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

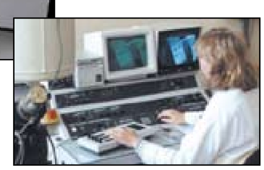
- 3D models of parts and assemblies produced in SolidWorks

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 27.6 MPa
- Thermal cycling from -70 to 200ºC
- Seal characterization at temperatures up to 1200ºC
- 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.

USA

Garlock Helicoflex

2770 The Boulevard
Columbia, SC 29209 USA

Email: sales@helicoflex.com
Web Site: www.helicoflex.com

Tel: (803) 783.1880
Toll Free: 800-233-1722
Fax: (803) 783.4279

Nuclear Power Plant
Emergency Response Contact
(803) 695-3553 (U.S.A.)

EUROPE

Garlock (Great Britain) Limited

Premier Way
Lowfields Business Park
Elland, West Yorkshire HX5 9HF
United Kingdom

Email: enquiries@garlockgb.co.uk
Email: sales@garlockgb.co.uk
Web Site: www.garlock.eu.com

Tel: 44 (14 2) 231.3600
Fax: 44 (14 2) 231.3601

Garlock France SAS

90, rue de la Roche du Geai
F-42029 Saint Etienne Cedex 1, France

Email: garlockfrance@garlock.com
Web Site: www.garlock.eu.com

Tel: 33 (4) 7743.5100
Fax: 33 (4) 7743.5151

Garlock GmbH Sealing Technologies Division

Falkenweg 1
41468 Neuss, Germany

Email: garlockgmbh@garlock.com
Web Site: www.garlock.eu.com

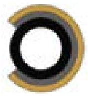
Tel: (49) 2131.3490
Fax: (49) 2131.349.222

ASIA

Garlock Valqua

Shinjyuku-Daiichiseimei
Building 15 F, 7-1
Nishishinjyuku 2-Chome
Shinjyuku-ku Tokyo, Japan

Phone: 03-3344-5835
Fax: 03-3344-5065

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	Actual leak rate in service will depend on the following:
Ultra-Helium	≤ 1 x 10^{-11} std.cc/sec He	**Seal Load:** Wall Thickness or Spring Load
Helium	≤ 1 x 10^{-9} std.cc/sec He	**Surface Finish:** Seal and Cavity
Bubble	≤ 1 x 10^{-4} std.cc/sec He	**Surface Treatment:** Coating/Plating/Jacket Material
Low Bubble	≤ 25 cc/sec @ 0.345 MPa Nitrogen per 25.4 mm of diameter	

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™	

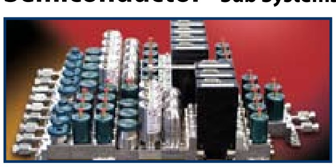
Oil & Gas - Refining & Downstream Factories

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



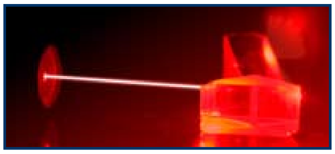
Gas Delivery System	Machined Seal*	
Mass Flow Controllers	Machined Seal*	DELTA®
Valve Manifold Box (VMB)	Machined Seal*	
Gas Isolation Box (GIB)	Machined Seal*	
Turbo Pumps	DELTA®	

* 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™	

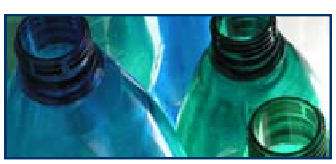
Power Gen: Land Based Turbines

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™		

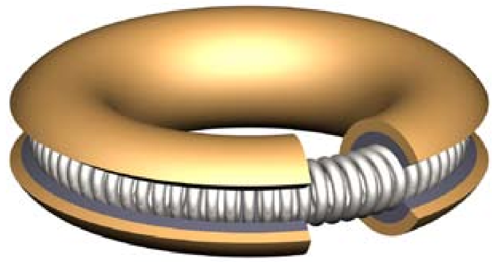
Plastic Injection Molding



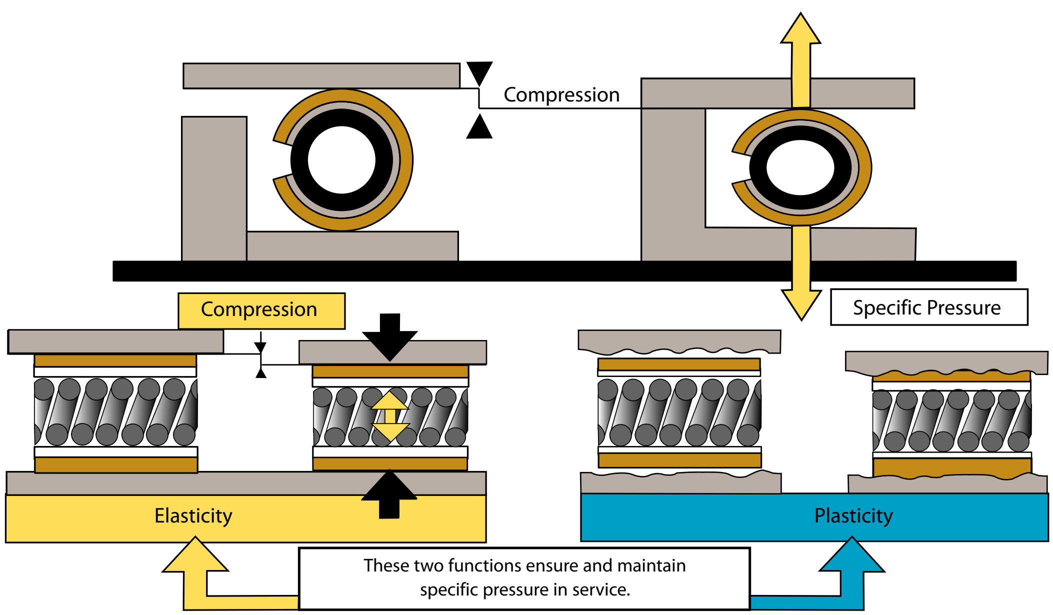
Hot Runner Components	HELICOFLEX®	O-FLEX™	C-FLEX™
Manifold Plates	HELICOFLEX®	O-FLEX™	C-FLEX™
Extruder Plates	HELICOFLEX®	O-FLEX™	C-FLEX™
Filter Packs	HELICOFLEX®	O-FLEX™	C-FLEX™
Spinnerrettes	HELICOFLEX®	O-FLEX™	C-FLEX™
Screen Changers	HELICOFLEX®	O-FLEX™	C-FLEX™
Instrumentation Ports	HELICOFLEX®	O-FLEX™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

* See Custom Seals Section

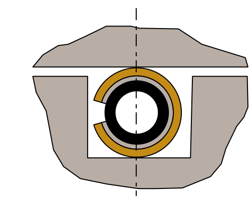
Sealing Concept



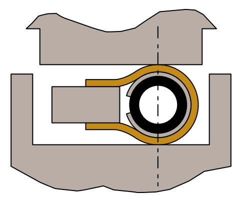
The sealing principle of the Helicoflex® family of seals is based upon the plastic deformation of a jacket of greater ductility than the flange materials. This occurs between the sealing face of a flange and an elastic core composed of a close-wound helical spring. The spring is selected to have a specific 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.



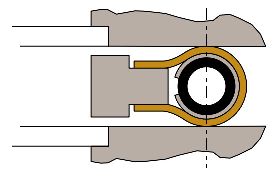
Typical Configurations



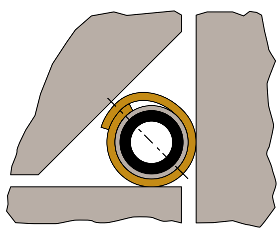
HN200
Groove Assembly



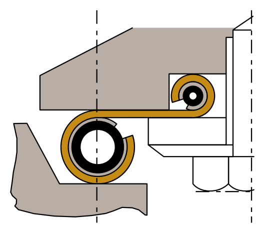
HN203
Tongue & Groove



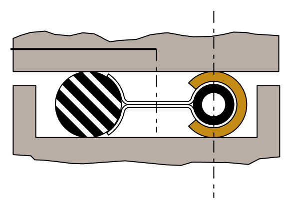
HN208
Raised face flange -
ANSI B16.5



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

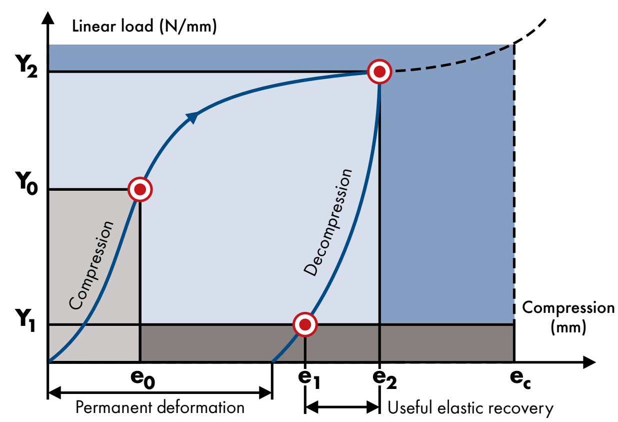
Characteristic Curve

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.

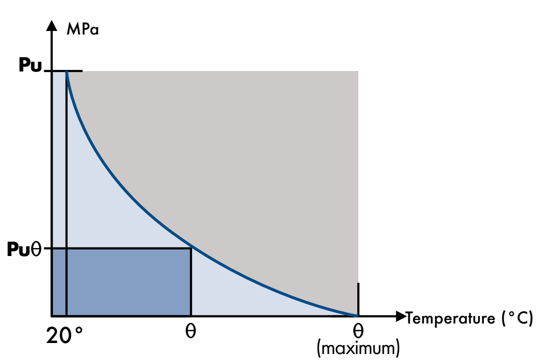
Definition of Terms

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.



