
Maximum Pressure: ______________
Working Temperature: ______________
Maximum Temperature: ______________
❑ Remote Handling Required (Radiation?)

Temp/Pressure Cycles: ______________
Media: ______________
Required Sealing Level: ______________
Life Expectancy: ______________
❑ Non-Magnetic Required

FLANGE DETAILS

❑ Garlock to Design (If flange design exists, then fill out "Standard" or "Special" Section below as appropriate).

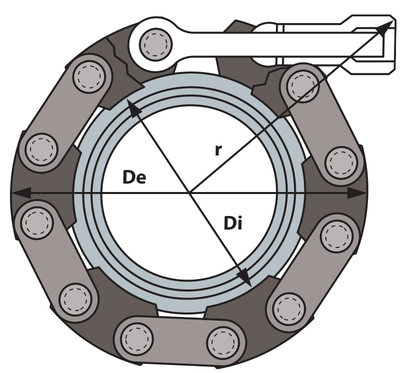
❑ Standard Size (ie. ND, KF, DN, ISO, etc): ______________ Face Surface Finish: ______________ (RMS)

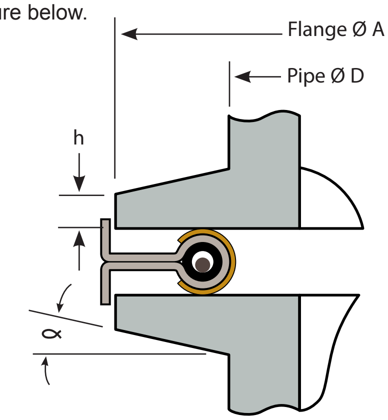
Flange Material ______________________________

❑ Special

If not standard, provide drawing or dimensions in picture below.

Flange Material = ____________
Ø D = ____________
Ø A = ____________
Flange Thickness h = ____________
Flange Angle ∝ = ____________
Clamp Width/Thickness = ____________
Clamp Clearance De = ____________
Bolt Clearance r = ____________
Flange Stub Length = ____________





PIPE DETAILS

Size: ______________________________ Material Grade: ______________________________

Thickness: (Schedule / ISO Size may be provided instead) ______________________________

COMMENTS / NOTES

____

____

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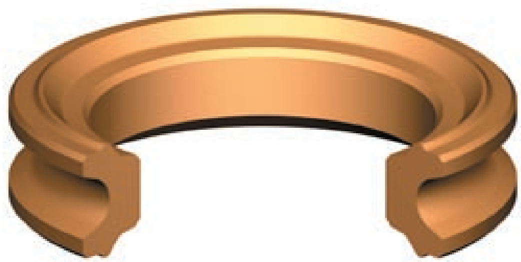
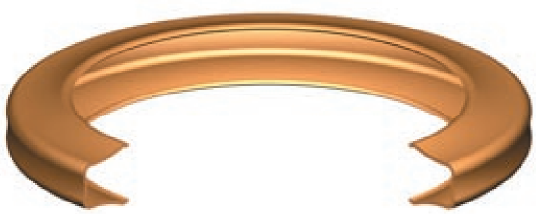
Garlock Helicoflex offers custom designed sealing solutions for difficult or extreme applications. Our design capabilities are supported with seal modeling, prototyping and testing services. Contact Applications Engineering for more information regarding these products and services.

Machined Seals

Machined seals are made from solid metal and are typically used in applications requiring a very small diameter. The seal geometry and material can be custom designed to meet most customer requirements.



U-Flex™



The U-Flex™ is a variation of the E-Flex™. It has very good spring back but does not have the compression range of most E-Flex™ seals. However, it may be a cost effective solution for applications requiring more spring back than a typical C-Flex™.

Custom Configurations

Most metal seals can be manufactured in various shapes and sizes. The Helicoflex® Spring Energized Seal is particularly flexible in design and function. Helicoflex® seals can be designed and manufactured for remote handling, tandem sealing, quartz windows, radio frequency wave guides and many other custom applications.

Other Custom Products

Locking Rings
Boss Seals
Dampening Rings

Garlock Helicoflex®

PERFORMANCE METAL SEALS

an EnPro Industries company

HELICOFLEX DATA SHEET

Tel: 800-233-1722 Fax: 803-783-4279
E-Mail: sales@helicoflex.com

COMPANY:	PHONE:
CONTACT:	FAX:
ADDRESS:	E-MAIL:
	DATE:

APPLICATION: (please attach customer drawing / sketch)

Brief Description:

Annual quantities:			RFQ Quantities:		
Is This a New Design?	❏ Yes	❏ No	Are Modifications Possible?	❏ Yes	❏ No
Drawing or Sketch Attached?	❏ Yes	❏ No	What is the Seal Type?	❏ Shaped	❏ Circular

SERVICE CONDITIONS:

Media:	Life Expectancy:
Working Temperature:	Max/Proof Pressure: @ Temp. =
Working Pressure:	Max Temperature: @ Pressure =
Pressure Direction: (Internal/External/Axial)	**Target Sealing Level:** Helium: Std.cc/sec
Pressure Cycles:	Flow Rate: cc/minute
Temperature Cycles:	Other:

FLANGE DETAILS: (Please Provide Drawing)

Amount of Flange Movment in Service: (Inches) Radial: Axial: #Cycles:

Material: Thickness:

❏ Groove / Counter Bore: Please list dimensions in Groove Details section

❏ ANSI Raised Face Size: # Rating: Face Surface Finish: (RMS)

❏ Flange(s) with Clamping System: (ISO,KF, etc) Standard: Size:

❏ Other: Description: (Please Provide Drawing)

GROOVE DETAILS: (Please Provide Drawing)

Type (Rectangular, Dovetail, etc.):

Outer Diameter:	Tolerance:	Depth:	Tolerance:
Inner Diameter:	Tolerance:	Finish (RMS)	Type:

Finish Type: lathe (circular), endmill (multi-directional), other

BOLTING DETAILS: (Please Provide Drawing)