HELICOFLEX®
Spring Energized Seals

Dimensions in mm

	HELIUM SEALING							BUBBLE SEALING				
Jacket Material	Cross Section	e_2	e_C	Y_2 N/mm	Y_1 N/mm	Pu20°C MPa	PuΘ200°C MPa	Y_2 N/mm	Y_1 N/mm	Pu20°C MPa	PuΘ200°C MPa	Max Temp °C
Aluminum	1.60	0.60	0.70	150	20	50	n/a	90	20	35	n/a	150
	1.90	0.70	0.85	160	20	52	n/a	100	20	40	n/a	150
	2.20	0.70	0.90	165	20	53	n/a	105	20	40	n/a	180
	2.50	0.70	0.90	175	20	55	5	115	20	42	5	220
	3.00	0.80	1.00	185	25	55	10	130	20	45	10	250
	3.50	0.80	1.00	190	25	55	14	140	20	47	14	250
	4.00	0.90	1.10	200	25	60	17	150	20	50	17	280
	4.50	0.90	1.20	210	25	60	20	160	20	52	20	280
	5.00	0.90	1.40	220	30	63	22	170	25	55	22	300
	5.50	0.90	1.60	230	30	65	24	180	25	57	24	320
	6.00	1.00	1.80	245	35	67	25	195	30	60	25	340
	7.00	1.00	2.20	270	40	70	28	205	35	65	28	340
	8.00	1.00	2.60	290	50	72	32	225	40	68	31	360
							PuΘ250°C				PuΘ250°C	
Silver	1.60	0.50	0.60	200	30	65	n/a	150	30	40	n/a	240
	1.90	0.60	0.70	220	30	65	n/a	150	30	40	n/a	240
	2.20	0.60	0.80	230	35	70	n/a	160	30	40	4	280
	2.50	0.70	0.90	240	45	75	8	170	40	45	5	280
	3.00	0.80	1.00	260	50	85	14	180	45	50	9	300
	3.50	0.80	1.00	280	50	95	22	190	45	55	13	300
	4.00	0.80	1.10	300	55	105	27	200	50	60	16	350
	4.50	0.80	1.10	320	60	115	31	220	50	70	19	370
	5.00	0.80	1.30	340	60	125	36	230	50	80	22	370
	5.50	0.80	1.40	360	65	135	40	250	60	90	25	400
	6.00	0.90	1.70	400	70	150	47	270	60	110	30	450
	7.00	0.90	2.00	440	80	160	54	300	65	125	36	450
	8.00	0.90	2.40	490	90	170	60	350	70	140	42	500
							PuΘ300°C				PuΘ300°C	
Copper, Soft Iron, Mild Steels and Annealed Nickel	1.60	0.50	0.60	260	40	50	10	190	30	35	5	350
	1.90	0.60	0.70	280	50	50	11	200	40	35	6	350
	2.20	0.60	0.80	300	60	55	13	220	50	35	8	360
	2.50	0.70	0.90	320	70	60	17	230	60	40	10	380
	3.00	0.70	1.00	350	80	65	20	250	70	40	12	380
	3.50	0.70	1.00	390	80	70	23	270	70	45	15	400
	4.00	0.80	1.10	430	90	70	27	290	80	45	17	420
	4.50	0.80	1.10	470	100	80	30	320	80	45	19	450
	5.00	0.80	1.30	510	110	85	33	330	90	50	21	450
	5.50	0.80	1.40	550	120	90	36	360	100	50	23	480
	6.00	0.90	1.70	630	140	95	40	400	100	55	26	520
	7.00	0.90	2.00	740	160	100	45	460	110	60	29	520
	8.00	0.90	2.40	860	190	110	49	530	130	65	32	550
							PuΘ350°C				PuΘ350°C	
Nickel, Monel, Tantalum	1.60	0.40	0.50	320	80	70	11	200	60	40	7	380
	1.90	0.50	0.60	350	80	72	16	220	60	42	9	380
	2.20	0.50	0.70	390	90	76	21	230	70	44	12	420
	2.50	0.60	0.80	440	100	82	27	270	70	47	16	450
	3.00	0.60	0.90	440	110	87	34	300	80	50	20	480
	3.50	0.60	0.90	490	120	93	40	340	90	54	23	500
	4.00	0.70	1.00	580	140	96	45	380	100	57	27	550
	4.50	0.70	1.00	720	150	105	52	420	110	60	30	600
	5.00	0.70	1.00	780	180	110	57	460	110	65	33	650
	5.50	0.70	1.30	810	200	115	62	500	120	67	37	650
	6.00	0.80	1.60	n/a	n/a	n/a	n/a	560	130	72	41	650
	7.00	0.80	1.80	n/a	n/a	n/a	n/a	650	150	78	45	650
	8.00	0.80	2.10	n/a	n/a	n/a	n/a	730	160	83	50	650
							PuΘ400°C				PuΘ400°C	
Stainless Steel, Inconel, Titanium	1.60	0.40	0.50	350	100	90	25	300	80	47	6	420
	1.90	0.50	0.60	400	100	91	27	320	80	50	8	420
	2.20	0.50	0.70	450	110	92	29	350	90	52	11	480
	2.50	0.60	0.80	500	120	97	32	380	100	57	15	500
	3.00	0.60	0.90	575	130	100	36	425	110	62	20	500
	3.50	0.60	0.90	660	150	104	39	470	130	67	25	550
	4.00	0.70	1.00	750	170	107	42	520	150	72	30	600
	4.50	0.70	1.00	825	220	110	45	560	180	77	34	650
	5.00	0.70	1.10	n/a	n/a	n/a	n/a	600	190	82	37	700
	5.50	0.70	1.30	n/a	n/a	n/a	n/a	650	200	87	42	700
	6.00	0.80	1.60	n/a	n/a	n/a	n/a	720	220	94	47	700
	7.00	0.80	1.80	n/a	n/a	n/a	n/a	800	260	102	52	700
	8.00	0.80	2.10	n/a	n/a	n/a	n/a	900	290	108	58	700

Definition of Characteristic Values

Dj	Mean reaction diameter of the seal. (For a double section seal, $Dj = Dj_1 + Dj_2$)	________	mm
$\mathbf{Y_2}$	Linear load corresponding to e_2 compression	________	N/mm
$\mathbf{Y_1}$	Linear load on the seal to maintain sealing in service at low pressure (=Ym1)	________	N/mm
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.	________	MPa
$\mathbf{Pu_\Theta}$	Value of Pu at temperature Θ	________	MPa
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	________	MPa
$\mathbf{Y_{m2}}$	Linear tightening load on the seal at room temperature to maintain sealing under pressure. $Y_{m2} = Y_2 \frac{P}{Pu}$	________	N/mm
$\mathbf{Y_{m2\Theta}}$	Value of Y_{m2} at temperature Θ. $Y_{m2\Theta} = Y_2 \frac{P}{Pu\Theta}$	________	N/mm
Et	Young's modulus of bolt material at 68°F (20°C)	________	MPa
$\mathbf{Et_s}$	Young's modulus of bolt material at operating temperature	________	MPa

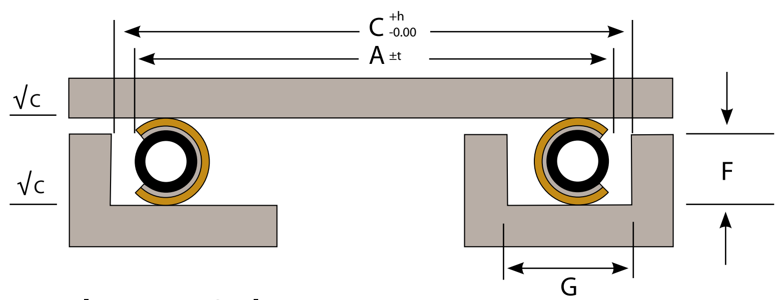
Load Calculations

Fj	Total tightening load to compress the seal to the operating point (Y_2; e_2) $Fj = \pi \times Dj \times Y_2$	________	N
$\mathbf{F_F}$	Total hydrostatic end force $F_F = \pi/4\, Dj_1^2 \times P$ ($Dj_1 = Dj$ in case of a single section seal)	________	N
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)	________	N
Fs	Total load to be applied on the bolts to maintain sealing in service $Fs = F_F + F_m$	________	N
Fs*	Increased value of Fs to compensate for Young's modulus at temperature $Fs^* = Fs\ Et / Et_s$	________	N
$\mathbf{F_B}$	LOAD TO BE APPLIED: If Fs* > Fj then Fb = Fs* If Fj > Fs* then Fb = Fj	________	N

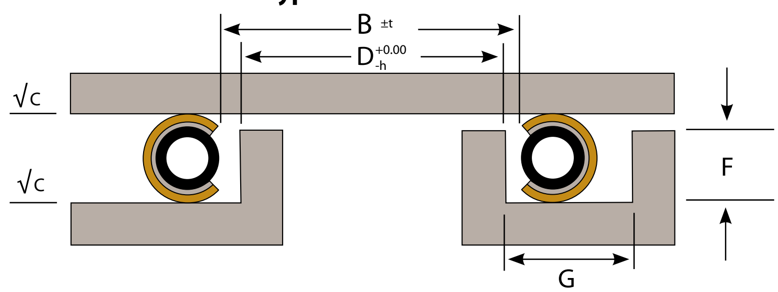
Note 1: wherever the working pressure is high and/or seal diameter is big, to such an extent that $P \cdot Dj \geq 32\, Y_m$, in order to remain on the safe side, whatever the inaccuracy on the tightening load may be, it is recommended to take the Fj value in lieu of F_m for the calculation of Fs so 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
8.90 to 50.80	0.13	0.13	0.10	0.10
50.81 to 304.80	0.25	0.25	0.10	0.10
304.81 to 635.00	0.25	0.25	0.15	0.15
635.01 to 1220.00	0.38	0.38	0.20	0.20
1220.01 to 1830.00	0.51	0.38	0.25	0.20
>1830.00	Contact Applications Engineering			

Flatness

Seal Diameter Range	Amplitude	Tangential Slope	Radial Slope
10 to 500	0.20	1:1000	1:100
501 to 2000	0.40	2:1000	2:100

Dimensions in mm

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).

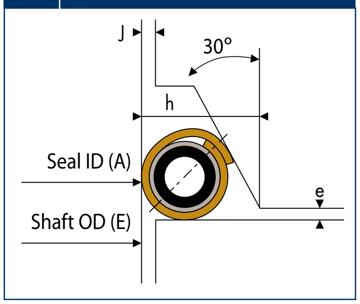
Seating Load: The load (Y2) to seat the seal is approximately 30% higher due to a slightly stiffer spring design.

Dimensions in mm

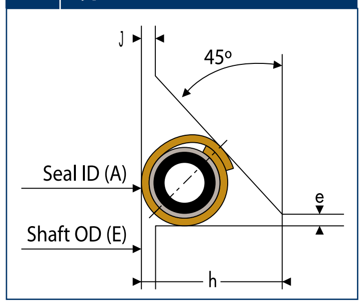
	SEAL			GROOVE				
				Pressure < 20 bar	Pressure ≥ 20 bar			
Jacket Material	Free Height	Installation Compression e2	Seal Diameter Range	Diametrical Clearance X	Diametrical Clearance X	Groove Depth F	Groove Width (Min.) G	Groove Finish Ra µm
	1.60	0.60	12.70 to 101.60	0.60	0.30	1.00 ± 0.07	2.82	
	1.90	0.70	15.88 to 152.40	0.70	0.30	1.20 ± 0.09	3.33	
	2.20	0.70	19.05 to 254.00	0.70	0.30	1.50 ± 0.09	3.63	0.8 - 3.2
	2.50	0.70	22.23 to 381.00	0.70	0.30	1.80 ± 0.09	3.91	
	3.00	0.80	25.40 to 508.00	0.80	0.30	2.20 ± 0.09	4.57	Contact
Aluminum	3.50	0.80	31.75 to 635.00	0.80	0.50	2.70 ± 0.09	5.08	Applications
	4.00	0.90	44.45 to 762.00	0.90	0.50	3.10 ± 0.11	5.77	Engineering
	4.50	0.90	50.80 to 1016.00	0.90	0.50	3.60 ± 0.11	6.27	for
	5.00	0.90	76.20 to 1270.00	0.90	0.50	4.10 ± 0.11	6.78	Recommendation
	5.50	0.90	101.60 to 1270.00 +	0.90	0.50	4.60 ± 0.11	7.29	
	6.00	1.00	127.00 to 1270.00 +	1.00	0.50	5.00 ± 0.12	7.98	
	7.00	1.00	152.40 to 1270.00 +	1.00	0.70	6.00 ± 0.12	8.99	
	8.00	1.00	203.20 to 1270.00 +	1.00	0.70	7.00 ± 0.12	9.98	
	1.60	0.50	12.70 to 101.60	0.50	0.30	1.10 ± 0.06	2.62	
	1.90	0.60	15.88 to 152.40	0.60	0.30	1.30 ± 0.07	3.12	
	2.20	0.60	19.05 to 254.00	0.60	0.30	1.60 ± 0.07	3.43	1.6 - 3.2
	2.50	0.70	22.23 to 381.00	0.70	0.30	1.80 ± 0.09	3.91	
	3.00	0.80	25.40 to 508.00	0.80	0.30	2.20 ± 0.09	4.57	Contact
	3.50	0.80	31.75 to 635.00	0.80	0.50	2.70 ± 0.09	5.08	Applications
Silver	4.00	0.80	44.45 to 762.00	0.80	0.50	3.20 ± 0.09	5.56	Engineering
	4.50	0.80	50.80 to 1016.00	0.80	0.50	3.70 ± 0.09	6.07	for
	5.00	0.80	76.20 to 1270.00	0.80	0.50	4.20 ± 0.09	6.58	Recommendation
	5.50	0.80	101.60 to 1270.00 +	0.80	0.50	4.70 ± 0.09	7.09	
	6.00	0.90	127.00 to 1270.00 +	0.90	0.50	5.10 ± 0.11	7.77	
	7.00	0.90	152.40 to 1270.00 +	0.90	0.70	6.10 ± 0.11	8.79	
	8.00	0.90	203.20 to 1270.00 +	0.90	0.70	7.10 ± 011	9.78	
	1.60	0.50	12.70 to 101.60	0.50	0.30	1.10 ± 0.06	2.62	
	1.90	0.60	15.88 to 152.40	0.60	0.30	1.30 ± 0.07	3.12	
	2.20	0.60	19.05 to 254.00	0.60	0.30	1.60 ± 0.07	3.43	1.6 - 3.2
	2.50	0.70	22.23 to 381.00	0.70	0.30	1.80 ± 0.09	3.91	
	3.00	0.70	25.40 to 508.00	0.70	0.30	2.30 ± 0.09	4.42	Contact
	3.50	0.70	31.75 to 635.00	0.70	0.50	2.80 ± 0.09	4.93	Applications
Copper, Soft Iron, Mild Steels and Annealed Nickel	4.00	0.80	44.45 to 762.00	0.80	0.50	3.20 ± 0.09	5.56	Engineering
	4.50	0.80	50.80 to 1016.00	0.80	0.50	3.70 ± 0.09	6.07	for
	5.00	0.80	76.20 to 1270.00	0.80	0.50	4.20 ± 0.09	6.58	Recommendation
	5.50	0.80	101.60 to 1270.00 +	0.80	0.50	4.70 ± 0.09	7.09	
	6.00	0.90	127.00 to 1270.00 +	0.90	0.50	5.10 ± 0.11	7.77	
	7.00	0.90	152.40 to 1270.00 +	0.90	0.70	6.10 ± 0.11	8.79	
	8.00	0.90	203.20 to 1270.00 +	0.90	0.70	7.10 ± 0.11	9.78	
	1.60	0.40	12.70 to 101.60	0.40	0.30	1.20 ± 0.05	2.41	
	1.90	0.50	15.88 to 152.40	0.50	0.30	1.40 ± 0.06	2.92	
	2.20	0.50	19.05 to 254.00	0.50	0.30	1.70 ± 0.06	3.23	0.8 - 1.6
	2.50	0.60	22.23 to 381.00	0.60	0.30	1.90 ± 0.07	3.71	
	3.00	0.60	25.40 to 508.00	0.60	0.30	2.40 ± 0.07	4.22	Contact
Nickel, Monel, Tantalum	3.50	0.60	31.75 to 635.00	0.60	0.50	2.90 ± 0.07	4.72	Applications
	4.00	0.70	44.45 to 762.00	0.70	0.50	3.30 ± 0.09	5.41	Engineering
	4.50	0.70	50.80 to 1016.00	0.70	0.50	3.80 ± 0.09	5.92	for
	5.00	0.70	76.20 to 1270.00	0.70	0.50	4.30 ± 0.09	6.43	Recommendation
	5.50	0.70	101.60 to 1270.00 +	0.70	0.50	4.80 ± 0.09	6.93	
	6.00	0.80	127.00 to 1270.00 +	0.80	0.50	5.20 ± 0.09	7.57	
	7.00	0.80	152.40 to 1270.00 +	0.80	0.70	6.20 ± 0.09	8.59	
	8.00	0.80	203.20 to 1270.00 +	0.80	0.70	7.20 ± 0.09	9.58	
	1.60	0.40	12.70 to 101.60	0.40	0.30	1.20 ± 0.05	2.41	
	1.90	0.50	15.88 to 152.40	0.50	0.30	1.40 ± 0.06	2.92	
	2.20	0.50	19.05 to 254.00	0.50	0.30	1.70 ± 0.06	3.23	
	2.50	0.60	22.23 to 381.00	0.60	0.30	1.90 ± 0.07	3.71	0.8 - 1.6
	3.00	0.60	25..40 to 508.00	0.60	0.30	2.40 ± 0.07	4.22	
Stainless Steel, Inconel, Titanium	3.50	0.60	31.75 to 635.00	0.60	0.50	2.90 ± 0.07	4.72	Contact
	4.00	0.70	44.45 to 762.00	0.70	0.50	3.30 ± 0.09	5.41	Applications
	4.50	0.70	50.80 to 1016.00	0.70	0.50	3.80 ± 0.09	5.92	Engineering
	5.00	0.70	76.20 to 1270.00	0.70	0.50	4.30 ± 0.09	6.43	for
	5.50	0.70	101.60 to 1270.00 +	0.70	0.50	4.80 ± 0.09	6.93	Recommendation
	6.00	0.80	127.00 to 1270.00 +	0.80	0.50	5.20 ± 0.09	7.57	
	7.00	0.80	152.40 to 1270.00 +	0.80	0.70	6.20 ± 0.09	8.59	
	8.00	0.80	203.20 to 1270.00 +	0.80	0.70	7.20 ± 0.09	9.58	

Three Face Compression

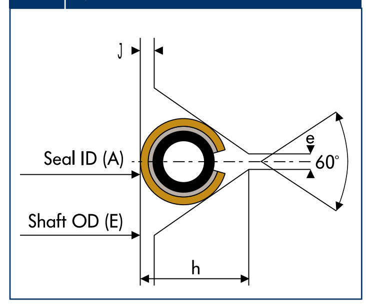
30° | Type HN140-240



45° | Type HN140-240



60° | Type HN100-200

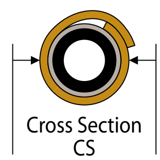


$$E = \text{Shaft OD}\ {}^{+0.00}_{-0.05} \qquad A = \text{Seal ID}\ {}^{+0.05}_{-0.00}$$

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	< 0.8 Ra µm

COEFFICIENT VALUES

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



"h" Values

Seal Cross Section CS	30°		45°		60°	
	Aluminum Jacket	Other Jackets	Aluminum Jacket	Other Jackets	Aluminum Jacket	Other Jackets
2.60	3.30	3.20	4.15	4.00	3.20	3.40
3.20	4.00	4.00	5.05	5.05	4.00	4.20
4.20	5.25	5.25	6.60	6.60	5.40	5.60
5.20	6.60	6.60	8.30	8.30	6.90	7.10
6.40	8.15	8.15	10.20	10.20	8.60	8.80

Dimensions in mm

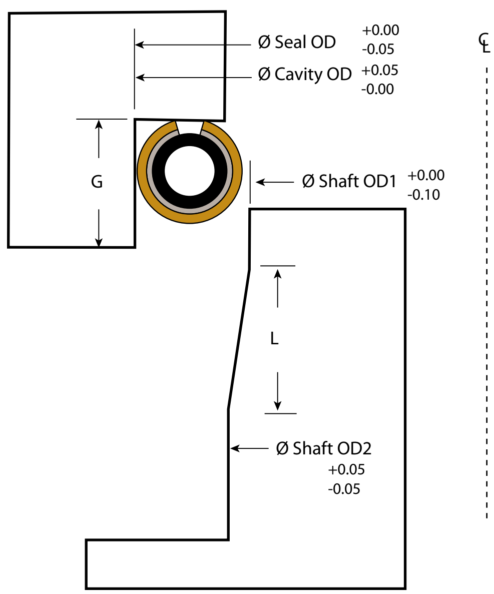
Target Sealing Criteria

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.