Size:	Type / Grade:
Number: Bolt Circle	Tapped / Through:

OTHER:

Special coating / plating specification:

Special quality / inspection specifications:

Other:

Common Material AMS Specifications

Material	Grade	Tubing		Sheet / Strip
		Seamless	Welded	
Aluminum	1100	-	-	4001
Nickel	201	-	-	5553
St. Steel	304	5560	5565	5513
St. Steel	304L	-	-	5511
St. Steel	316	5573	-	5524
St. Steel	316L	-	-	5507
St. Steel	321	5570	5576	5510
Alloy	C276	-	-	5530
Alloy	400	4574	-	4544
Alloy	600	5580	-	5540
Alloy	625	5581	5581	5599
Alloy	718	5590	-	5596
Alloy	X-750	5582	-	5598
Titanium	Grd 2	-	-	4902
Waspaloy		-	-	5544

Heat Treatments

Solution Heat Treat / Anneal

Stainless Steel (300 series): Anneal at 2000ºF for 3 minutes
Nickel: Anneal at 1325ºF for 90 minutes
Alloy X-750: Solution heat treat/anneal per AMS 5598 Section 3.4
Alloy 718: Solution heat treat/anneal per AMS 5596 Section 3.4
Other materials: Contact Applications Engineering

Precipitation Harden / Age

Stainless Steel (300 Series): N/A
Nickel: N/A
Alloy X-750: Precipitation harden per AMS 5598 per Section 3.5.2
Alloy 718: Precipitation harden per AMS 5596 Section 3.5.2
Other materials: Contact Applications Engineering

Special Heat Treatments

NACE: Temper per NACE MR0175 for control of stress corrosion cracking
Custom 2-stage stainless steel anneal (316L VIMVAR stainless steel)
Aluminum anneal (Alloys 6061 and 2024)

Contact Applications Engineering for more information.

	Grade	UNS Description	Description	Density lb/in³ (g/cm³)	Tensile Strength ksi (Mpa)	Yield Strength at 0.2% offset ksi (MPa)	Elongation %	Hardness
Stainless Steels	304	S30400	Chromium-Nickel austenitic alloy. Used for a wide variety of home and commercial applications, this is one of the most familiar and most frequently used alloys in the stainless steel family.	0.285 (7.90)	75 (515)	30 (205)	30 (205)	92 Rb
	316	S31600	Molybdenum-bearing austenitic stainless steel which is more resistant to general corrosion and pitting/crevice corrosion than the conventional chromium-nickel austenitic stainless steels. This alloy offers higher creep, stress-to-rupture and tensile strength at elevated temperatures.	0.290 (8.03)	75 (515)	30 (205)	30 (205)	95 Rb
	321	S32100	A stabilized stainless steel which offers an excellent resistance to intergranular corrosion following exposure to temperature in the chromium carbide precipitation range from 800-1500°F (430-820°C).	0.286 (7.92)	75 (515)	30 (205)	30 (205)	95 Rb
Nickel Alloys	Alloy 276	N10276	A nickel-molybdenum-chromium-iron-tunsten alloy which is among the most corrosion resistant of alloys currently available. Alloy 276 alloy is widely used in the severest environments.	0.321 (8.89)	120 (825)	60 (415)	55	90 Rb
	Alloy 400	N04400	A ductile nickel-copper alloy with resistance to a variety of corrosive conditions.	0.318 (8.80)	80 (550)	40 (275)	40	70 Rb
	Alloy 600	N06600	A non-precipitation hardenable, high-strength nickel-chromium alloy. Service temperatures up to 1000ºF.	0.306 (8.47)	95 (655)	45 (310)	40	80 Rb
	Alloy 625	N06625	An austenitic nickel-base superalloy possessing excellent resistance to oxidation and corrosion over a broad range of corrosive conditions. It has outstanding strength and toughness at temperatures ranging from cryogenic to high temperature.	0.305 (8.44)	135 (930)	70 (485)	45	95 Rb
	Alloy 718	N07718	A precipitation hardenable, high-temperature nickel alloy that combines excellent corrosion resistance, high-strength and weldability. Resistant to post-weld cracking. Service temperatures up to 1200ºF.	0.297 (8.23)	195 (1345) (Heat Treated)	170 (1170) (Heat Treated)	17 (Heat Treated)	43 Rc (Heat Treated)
	Alloy X-750	N07750	A precipitation hardenable, high-strength and high-temperature nickel alloy. Service temperatures up to 1100ºF.	0.299 (8.28)	175 (1207) (Heat Treated)	115 (793) (Heat Treated)	20 (Heat Treated)	35 Rc (Heat Treated)
	Waspaloy	N07001	A precipitation hardenable nickel alloy with excellent high-temperature strength. Service temperatures up to 1350ºF.	0296 (8.19)	80 (550)	40 (275)	40	70 Rb

	Grade	UNS Description	Description	Density lb/in³ (g/cm³)	Tensile Strength ksi (Mpa)	Yield Strength at 0.2% offset ksi (MPa)	Elongation %	Hardness
Other Materials	Nickel 201	N02201	Commercially pure wrought Nickel with similar properties to Alloy 200 but with a lower carbon content to prevent embrittlement by intergranular carbon at elevated temperatures.	0.321 (8.89)	58.6 (403)	14.9 (103)	50	75-100 HB
	Aluminum (Alloy 1100)	A91100	Commercially pure aluminum that contains a minimum of 99.0% aluminum. It has good formability and high resistance to corrosion.	0.098 (2.71)	13 (89.6)	5 (34.5)	45	23 HB
	Silver (99.99 pure)		Commercially pure silver is very ductile, malleable, and capable of a high degree of polish.	0.379 (10.491)	20.3 (140)			25 HV
	Titanium	R50400	Commercially pure Titanium Grade 2 is the most commonly used and widely available grade of unalloyed titanium. The grade combines excellent corrosion resistance and weldability with good strength, ductility and formability.	0.163 (4.51)	50 (340) Min.	40 (280) Min.	22	80 Rb
	Tantalum		Superior resistance to all acids except hydrofluoric and hot sulfuric. Good for most aqueous salt solutions.	0.6 (16.6)	40 (276)	25 (172)	50	35 Rb
	Copper	C11000	Good to excellent corrosion resistance. Excellent hot and cold workability.	0.323 (8.94)	33 (227)	11 (76)	41	72 Rb

Typical room temperature mechanical properties.