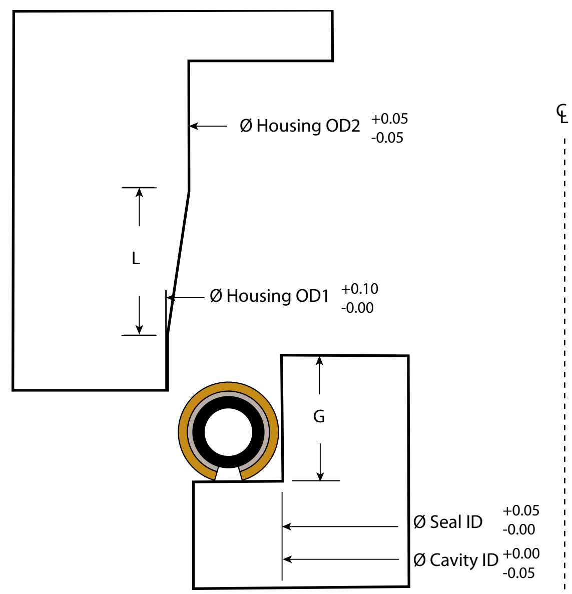
Helium Sealing: These Helicoflex seals are designed with a target Helium leak rate not to exceed 1×10^{-9} cc/sec. atm under a ΔP of 1 atmosphere. The ultimate leak rate will depend on the factors listed above.

Bubble Sealing: These Helicoflex seals are designed with a target air leak rate not to exceed 1×10^{-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 N/mm	Cross Section CS	e_3	Ya N/mm	Cross Section CS	e_3	Ya N/mm	Cross Section CS	e_3	Ya N/mm
1.60	0.30	19	1.60	0.25	30	1.70	0.20	38	1.60	0.20	40
2.60	0.35	24	2.60	0.30	34	2.34	0.25	44	2.60	0.25	54
3.00	0.40	27	3.10	0.35	36	3.24	0.30	50	3.20	0.30	60
4.00	0.50	32	4.20	0.45	40	4.34	0.40	58	4.20	0.40	76
5.08	0.50	36	5.20	0.45	46	5.34	0.40	66	5.20	0.40	92
6.60	0.60	41	6.20	0.50	54	6.34	0.45	80	6.40	0.45	112

Dimensions in mm

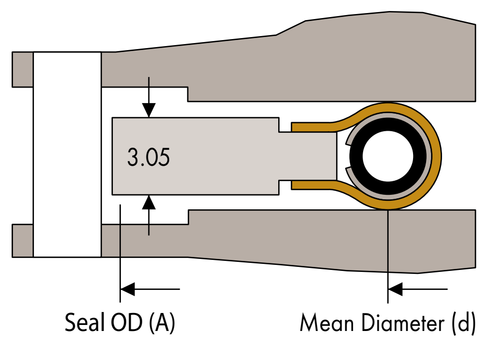
CALCULATIONS		
	Internal Compression	External Compression
G min = CS + e_3 + 0.20	Seal OD = Cavity OD	Seal ID = Cavity ID
L min = 10 x e_3	Seal ID = Seal OD - 2 CS	Seal OD = Seal ID + 2 CS
Cavity Finish: ≤ 0.8 Ra μm	Shaft OD1 ≤ Seal ID	Housing OD1 ≥ Seal OD
Ya = Axial Seating Load	Shaft OD2 = Seal ID + 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 (mm)	Seating Load (N/mm)*	Recommended Flange Finish (RMS)
Aluminum	Standard	4.06	201	1.6 - 3.2
Silver	Standard	4.06	302	1.6 - 3.2
Copper	Standard	3.94	394	1.6 - 3.2
Soft Iron	Optional	3.94	394	0.8 - 1.6
Nickel	Standard	3.81	490	0.8 - 1.6
Monel	Optional	3.81	490	0.8 - 1.6
Hastelloy C	Optional	3.81	665	0.8 - 1.6
Stainless Steel	Standard	3.81	665	0.8 - 1.6
Alloy 600	Optional	3.81	665	0.8 - 1.6
Alloy X750	Optional	3.81	701	0.8 - 1.6
Titanium	Optional	3.81	701	0.8 - 1.6



Dimensions in mm

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

SEAL DIMENSIONS								
Nominal Diameter (Inches)	Mean Diameter (d)	Seal OD (A)						
		150lb	300lb	400lb	600lb	900lb	1500lb	2500lb
1/2	21.00	47.60	54.00	54.00	54.00	63.50	63.50	69.90
3/4	28.00	57.20	66.70	66.70	66.70	69.90	69.90	76.20
1	36.00	66.70	73.00	73.00	73.00	79.30	79.30	85.70
1-1/4	48.00	76.20	82.60	82.60	82.60	88.90	88.90	104.80
1-1/2	58.00	85.70	95.30	95.30	95.30	98.40	98.40	117.50
2	74.00	104.80	111.10	111.10	111.10	142.90	142.90	146.10
2-1/2	87.00	123.80	130.20	130.20	130.20	165.10	165.10	168.30
3	106.00	136.50	149.20	149.20	149.20	168.30	174.60	196.90
3-1/2	119.00	161.90	165.10	165.10	161.90	N/A	N/A	N/A
4	133.50	174.60	181.00	177.80	193.70	206.40	209.60	235.00
5	162.00	196.90	215.90	212.70	241.30	247.70	254.00	279.40
6	190.50	222.30	250.80	247.70	266.70	289.89	282.60	317.50
8	243.00	279.30	308.00	304.80	320.70	358.80	352.40	387.40
10	297.00	339.70	362.00	358.80	400.10	435.00	435.00	476.50
12	352.00	409.60	422.30	419.10	457.20	498.50	520.70	549.30
14	383.50	450.90	485.80	482.60	492.10	520.70	577.90	N/A
16	437.00	514.40	539.80	536.60	565.20	574.70	641.40	N/A
18	497.00	549.30	596.90	593.70	612.80	638.20	704.90	N/A
20	548.00	606.40	654.10	647.70	682.60	698.50	755.70	N/A
24	653.50	717.60	774.70	768.40	790.60	838.10	901.70	N/A

NOTE: For ANSI Standard Bols

Dimensions in mm

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	$H = \pi.\frac{G^2}{4}.P$	$F_F = \pi.\frac{(Dj)^2}{4}.P$
Minimum service load	$H_P = 2.b.\pi.G.m.P$	$Fm = \pi.Dj.Ym$ $Ym = \begin{cases} Ym_1 = Y_1 \\ Ym_2 = Y_2 \frac{P}{Pu\,\theta} \end{cases}$ Use the greater of the two
Minimum tightening load to apply on bolts	$W = \begin{matrix} (1)\ W_{m2} \\ (2)\ H + Hp = W_{m1} \end{matrix}$ Use the greater of the two (1) or (2)	$F_B = \begin{matrix} (1)\ Fj \\ (2)\ F_F + F_m = Fs \end{matrix}$ 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	$H = F_F$ $G = Dj$ ↓ $H = \pi.\frac{(Dj)^2}{4}.P$
Minimum service load	$H_p = F_m$ $b = 1$ $G = Dj$ $2.m.P = Y_m$ $m = \frac{Ym}{2.P}$ ↓ $H_P = \pi.Dj.Ym$
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

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: (mm) Radial: Axial: #Cycles:

Material: Thickness:

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

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

❏ 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 (Ra µm) Type:

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

BOLTING DETAILS: (Please Provide Drawing)

Size: Type / Grade:

Number: Bolt Circle Tapped / Through:

OTHER:

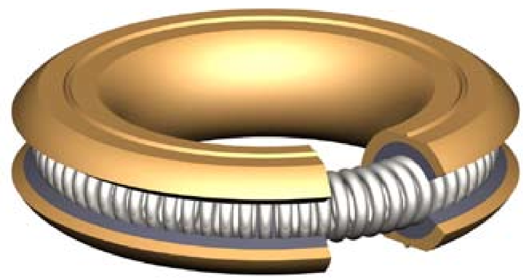
Special coating / plating specification:

Special quality / inspection specifications:

Other:

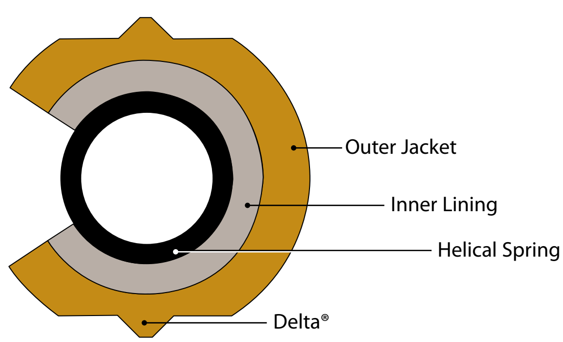
Garlock Helicoflex®
PERFORMANCE METAL SEALS
an EnPro Industries company

Sealing Concept

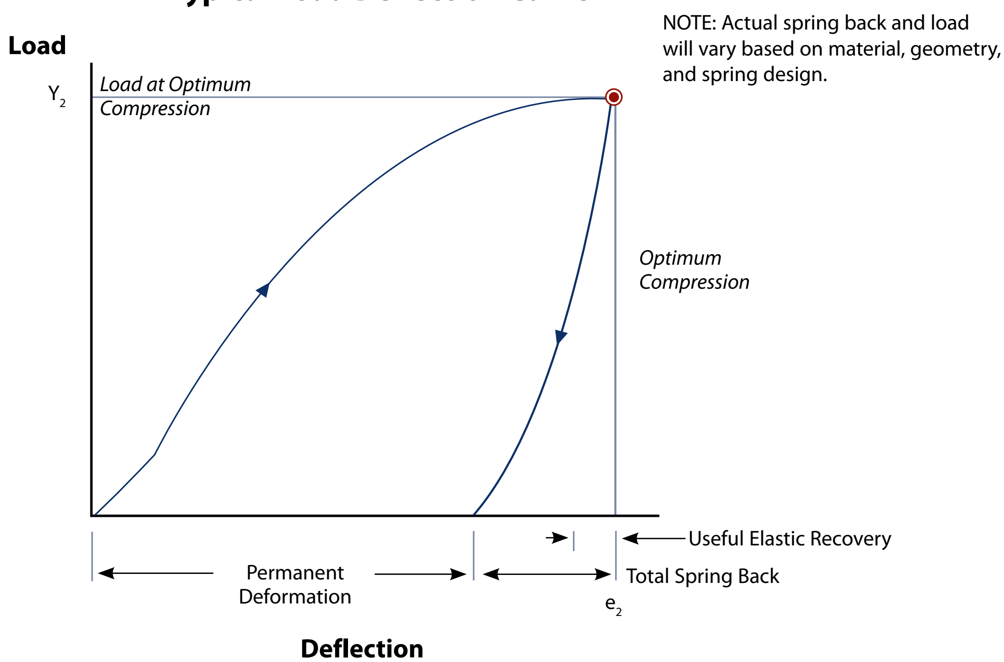


The Delta® seal is a member of the Helicoflex family of spring energized seals. The sealing principle of the Helicoflex family of seals is based upon the plastic deformation of a jacket that has greater ductility than the flange materials. This occurs between the sealing face of a flange and an elastic 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

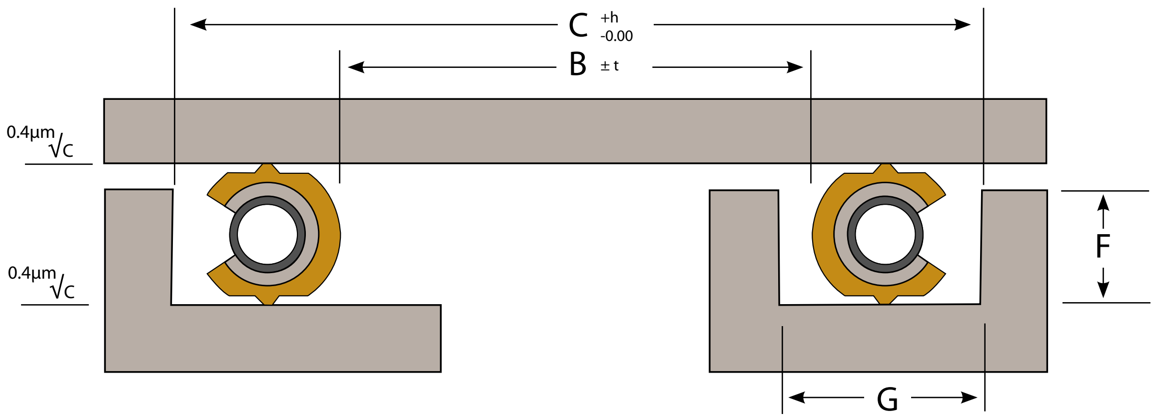
Jacket Material	Free Height	Seal Type	Installation Compression e_2	Seal Diameter Range	Seating Load Y2 N/mm	Maximum Temperature °C
Aluminum	1.90	HNV100	Contact Applications Engineering			
	2.60	HNV200	0.70	19.05 to 203.20	140	220
	3.30	HNV200	0.80	25.40 to 406.40	140	250
	4.00	HNV200	0.90	50.80 to 508.00	140	280
	4.80	HNV200	0.90	76.20 to 762.00	140	280
	5.60	HNV200	1.00	101.60 to 762.00	151	320
	6.70	HNV200	1.10	127.00 to 762.00	151	340
Silver	1.70	HNV100	Contact Applications Engineering			
	2.40	HNV200	0.60	19.05 to 152.40	160	280
	3.10	HNV200	0.60	25.40 to 304.80	160	300
	3.90	HNV200	0.70	50.80 to 457.20	160	350
	4.70	HNV200	0.80	76.20 to 508.00	160	370
	5.40	HNV200	0.80	101.60 to 508.00	170	400
	6.50	HNV200	0.90	127.00 to 508.00	180	450
Copper	1.65	HNV100	Contact Applications Engineering			
	2.34	HNV200	0.43	19.05 to 203.20	180	380
	3.05	HNV200	0.53	25.40 to 406.40	180	380
	3.94	HNV200	0.64	50.80 to 457.20	180	420
	4.55	HNV200	0.64	76.20 to 508.00	180	450
	5.33	HNV200	0.64	101.60 to 762.00	180	480
	6.35	HNV200	0.74	127.00 to 762.00	190	520
Nickel (Annealed)	1.65	HNV100	Contact Applications Engineering			
	2.34	HNV200	0.43	19.05 to 203.20	180	420
	3.05	HNV200	0.53	25.40 to 406.40	180	480
	3.94	HNV200	0.64	50.80 to 457.20	180	550
	4.55	HNV200	0.64	76.20 to 508.00	180	600
	5.33	HNV200	0.64	101.60 to 762.00	180	650
	6.35	HNV200	0.74	127.00 to 762.00	190	650
Stainless Steel	Contact Applications Engineering					

Dimensions in mm

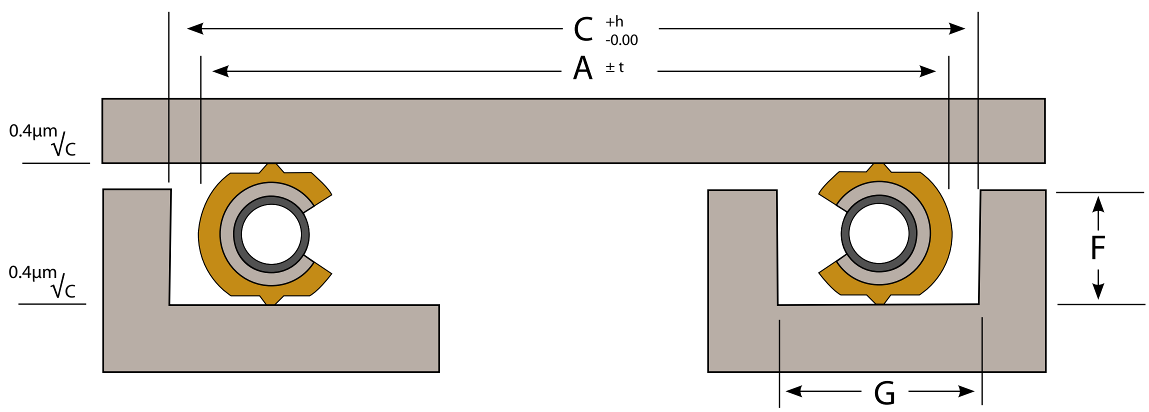
NOTES:

1. Seating load is in Newtons per millimeter of circumference.
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
< 305mm B = C - X - 2 (Seal Section x 0.933)
≥ 305mm Contact Applications Engineering

External Vacuum
A = C - X

Determining Groove Diameter:

Internal Vacuum
< 305mm C = B + X + 2 (Seal Section x 0.933)
≥ 305mm 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

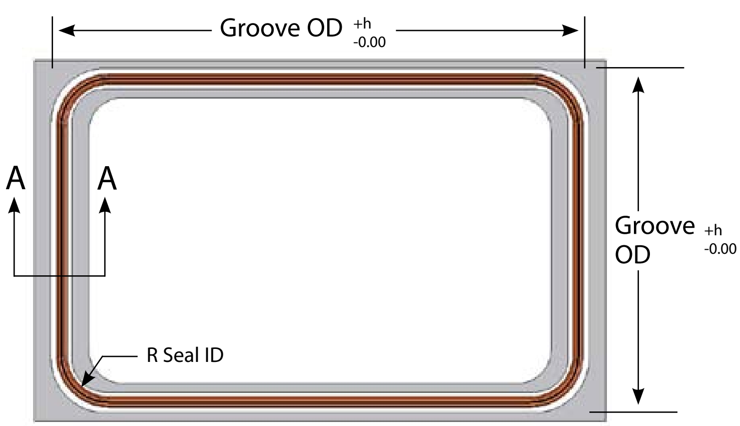
Seal						Groove					
Jacket Material	Free Height	Seal Section	Seal Type	Seal Diameter Range	Seal Tolerance t^3	Diametical Clearance x	Seating Load N/mm Y_2	Groove Tolerance h	Groove Depth F	Groove Width G (Min)	Min. Flange Hardness (Vickers)
Aluminum	1.90	2.00	HNV100	Contact Applications Engineering							
	2.60	2.70	HNV200	19.05 to 203.20	0.13	0.50	140	0.25	1.90 ± 0.05	3.80	65
	3.30	3.40	HNV200	25.40 to 406.40	0.13	0.75	140	0.25	2.50 ± 0.05	4.60	65
	4.00	4.10	HNV200	50.80 to 508.00	0.13	0.75	140	0.25	3.10 ± 0.05	5.30	65
	4.80	4.90	HNV200	76.20 to 762.00	0.13	0.90	140	0.25	3.90 ± 0.08	6.20	65
	5.60	5.80	HNV200	101.60 to 762.00	0.13	1.00	150	0.25	4.60 ± 0.08	7.10	65
	6.70	6.90	HNV200	127.00 to 762.00	0.13	1.00	150	0.25	5.60 ± 0.08	8.10	65
Silver	1.70	1.80	HNV100	Contact Applications Engineering							
	2.40	2.50	HNV200	19.05 to 152.40	0.13	0.50	160	0.25	1.80 ± 0.05	3.60	120
	3.10	3.20	HNV200	25.40 to 304.80	0.13	0.50	160	0.25	2.50 ± 0.05	4.20	120
	3.90	4.00	HNV200	50.80 to 457.20	0.13	0.65	160	0.25	3.20 ± 0.05	5.10	120
	4.70	4.80	HNV200	76.20 to 508.00	0.13	0.75	160	0.25	3.90 ± 0.08	6.00	120
	5.40	5.60	HNV200	101.60 to 508.00	0.13	0.75	170	0.25	4.60 ± 0.08	6.70	120
	6.50	6.70	HNV200	127.00 to 508.00	0.13	0.90	180	0.25	5.60 ± 0.08	8.00	120
Copper	1.65	1.75	HNV100	Contact Applications Engineering							
	2.34	2.44	HNV200	19.05 to 203.20	0.13	0.50	180	0.25	1.90 ± 0.03	3.30	130
	3.05	3.15	HNV200	25.40 to 406.40	0.13	0.50	180	0.25	2.50 ± 0.05	4.10	130
	3.94	4.04	HNV200	50.80 to 457.20	0.13	0.65	180	0.25	3.30 ± 0.05	5.10	130
	4.55	4.65	HNV200	76.20 to 508.00	0.13	0.65	180	0.25	3.90 ± 0.05	5.70	130
	5.33	5.54	HNV200	101.60 to 762.00	0.13	0.65	180	0.25	4.70 ± 0.05	6.50	130
	6.35	6.53	HNV200	127.00 to 762.00	0.13	0.75	190	0.25	5.60 ± 0.08	7.60	130
Nickel (Annealed)	1.65	1.74	HNV100	Contact Applications Engineering							
	2.34	2.44	HNV200	19.05 to 203.20	0.13	0.50	180	0.25	1.90 ± 0.03	3.30	220
	3.05	3.15	HNV200	25.40 to 406.40	0.13	0.50	180	0.25	2.50 ± 0.05	4.10	220
	3.94	4.04	HNV200	50.80 to 457.20	0.13	0.65	180	0.25	3.30 ± 0.05	5.10	220
	4.55	4.65	HNV200	76.20 to 508.00	0.13	0.65	180	0.25	3.90 ± 0.05	5.70	220
	5.33	5.54	HNV200	101.60 to 762.00	0.13	0.66	180	0.25	4.70 ± 0.05	6.50	220
	6.35	6.53	HNV200	127.00 to 762.00	0.13	0.75	190	0.25	5.60 ± 0.08	7.60	220
Stainless Steel	Contact Applications Engineering					Contact Applications Engineering					