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Performance of Resilient Metal Seals

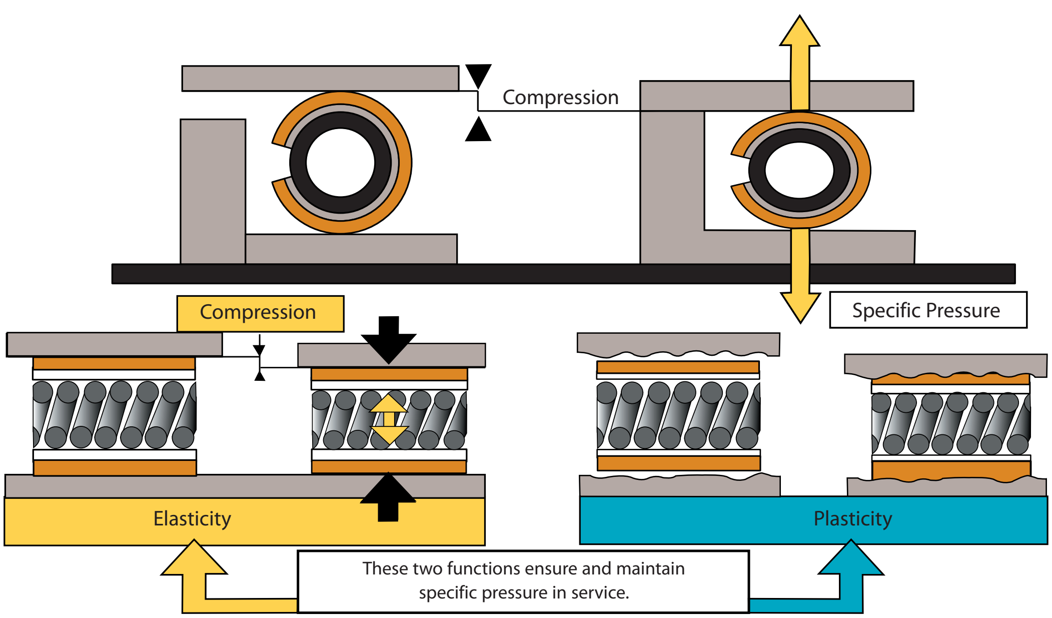
The performance of a resilient metal seal depends on two basic factors: elasticity and plasticity. The concept is similar to an elastomer seal such as Viton or Buna. The difference is that the elastomer compound serves both functions where a metal seal must use two components: a substrate and a soft outer layer.

Elasticity

Each seal has a resilient metal substrate in the form of a spring (Helicoflex®), tubing (O-Flex™), or formed strip (E-Flex™, C-Flex™). This substrate serves to provide a specific load that is used to deform a soft outer layer. The substrate also has a certain amount of spring back that helps maintain constant contact force during service. This spring back is not necessarily designed to compensate for axial or radial flange separation. Instead, it ensures that the seal maintains enough contact force to properly seal a static joint in service.

Plasticity

The soft outer layer is usually a plating/coating or a wrapped jacket. This outer layer is designed to plastically deform based on the specific load generated by the substrate. As the soft outer layer is deformed, it flows into the flange/groove imperfections and creates a seal. The tightness of the seal will depend on the amount of specific load, the ductility of the outer layer and the groove surface finish. An ideal groove/flange finish has machining marks that follow the circumference of the seal. Any radial marks or scratches may not be completely filled by the soft outer layer and could create a leak.



Bolted Joints

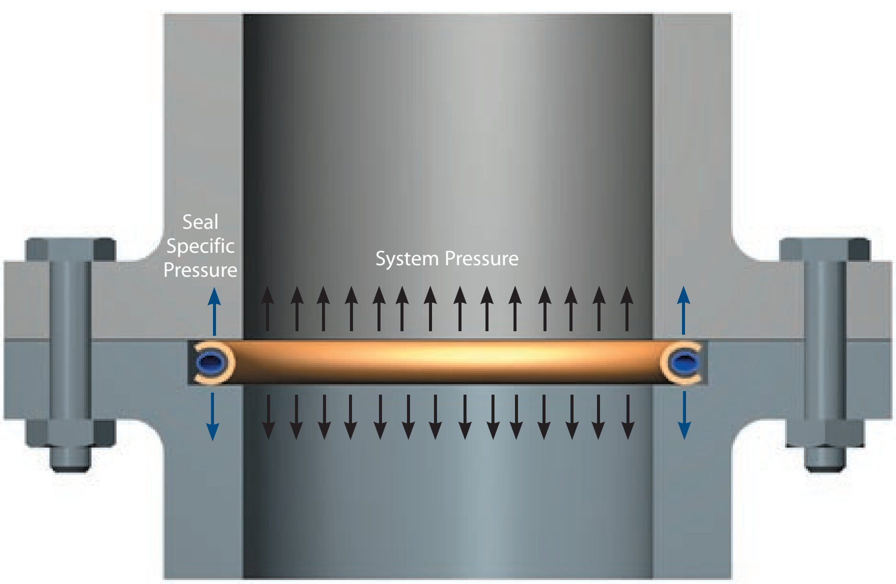
A bolted joint is an assembly that relies on each component to work properly. The performance and success of the bolted joint depends on the quality and design of each of these components. There are three major components of every bolted joint:

1. Flanges (Flange design / Groove dimensions & finish)
2. Bolts / Fasteners
3. Seal / Gasket

The above components cannot be designed mutually exclusive of each other. They must be considered together as a system during the design process. If any part of the bolted joint assembly does not perform properly, the joint as a whole will not perform to expectations and may leak.