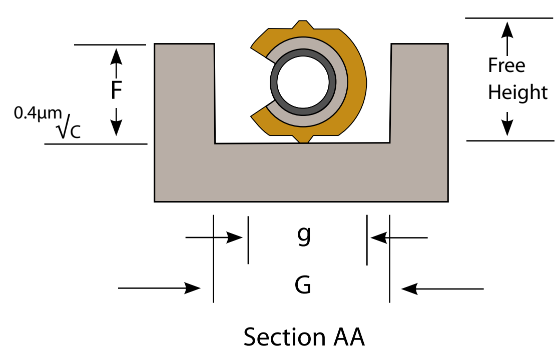
NOTES:
1. Contact Applications Engineering for additional sizes.
2. Seal type HNV100 is available as an option only. Type HNV200 is preferred due to its protective inner lining and can be expected to produce better results.
3. Seal diameters ≥ 305mm may require special tolerancing. Contact Applications 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 N/mm 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	1.90	2.00	HNV100	Contact Applications Engineering				Contact Applications Engineering			
	2.60	2.70	HNV200	0.70	210	Fit Template	19..05	0.25	1.90 ± 0.05	4.32	65
	3.30	3.40	HNV200	0.80	184	Fit Template	25.40	0.25	2..50 ± 0.05	5.08	65
	4.00	4.10	HNV200	0.90	184	Fit Template	28.58	0.25	3.10 ± 0.05	5.84	65
	4.80	4.90	HNV200	0.90	184	Fit Template	34.93	0.25	3.90 ± 0.08	6.73	65
	5..60	5.80	HNV200	1.00	205	Fit Template	38.10	0.51	4.60 ± 0.08	7.62	65
	6.70	6.90	HNV200	1.10	210	Fit Template	44.45	0.51	5.60 ± 0.08	8.64	65
Silver	1.70	1.80	HNV100	Contact Applications Engineering				Contact Applications Engineering			
	2.40	2.50	HNV200	0.60	184	Fit Template	15.88	0.25	1.80 ± 0.05	4.06	120
	3.10	3.20	HNV200	0.60	201	Fit Template	22.23	0.25	2.50 ± 0.05	4.70	120
	3.90	4.00	HNV200	0.70	193	Fit Template	25.40	0.25	3.20 ± 0.05	5.59	120
	4.70	4.80	HNV200	0.80	193	Fit Template	31.75	0.25	3.90 ± 0.08	6.48	120
Copper	1.65	1.75	HNV100	Contact Applications Engineering				Contact Applications Engineering			
	2.34	2.44	HNV200	0.43	193	Fit Template	15.88	0.25	1.91 ± 0.03	3.81	130
	3.05	3.15	HNV200	0.53	236	Fit Template	22.23	0.25	2.49 ± 0.05	4.57	130
	3.94	4.04	HNV200	0.64	223	Fit Template	25.40	0.25	3.30 ± 0.05	5.59	130
	4.55	4.65	HNV200	0.64	223	Fit Template	28.58	0.25	3.91 ± 0.05	6.22	130
Nickel (Annealed)	1.65	1.75	HNV100	Contact Applications Engineering				Contact Applications Engineering			
	2.34	2.44	HNV200	0.43	193	Fit Template	15.88	0.25	1.91 ± 0.03	3.81	220
	3.05	3.15	HNV200	0.53	236	Fit Template	22.23	0.25	2.49 ± 0.05	4.57	220
	3.94	4.04	HNV200	0.64	223	Fit Template	25.40	0.25	3.30 ± 0.05	5.59	220
	4.55	4.65	HNV200	0.64	223	Fit Template	28.58	0.25	3.91 ± 0.05	6.22	220
Stainless Steel	Contact Applications Engineering										

NOTES:
1. Seating load is in Newtons per millimeter of circumference.
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)
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: (mm) Radial: Axial: #Cycles:

Material:
Thickness:

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

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

❑ 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 (Ra µm) 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:

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.

Garlock Helicoflex makes no warranty, express or implied, that utilization of the technology or products disclosed herein will not infringe any industrial or intellectual property rights of third parties.

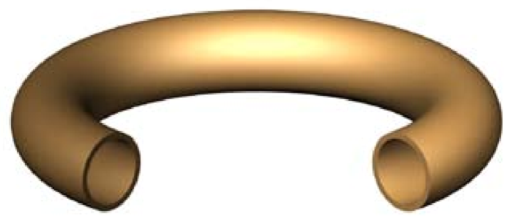
Garlock Helicoflex is constantly involved in engineering and development. Accordingly, Garlock Helicoflex reserves the right to modify, at any time, the technology and product specifications contained herein.

All technical data, specifications and other information contained herein is deemed to be the proprietary intellectual property of Garlock Helicoflex. No reproduction, copy or use thereof may be made without the express written consent of Garlock Helicoflex.

Garlock Helicoflex®
PERFORMANCE METAL SEALS
an EnPro Industries company

Sealing Concept

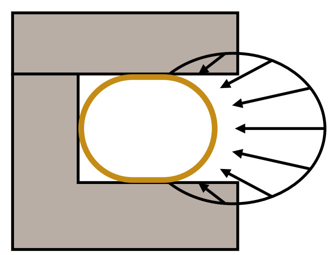
O-Flex™ Metal O-Rings are designed to provide a sealing option for high pressure/temperature applications that require minimal spring back. The O-Flex™ is made from high strength metal tubing that is coiled, cut and welded to size. It is available in standard cross section increments of 1/32". The O-Flex™ 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

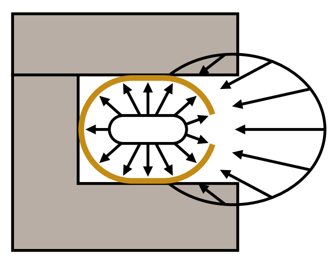
Basic

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



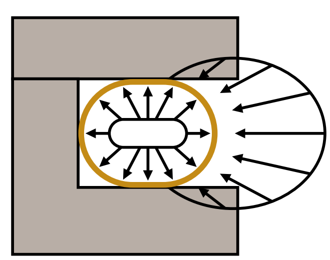
Self Energizing

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.



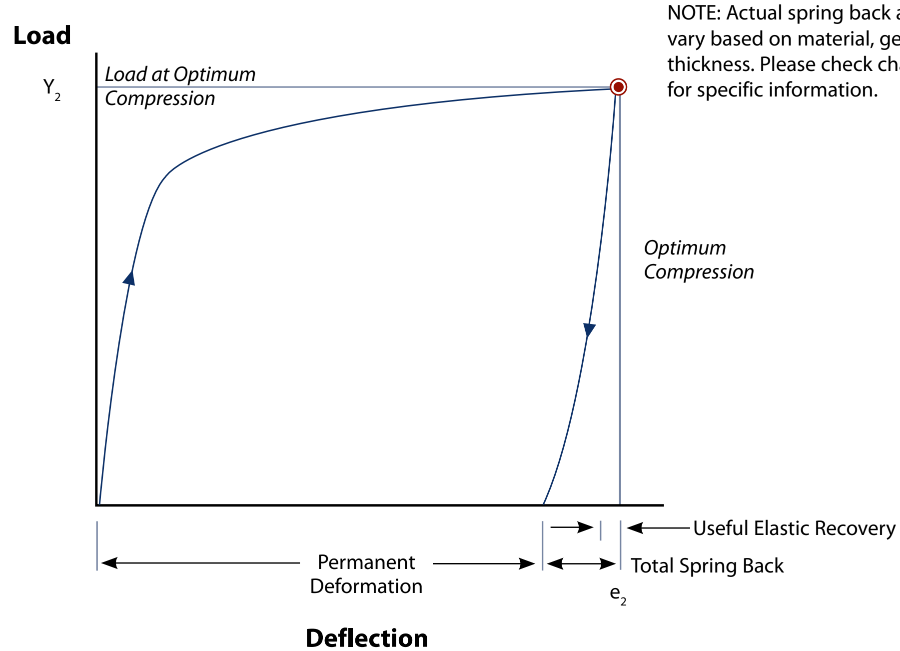
Pressure Filled

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

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
SS 321	Standard	T < 370ºC	NA
Alloy 600	Standard	T < 540ºC	NA
Alloy X750	Standard	T < 590ºC	NA
Alloy 718	Optional	T < 650ºC	NA
Other	Contact Applications Engineering		

Plating/Coating Selection

Plating/Coating	Status	Standard Thickness	Temperature	Groove Finish*
PTFE	Optional	0.03 - 0.08	T < 260ºC	0.4 - 0.8 µm
Silver	Standard	0.03 - 0.05	T < 425ºC	0.4 - 1.6 µm
Silver w/ Gold strike	Optional	0.03 - 0.05	T < 650ºC	0.4 - 1.6 µm
Nickel	Standard	0.03 - 0.05	T < 870ºC	0.4 - 0.8 µm
None	-	-	-	< 0.4 µm
Other	Contact Applications Engineering			

Dimensions in mm

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

O-Flex™ Characteristic Values

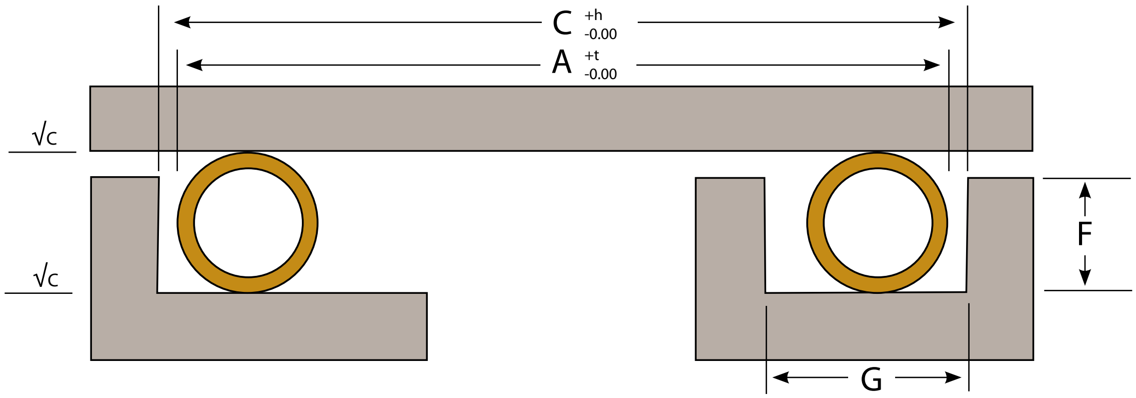
Free Height	Installation Compression e_2	Seal Diameter Range	Material Thickness	Thin (T) Medium (M) Heavy (H)	CHARACTERISTIC VALUES AT 21°C SS 321 Seating Load Y_2 N/mm	Alloy 600 Seating Load Y_2 N/mm	Alloy X-750 Seating Load Y_2 N/mm
0.81	0.15	12.70 to 101.60	0.15	T	80	88	104
			0.25	M	180	198	234
			-	H	-	-	-
1.60	0.30	12.70 to 254.00	0.25	T	100	110	130
			0.30	M	140	154	182
			0.36	H	220	242	286
2.39	0.51	25.40 to 508.00	0.25	T	60	66	78
			0.30	M	90	99	117
			0.46	H	230	253	299
3.18	0.66	50.80 to 1,016.00	0.25	T	60	66	78
			0.51	M	200	220	260
			0.64	H	360	396	468
3.96	0.79	76.20 to 1,270.00 +	-	T	-	-	-
			0.51	M	150	165	195
			0.64	H	250	275	325
4.78	0.99	101.60 to 1,270.00 +	-	T	-	-	-
			0.51	M	115	127	150
			0.81	H	370	407	481
6.35	1.30	127.00 to 1,270.00 +	0.64	T	140	154	182
			0.81	M	240	264	312
			1.24	H	530	583	689

Dimensions in mm

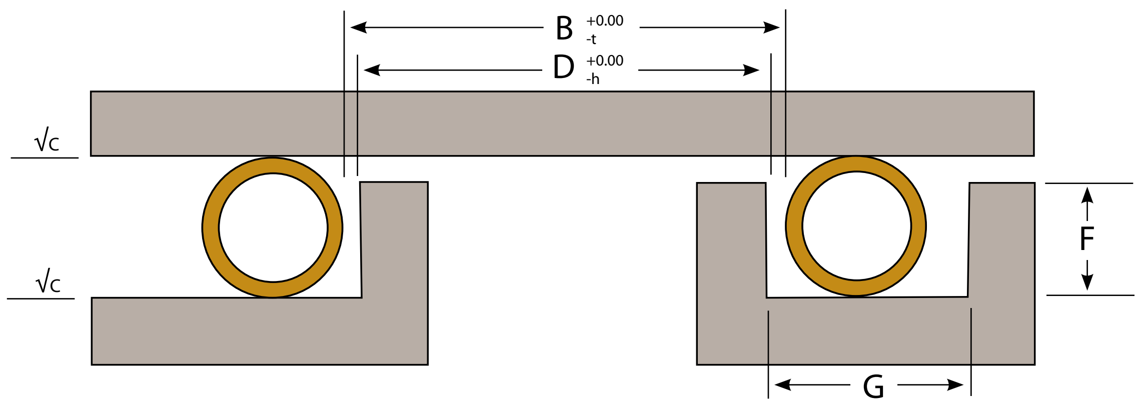
NOTES:

1. Seating Load is in Newtons per millimeter of circumference.
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	External
A = C-X-2Pmax	B = D + X + 2Pmax

Determining Groove Diameter:

Internal	External
C = A + X + 2Pmax	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
0.81	12.70 to 101.60	0.13	0.15	0.10	0.66 ±0.025	1.40
1.60	12.70 to 254.00	0.13	0.15	0.10	1.30 ±0.025	2.29
2.39	25.40 to 508.00	0.13	0.20	0.10	1.85 ±0.051	3.18
3.18	50.80 to 1016.00	0.13	0.20	0.10	2.51 ±0.051	4.06
3.96	76.20 to 1270.00 +	0.13	0.36	0.15	3.18 ±0.051	5.08
4.78	101.60 to 1270.00 +	0.13	0.36	0.15	3.78 ±0.051	6.35
6.35	127.00 to 1270.00 +	0.20	0.48	0.20	5.05 ±0.076	8.89

Dimensions in mm

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	0.81	■	■	●	■	■	●	■	●	●
	1.60	■	■	■	■	■	●	■	■	●
	2.39	■	■	■	■	■	●	■	■	●
	3.18	■	■	●	■	■	●	■	■	●
	3.96	■	■	●	■	■	●	■	■	●
	4.78	■	■	●	■	■	●	■	■	●
	6.35	■	●	●	■	●	●	■	●	●
	Wall Thickness	T	M	H	T	M	H	T	M	H
PTFE	0.81	●	▲	▲		▲	▲	●	▲	▲
	1.60	●	▲	▲		▲	▲	●	▲	▲
	2.39	●	●	▲		●	▲	●	●	▲
	3.18	●	▲	▲		▲	▲	●	▲	▲
	3.96	■	▲	▲	■	▲	▲	■	▲	▲
	4.78	■	●	▲	■	●	▲	●	●	▲
	6.35	▲	▲	▲	▲	▲	▲	▲	▲	▲
	Wall Thickness	T	M	H	T	M	H	T	M	H
Silver	0.81	●	●	▲	●	●	▲	●	●	▲
	1.60	●	●	▲	●	●	▲	●	●	▲
	2.39	■	●	▲	■	●	▲	●	●	▲
	3.18	■	●	▲	■	●	▲	●	●	▲
	3.96	■	●	▲	■	●	▲	■	●	▲
	4.78	■	●	▲	■	●	▲	■	●	▲
	6.35	●	●	▲	●	●	▲	●	●	▲
	Wall Thickness	T	M	H	T	M	H	T	M	H
Nickel	0.81	■	●	●	■	●	●	■	●	●
	1.60	■	■	●	■	●	●	■	●	●
	2.39	■	■	●	■	■	●	■	■	●
	3.18	■	●	●	■	●	●	■	●	●
	3.96	■	●	●	■	●	●	■	●	●
	4.78	■	■	●	■	■	●	■	●	●
	6.35	■	●	●	●	●	●	●	●	▲

Dimensions in mm

Legend

■ : Q > 1.32×10^{-5} std.cc/sec He

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

▲ : Q <1.32×10^{-9} std.cc/sec He

Q : Approximate leak rate per meter of circumference

T: Thin
M: Medium
H: Heavy

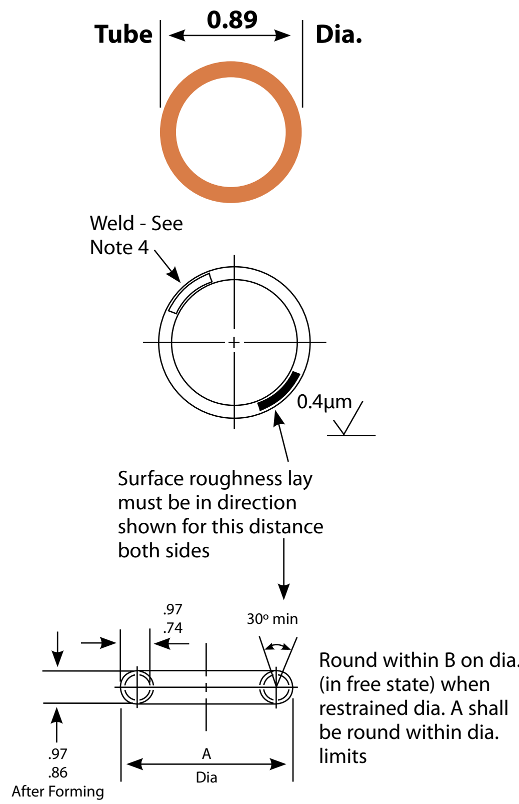
O-Flex™ Seals for Military Standards

Tube 0.89 Diameter

Military Standard

MS 9141 Gasket, metal O-ring, .89 tube x .15 wall, cres
MS 9371 Gasket, metal O-ring, .89 tube x .15 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 3.20 of Weld. Dimensions at blend shall not be more than .76 below adjacent surfaces.
5. Finish: Silver plate AMS 2410 0.25 - 0.38 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 mm.
10. Do not use unassigned part numbers.
11. Contact Applications Engineering for design requirements.



Add to MS Number	A +0.13 -0.00	B
-03	6.35 †	0.51
-04	7.14 †	0.51
-05	7.92 †	0.51
-06	8.74 †	0.51
-07	9.53 †	0.51
-08	10.31 †	0.51
-09	11.13 †	0.51
-10	11.91 †	0.51
-11	12.70	0.51
-12	14.27	0.51
-13	15.88*	0.51
-14	17.48	0.51

Add to MS Number	A +0.13 -0.00	B
-15	19.05*	0.51
-16	20.62	0.51
-17	22.23*	0.51
-18	23.83	0.51
-19	25.40*	0.51
-20	28.58	0.51
-21	31.75	0.51
-22	34.93	0.51
-23	38.10*	0.51
-24	41.28	0.51
-25	44.45*	0.51
-26	47.63	0.51
-27	50.80*	0.51

Dimensions in mm

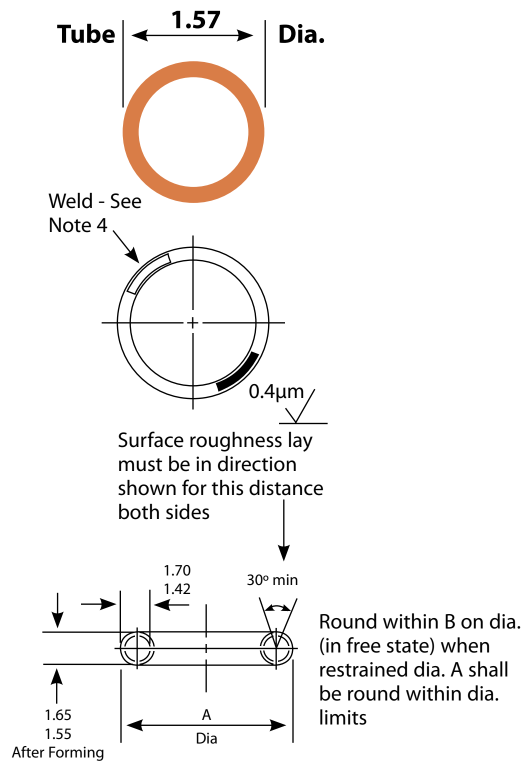
† Contact Applications Engineering for these sizes.