Bolt Load and Tightening Torque

When using bolts to fasten the sealing joint the bolts must be of suitable strength and quantity to compress the seal and withstand the maximum hydrostatic load. Additionally, the bolts and flanges must be robust enough to prevent warpage, distortion or separation during service. All service factors must be considered such as thermal stresses, differential expansion, external loads and vibration.



Bolt Load Estimates

The following equations may be used to estimate required bolt loads.

NOTE: These estimates are offered as guidelines only. There are many other factors that the flange designer must consider such as: thermal cycling, vibration, cyclic fatigue, flange thickness, flange rotation, bolt stress relaxation, additional bolt preload, externally applied loads, etc. The customer is responsible for the flange design and for ensuring that the flanges, bolts and bolt loads are sufficient for the application. Please refer to Section VIII of the ASME Boiler and Pressure Vessel Code for code requirements.

Total Bolt Load ≥ Seal Seating Load + Hydrostatic Load + Safety Factor

Seal Seating Load

Total load required to compress the seal to optimal level. This information can be found for each seal type in the Performance Data sections of the catalog. It is referenced as Y_2 and is given in pounds per circumferential inch (PCI).

Seal Seating Load = Seal Diameter x π x Y_2

Hydrostatic Load

Load required to contain the system pressure.

Hydrostatic Load = Maximum system pressure x (π/4) x (Seal Diameter)^2

Safety Factor

This is a customer determined safety factor and must consider: system temperature effects, temperature cycling/spikes, pressure cycling/spikes, vibration, etc.

NOTE: A more detailed calculation is available for the Helicoflex spring energized seals. Please see the Helicoflex Seal product section.

Example Calculation

Seal:
O-Flex metal o-ring, Material = SS321
OD = 4.000in, CS = .125in, wall thickness = .020in
Y_2 = 1142 lbs/in

Operating Conditions:
Pressure: 500 psi, Temperature: 70 F

Seating Load = 4.000in x π x 1142lbs/in = 14351 lbs
Hydrostatic Load = 500 lbs/in^2 x (π/4) x (4.000in)^2 = 6283 lbs

Total Bolt Load Estimate ≥ 14351 lbs + 6283 lbs + customer safety factor

NOTE: each application should be reviewed to determine if additional bolt preload may be required for proper bolt stretch.

Tightening Torque and Bolt Tension

The following equation may be used to create a rough estimate of the required torque:

$$T = K \times P \times D$$

Where: T= tightening torque (in-lbs)
K*= dynamic coefficient of friction (i.e. minimum = .15 (dry-zinc plated))
P= total bolt load / number of bolts (lbf)
D= nominal bolt diameter (in)

(* Also referred to as the "nut factor" in some texts.)

It must be understood that every bolted joint is unique and the tightening torque should be determined for each application through experimentation. A properly tightened bolt is one that is stretched, thus acting like a very rigid spring pulling the mating surfaces together. As the bolt is tightened it begins to stretch and goes into a state of tension. There are many factors that affect how much tension occurs when a given amount of tightening torque is applied. These factors include bolt diameter, bolt grade (strength), and friction. Torque calculations can have significant errors based on these factors, especially friction. Best practice indicates that bolts should be properly lubricated and hardened washers used under the head and nut.

Where possible, it is recommended the fastener elongation, or stretch, be measured directly to ensure proper tension or preload, in the fastener.

NOTE: These estimates are offered as guidelines only. There are many other factors that the flange designer must consider such as: thermal cycling, vibration, cyclic fatigue, flange thickness, flange rotation, bolt stress relaxation, additional bolt preload, externally applied loads, etc. The customer is responsible for the flange design and for ensuring that the flanges, bolts and bolt loads are sufficient for the application. Please refer to Section VIII of the ASME Boiler and Pressure Vessel Code for code requirements.

Typical Bolt / Fastener Information

Size / Nominal Diameter	Nominal Diameter inches	Pitch (THD/IN)	Area at Root of Thread sq. in.	30000 PSI Stress		45000 PSI Stress		60000 PSI Stress	
				Fastener Preload lbs	Torque Req'd K= .15 lbs-in	Fastener Preload lbs	Torque Req'd K= .15 lbs-in	Fastener Preload lbs	Torque Req'd K= .15 lbs-in
#6	0.138	32	0.008	225	5	338	7	450	9
#8	0.164	32	0.012	360	9	540	13	720	18
#10	0.190	24	0.015	435	12	653	19	870	25
#12	0.226	24	0.021	618	21	927	31	1236	42
1/4"	0.250	20	0.027	807	30	1211	45	1614	61
5/16"	0.313	18	0.045	1362	64	2043	96	2724	128
3/8"	0.375	16	0.068	2034	114	3051	172	4068	229
7/16"	0.438	14	0.093	2799	184	4199	276	5598	367
1/2"	0.500	13	0.126	3771	283	5657	424	7542	566
9/16"	0.563	12	0.162	4860	410	7290	615	9720	820
5/8"	0.625	11	0.202	6060	568	9090	852	12120	1136
3/4"	0.750	10	0.302	9060	1019	13590	1529	18120	2039
7/8"	0.875	9	0.419	12570	1650	18855	2475	25140	3300
1"	1.000	8	0.551	16530	2480	24795	3719	33060	4959
1-1/8"	1.125	8	0.728	21840	3686	32760	5528	43680	7371
1-1/4"	1.250	8	0.929	27870	5226	41805	7838	55740	10451
1-3/8"	1.375	8	1.155	34650	7147	51975	10720	69300	14293
1-1/2"	1.500	8	1.405	42150	9484	63225	14226	84300	18968
1-3/4"	1.750	8	1.980	59400	15593	89100	23389	118800	31185
2"	2.000	8	2.652	79560	23868	119340	35802	159120	47736

NOTES:

1. For fasteners larger than one inch, it is often customary to use a thread pitch of 8 in place of UNC thread pitch.
2. Contact Applications Engineering for other sizes.
3. These values/estimates are offered as guidelines only. There are many other fators that the flange designer must consider such as: thermal cycling, vibration, cyclic fatigue, flange thickness, flange rotation, bolt stress relaxation, additional bolt preload, externally applied loads, etc. The customer is responsible for the flange design and for ensuring that the flanges, bolts and bolt loads are sufficient for the application. Please refer to Section VIII of the ASME Boiler and Pressure Vessel Code for code requirements.

Installation Procedures

Seal installation is as important to the performance of the bolted joint as the flange, bolt and seal design. Following these simple steps will help ensure a successful installation.

Preparation Verify the seal part number, required bolt loading and any special handling or installation instructions. Seals should remain in original protective packaging and preferably be stored in a controlled environment until time of installation. Finally, the packaging should be opened carefully to avoid scratching or damaging the seal. Be especially careful when using razor knives to open seal packaging or container.

Inspection Inspect the groove and flanges to make sure the seal track area is free of burrs, debris and any radial marks or scratches. If necessary, clean the groove carefully with acetone or alcohol using a lint free cloth. Any radial scratches must be removed by careful polishing (polishing marks must follow seal circumference). Deeper scratches may require re-cutting the groove and/or re-facing the flange. Additionally, the sealing surface of the seal should be inspected for scratches and carefully handled to avoid dings, dents and radial marks or scratches.

Seal installation Carefully, place the seal into the groove or onto the flange. Gently bring the mating flange into place taking care not to scratch or damage the seal during all steps of the process.

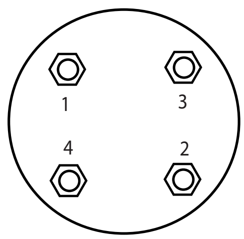
Note: Large seals (> 36") should be supported every three feet of circumference to prevent bending or crimping.

Bolts / Fasteners Bolts, bolt holes and nuts should be free of burrs, debris and galling. Bolts and nuts should be well lubricated with a process compatible lubricant. Hardened washers should be used when possible to further reduce friction. Note: for critical applications the installer may want to preload the bolts and release (without the seal) two or three times to "run in" the threads.

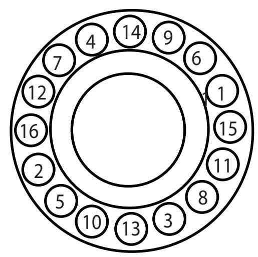
Bolt Tightening Bolts should be tightened using a star pattern (see diagram). Number the bolts with an indelible marker to make the process easier. First, tighten the nuts until "finger tight". Then, tighten bolts in one-third increments, according to the proper star bolting pattern. Make a final check pass at the final target torque value moving consecutively from bolt to bolt in a rotational order starting with bolt number one. It is recommended to re-torque 12-24 hours after initial installation, especially for high temperature applications.

Removing Used Seals Most metal seals are designed to make some light contact with the groove wall during compression and service. This helps to reinforce the seal against the system pressure. As a result, it may be difficult to remove the seal with finger force only, especially if the groove is very narrow. Ideally, a hard plastic pick can be used to remove the seal. For some seals, you may carefully drill a small hole in the top of the seal and use a small pick. In all cases, great care must be taken not to scratch the groove when using tools to remove the seal.

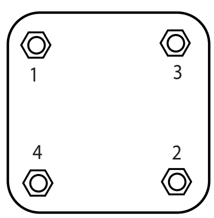
Correct Bolting Patterns



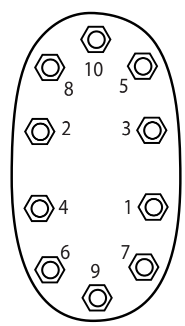
Circular Four-Bolt



Circular Multibolt



Square
Four Bolt



Noncircular
Multibolt

Jacket –vs- Plating/Coating

There are two types of soft outer layers that can be applied to metal seals to improve leakage performance. In both cases, the substrate must provide enough specific load to plastically deform the soft outer layer into the flange imperfections.

Wrapped Jacket The Helicoflex Spring Energized Seal has a soft outer jacket that consists of a metal strip that has been wrapped or formed around the spring. Typically it is much thicker than platings or coatings. For example, a Silver jacket is approximately .012" to .020" thick where Silver plating is approximately .001" to .002" thick.

There are two primary advantages of the wrapped jacket. First, there is greater flexibility in material choice since the jacket is not limited by available plating technology. The Helicoflex seal can be made with most metals available in strip or sheet form which helps match the seal material to temperature and corrosion requirements. Secondly, because the jacket is thicker, it typically performs better on rougher surface finishes. This is especially helpful for older vessels, such as aging nuclear reactor pressure vessels, where the grooves may have been polished or refinished.

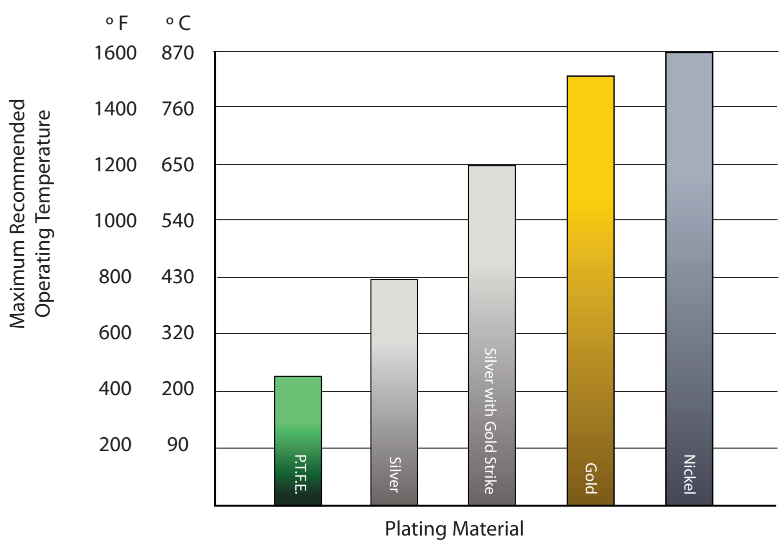
The Helicoflex seal spring is specifically designed for each jacket material to ensure plastic deformation is achieved.

Platings/Coatings Platings and coatings are applied directly to the seal substrate. Typically these treatments are very thin and are usually .001/.002" thick. Therefore, they require a smooth groove/flange finish for optimal performance. Platings such as Silver and Nickel are applied by an electroplating process while coatings such as PTFE are typically applied by a spray or dip process. It is more difficult to match materials to temperature and corrosion requirements because platings and coatings are limited in choice by available deposition technologies.

It is important to note that each plating material requires a minimum amount of specific load to plastically deform. Below are some guidelines for Silver plated non-spring energized seals.

Cross sections: 0.063 to 0.156 = minimum load of 400 lbs per inch of circumference.
Cross sections: 0.188 to 0.250 = minimum load of 800 lbs per inch of circumference.

Maximum Recommended Operating Temperatures for Platings and Coatings



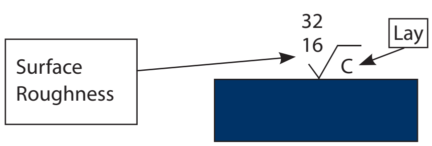
Contact Applications Engineering for additional platings and coatings.

Surface Finish

The leak rate of any joint is largely influenced by the condition of the surfaces in the joint. Leak paths are inherent in any sealing surface. Both the surface roughness of the seal and the surface roughness of the mating flange surfaces will affect sealing performance.

Surface roughness, also called surface texture or finish, is a trait of any surface. The design engineer usually specifies the required surface roughness of a flange sealing surface to ensure proper function of the flange in the joint.

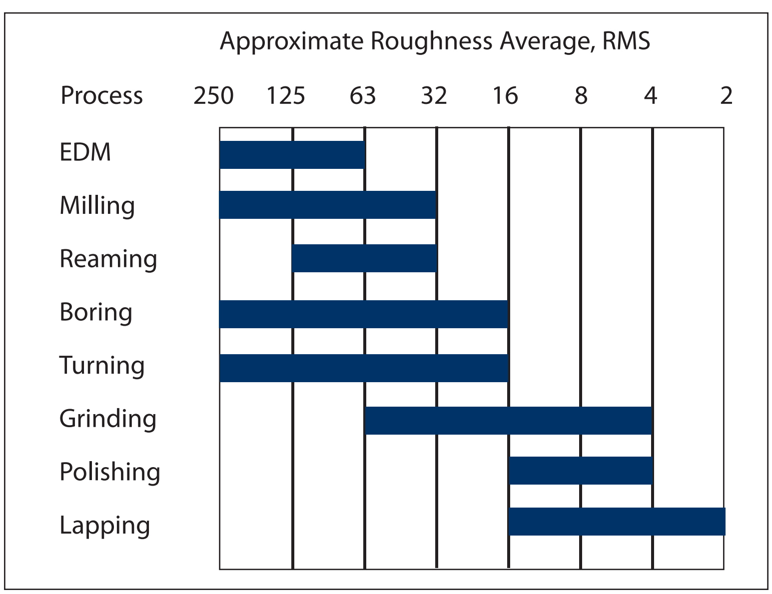
Surface roughness is usually specified with a "check mark" symbol on a drawing as shown in the figure below. Surface roughness is typically indicated in RMS or microinches (μin) and is located on the left side of the symbol above the check mark. In the example below the roughness value is 32 RMS maximum and 16 RMS minimum. If a single value is specified, this value is interpreted as a maximum value.



/ / parallel lay
⊥ perpendicular lay
C circular lay*
R radial lay
M multi-directional lay
X angular lay in both directions

* Most metal seal applications require a circular or circumferential lay

The directional lay of a finished surface refers to the direction of the machining or polishing marks. The lay of a sealing surface is specified under the surface roughness symbol as shown in the figure above.



Understanding Leakage

Leakage is the flow of a fluid through an orifice or permeation through a material and typically occurs as a result of a pressure differential. It is important to understand that all materials and mechanical joints permit some leakage over a period of time. This leakage may range from as much as several gallons or cubic feet per minute to as little as a bubble of air in several years.

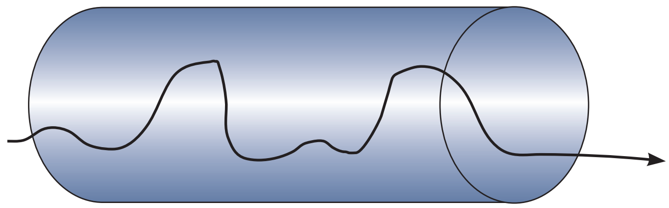
Helicoflex designs and manufactures a wide range of seals to satisfy a broad range of sealing requirements including leakage rate. Therefore, it is necessary to establish leakage rate criteria so that a suitable seal can be selected or designed. A specification that defines a "no leak" or "zero leakage" requirement is, in a technical sense, unrealistic and may lead to costly attempts at sealing. Leak tightness must be considered in relation to the medium being sealed, the normal operating conditions, and the sealing requirements regarding safety, contamination, and reliability.

Gas Flow

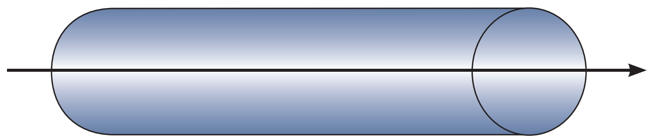
Gas flow is used in characterizing leakage and performing leakage testing. Even at very low pressures, gases behave and flow like fluids. Gas flow is categorized into different types of flow modes as follows:

Flow Mode	Flow Description	Leakage Rate (std cc/sec)
Turbulent Flow (Viscous Flow)	Flow through a passage that is typified as a large leak and at high pressure differentials. Leaks with turbulent flow are large and can be readily located and repaired.	Greater than 10^{-2}
Laminar Flow (Viscous Flow)	Flow in a passage that is typified by slow movement of fluid in a relatively straight path along the centerline of a passage.	10^{-1} to 10^{-6}
Transitional Flow	Flow that occurs between the laminar and molecular flow regimes.	10^{-4} to 10^{-7}
Molecular Flow	At molecular flow each molecule travels independently of other molecules. However, the general flow is in direction of the lower pressure.	Less than 10^{-7}

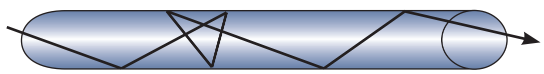
Note: Both turbulent flow and laminar flow are types of viscous flow.



Path of a molecule through a leak path in turbulent flow.



Path of a molecule through a leak path in laminar flow.



Path of a molecule through a leak path in molecular flow.

Viscosity: Why liquids and gases have different leakage rates

Viscosity is the internal friction of molecules of a liquid or gas and characterizes the resistance of a fluid to flow at a given temperature. High viscosity indicates a greater resistance to flow and low viscosity indicates a lesser resistance to flow. Therefore, fluids with a low viscosity have a higher probability of leaking or flowing at a higher rate.
Examples of typical fluid viscosities at room temperature (68°F, 20°C):

Fluid	Viscosity (in centipoises) at 68ºF, 20ºC
SAE 10 Grease	65
Water	0.95
Gasoline	0.6
Liquid Propane	0.11
Helium	0.019
Air	0.018
Hydrogen	0.009

From the above viscosity values it can be seen that at ambient temperature, water has a viscosity that is approximately 53 times greater than air. Therefore, at low pressure, the volume of water flow will be 53 times less than that of air.

Equivalent Leakage Rates

Std cc/sec*	mbar-l/sec	Torr Liters/sec	Time for one cc to Leak	Time for one bubble** to leak
10^{-1}	1.01×10^{-1}	7.6×10^{-2}	10 seconds	0.25 seconds
10^{-2}	1.01×10^{-2}	7.6×10^{-3}	100 seconds	2.5 seconds
10^{-3}	1.01×10^{-3}	7.6×10^{-4}	16.7 minutes	25 seconds
10^{-4}	1.01×10^{-4}	7.6×10^{-5}	2.8 hours	4 minutes
10^{-5}	1.01×10^{-5}	7.6×10^{-6}	28 hours	40 minutes
10^{-6}	1.01×10^{-6}	7.6×10^{-7}	11.5 days	7 hours
10^{-7}	1.01×10^{-7}	7.6×10^{-8}	3.8 months	3 days
10^{-8}	1.01×10^{-8}	7.6×10^{-9}	3.2 years	1 month
10^{-9}	1.01×10^{-9}	7.6×10^{-10}	32 years	9 months
10^{-10}	1.01×10^{-10}	7.6×10^{-11}	320 years	8 years
10^{-11}	1.01×10^{-11}	7.6×10^{-12}	3200 years	80 years

* Std cc/sec = One cubic centimeter of gas flow per second at 14.7 psi of pressure and a temperature of 77°F

** Bubble diameter is 3mm

Leak Legend	Approximate Leak Rates per meter of circumference	Actual leak rate in service will depend on the following:
Ultra-Helium	≤ 1×10^{-11} std.cc/sec He	**Seal Load:** Wall Thickness or Spring Load
Helium	≤ 1×10^{-9} std.cc/sec He	**Surface Finish:** Seal and Cavity
Bubble	≤ 1×10^{-4} std.cc/sec He	**Surface Treatment:** Coating/Plating/Jacket Material
Low Bubble	≤ 25 cc/sec @ 50 psig Nitrogen per inch of diameter	

Conversion of helium leakage rate to leakage rates of other gases

To Convert to Leakage Rate of:	Multiply Helium Leakage Rate by:	
	Laminar Flow	Molecular Flow
Argon	0.88	0.316
Air	1.08	0.374
Nitrogen	1.12	0.374
Water vapor	2.09	0.469
Hydrogen	2.23	1.410

Sources:

1. Leakage Testing Handbook, Prepared for Liquid Propulsion Section, Jet Propulsion Laboratory, National Aeronautics and Space Administration, Pasadena, California
2. Nondestructive Testing Handbook, Volume One, Leaktesting, American Society for Nondestructive Testing.
3. Leakage Testing Handbook, Revised Edition, July 1969, General Electric.
4. Fluid Flow in Small Passages, Mars Hablanian, J.W.Marr, Varian

Common Conversion Tables

Length

To Obtain / Multiply		Inch	micron	mm	cm	meter
inch	by	1	2.5400E+04	25.4000	2.5400	2.5400E-02
micron	by	3.9370E-05	1	1.0000E-03	1.0000E-04	1.000E-06
mm	by	3.9370E-02	1.0000E+03	1	1.0000E-01	1.000E-03
cm	by	3.9370E-01	1.0000E+04	10.0000	1	1.0000E-02
meter	by	39.3700	1.0000E+06	1.0000E+03	1.0000E+02	1

Pressure

To Obtain / Multiply		bar	pascal	Mpascal	torr	psi	inches mercury 0°C	inches water 4°C
bar	by	1	1.0000E+05	1.0000E-01	7.5006E+02	14.5040	29.5300	4.0146E+02
pascal	by	1.0000E-05	1	1.0000E-06	7.5006E-03	1.4504E-04	2.9530E-04	4.0146E-03
Mpascal	by	10.0000	1.0000E+06	1	7.5006E+03	1.4504E+02	2.9530E+02	4.0146E+03
torr	by	1.3332E-03	1.3332E+02	1.3332E-04	1	1.9337E-02	3.9370E-02	5.3524E-01
psi	by	6.8948E-02	6.8948E+03	6.8948E-03	51.7150	1	2.0360	27.6800
inches mercury 0°C	by	3.3863E-02	3.3863E+03	3.3863E-03	25.4000	4.9115E-01	1	13.5950
inches water 4°C	by	2.4909E-03	2.4909E+02	2.4909E-04	1.8683	3.6127E-02	7.3556E-02	1

Vacuum Leak Rate

To Obtain / Multiply		$torr.l.s^{-1}$	$atm.cm^3.s^{-1}$	$mbar.l.s^{-1}$	$Pa.m^3.s^{-1}$
$torr.l.s^{-1}$	by	1	1.316	1.333	1.333E-01
$atm.cm^3.s^{-1}$	by	7.600E-01	1	1.013	1.013E-01
$mbar.l.s^{-1}$	by	7.501E-01	9.862E-01	1	1.000E-01
$Pa.m^3.s^{-1}$	by	7.501	9.869	10.000	1

Mass

To Obtain / Multiply		Kgf	N	lbf
Kgf	by	1	9.8067	2.2046
N	by	1.0197E-01	1	2.2481E-01
lbf	by	4.5359E-01	4.4482	1

Torque

To Obtain / Multiply		lb.in	Kg.m	N.m
lb.in	by	1	1.1521E-02	1.1298E-01
Kg.m	by	86.7962	1	9.8067
N.m	by	8.8507	1.0197E-01	1

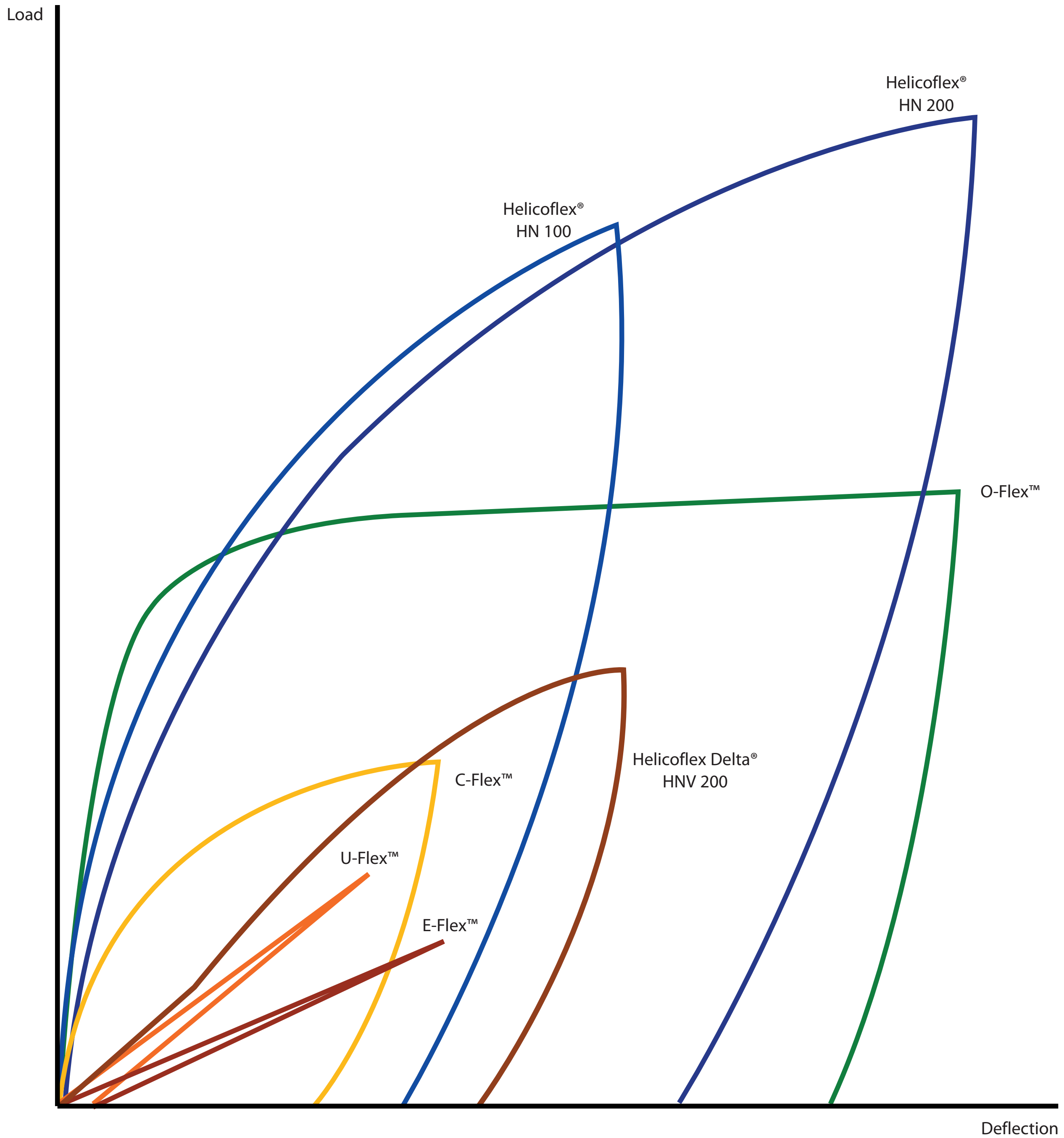
Units of Load/Unit Length

Multiply	by	To Obtain
$N.mm^{-1}$	5.71	$lb.in^{-1}$
$lb.in^{-1}$	1.75E-01	$N.mm^{-1}$

Temperature

Fahrenheit	F° = (9/5)C+32
Celsius	C° = 5/9 (F-32)
Kelvin	K = C+273

NOTE: The technical data contained herein is by way of example and should not be relied on for any specific application.


Load
Helicoflex®
HN 200
Helicoflex®
HN 100
O-Flex™
C-Flex™
Helicoflex Delta®
HNV 200
U-Flex™
E-Flex™
Deflection

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