Tube 1.57 Diameter

Military Standard

MS 9142 Gasket, metal O-ring, 1.57 tube x 0.15 wall, cres
MS 9202 Gasket, metal O-ring, 1.57 tube x 0.25 wall, cres
MS 9372 Gasket, metal O-ring, 1.57 tube x 0.15 wall, cres, silver plated
MS 9373 Gasket, metal O-ring, 1.57 tube x 0.25 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 3.20 of Weld. Dimensions at blend shall not be more than .10 below adjacent surfaces.
5. Finish: Silver plate AMS 2410 0.25 - 0.38 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 mm.
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 +0.13 -0.00	B	Add to MS Number	A +0.13 -0.00	B	Add to MS Number	A +0.13 -0.00	B	Add to MS Number	A +0.13 -0.00	B
-013	11.13*	0.76	-037	30.18	0.76	-061	66.68	1.52	-103	133.35	2.29
-014	11.91	0.76	-038	30.96	0.76	-062	68.28	1.52	-105	136.53	2.29
-015	12.70*	0.76	-039	31.75	0.76	-063	69.85*	1.52	-107	139.70	2.29
-016	13.49	0.76	-040	33.32	0.76	-064	71.42	1.52	-109	142.88	2.29
-017	14.27*	0.76	-041	34.93	0.76	-065	73.03	1.52	-111	146.05	2.29
-018	15.09	0.76	-042	36.53	0.76	-066	74.63	1.52	-113	149.23	2.29
-019	15.88*	0.76	-043	38.10	0.76	-067	76.20*	1.52	-115	152.40*	2.29
-020	16.66	0.76	-044	39.67	0.76	-069	79.38	1.52	-117	155.58	2.29
-021	17.48*	0.76	-045	41.28	0.76	-071	82.55	1.52	-119	158.75	2.29
-022	18.26	0.76	-046	42.88	0.76	-073	85.73	1.52	-121	161.93	2.29
-023	19.05*	0.76	-047	44.45	0.76	-075	88.90*	1.52	-123	165.10	2.29
-024	19.84	0.76	-048	46.02	0.76	-077	92.08	1.52	-125	168.28	2.29
-025	20.62	0.76	-049	47.63	0.76	-079	95.25	1.52	-127	171.45	2.29
-026	21.44	0.76	-050	49.23	0.76	-081	98.43	1.52	-129	174.63	2.29
-027	22.23*	0.76	-051	50.80	0.76	-083	101.60*	1.52	-131	177.80*	2.29
-028	23.01	0.76	-052	52.37	0.76	-085	104.78	1.52	-133	180.98	2.29
-029	23.83	0.76	-053	53.98	0.76	-087	107.95	1.52	-135	184.15	2.29
-030	24.61	0.76	-054	55.58	0.76	-089	111.13	1.52	-137	187.33	2.29
-031	25.40*	0.76	-055	57.15	0.76	-091	114.30*	1.52	-139	190.50	2.29
-032	26.19	0.76	-056	58.72	0.76	-093	117.48	1.52	-141	193.68	2.29
-033	26.97	0.76	-057	60.33	0.76	-095	120.65	1.52	-143	196.85	2.29
-034	27.79	0.76	-058	61.93	0.76	-097	123.83	1.52	-145	200.03	2.29
-035	28.58*	0.76	-059	63.50	0.76	-099	127.00*	1.52	-147	203.20*	2.29
-036	29.36	0.76	-060	65.07	1.52	-101	130.18	2.29			

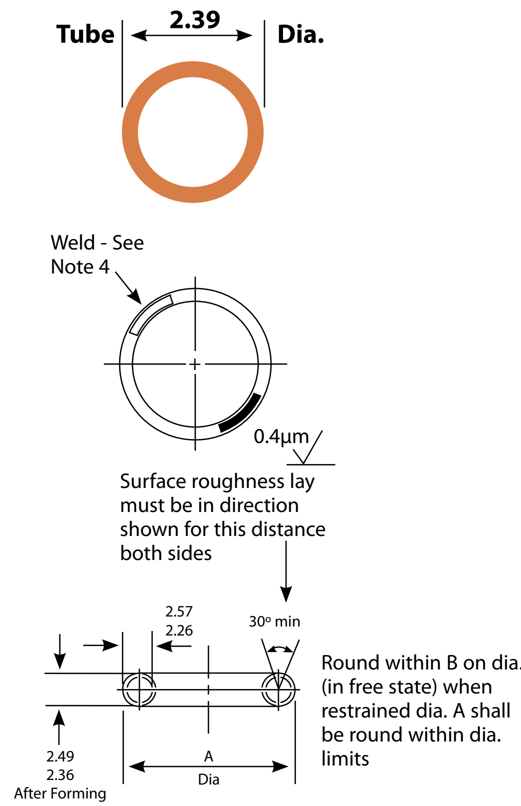
Dimensions in mm

Tube 2.39 Diameter

Military Standard

MS 9203 Gasket, metal O-ring, 2.39 tube x 0.15 wall, cres
MS 9204 Gasket, metal O-ring, 2.39 tube x 0.25 wall, cres
MS 9374 Gasket, metal O-ring, 2.39 tube x 0.15 wall, cres, silver plated
MS 9375 Gasket, metal O-ring, 2.39 tube x 0.25 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 3.20 of Weld. Dimensions at blend shall not be more than 0.10 below adjacent surfaces.
5. Finish: Silver plate AMS 2410 0.25 - 0.38 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 mm.
10. Do not use unassigned part numbers.
11. Contact Applications Engineering for design requirements.

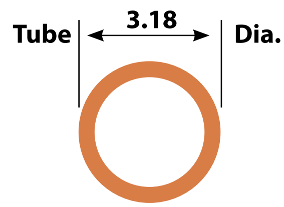


NOTE: MS 9374 and MS 9375 available only through dash 195

Add to MS Number	A +0.13 -0.00	B	Add to MS Number	A +0.13 -0.00	B	Add to MS Number	A +0.13 -0.00	B	Add to MS Number	A +0.13 -0.00	B
-010	25.40*	0.76	-038	55.58	0.76	-065	98.43	1.52	-143	222.25	2.29
-012	26.19	0.76	-039	57.15*	0.76	-066	100.03	1.52	-147	228.60*	2.29
-013	26.97	0.76	-040	58.72	0.76	-067	101.60*	1.52	-151	234.95	2.29
-014	27.79	0.76	-041	60.33	0.76	-069	104.78	1.52	-155	241.30	2.29
-015	28.58*	0.76	-042	61.93	0.76	-071	107.95	1.52	-159	247.65	2.29
-016	29.36	0.76	-043	63.50*	0.76	-073	111.13	1.52	-163	254.00*	2.29
-017	30.18	0.76	-044	65.07	1.52	-075	114.30*	1.52	-167	260.35	3.18
-018	30.96	0.76	-045	66.68	1.52	-077	117.48	1.52	-171	266.70	3.18
-019	31.75*	0.76	-046	68.28	1.52	-079	120.65	1.52	-175	273.05	3.18
-020	32.54	0.76	-047	69.85*	1.52	-081	123.83	1.52	-179	279.40*	3.18
-021	33.32	0.76	-048	71.42	1.52	-083	127.00*	1.52	-183	285.75	3.18
-022	34.14	0.76	-049	73.03	1.52	-085	130.18	2.29	-187	292.10	3.18
-023	34.93*	0.76	-050	74.63	1.52	-087	133.35	2.29	-191	298.45	3.18
-024	35.71	0.76	-051	76.20	1.52	-089	136.53	2.29	-195	304.80*	3.18
-025	36.53	0.76	-052	77.77	1.52	-091	139.70*	2.29	-203	317.50	3.81
-026	37.31	0.76	-053	79.38	1.52	-095	146.05	2.29	-211	330.20	3.81
-027	38.10*	0.76	-054	80.98	1.52	-099	152.40*	2.29	-219	342.90	3.81
-028	39.67	0.76	-055	82.55	1.52	-103	158.75	2.29	-227	355.60	3.81
-029	41.28	0.76	-056	84.12	1.52	-107	165.10	2.29			
-030	42.88	0.76	-057	85.73	1.52	-111	171.45	2.29			
-031	44.45*	0.76	-058	87.33	1.52	-115	177.80*	2.29			
-032	46.02	0.76	-059	88.90*	1.52	-119	184.15	2.29			
-033	47.63	0.76	-060	90.47	1.52	-123	190.50	2.29			
-034	49.23	0.76	-061	92.08	1.52	-127	196.85	2.29			
-035	50.80*	0.76	-062	93.68	1.52	-131	203.20*	2.29			
-036	52.37	0.76	-063	95.25	1.52	-135	209.55	2.29			
-037	53.98	0.76	-064	96.82	1.52	-139	215.90	2.29			

Dimensions in mm

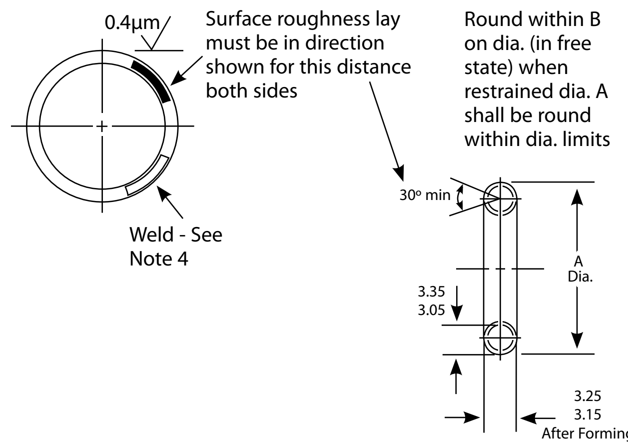
Tube 3.18 Diameter



Military Standard

MS 9205 Gasket, metal O-ring, 3.18 tube x .25 wall, cres
MS 9376 Gasket, metal O-ring, 3.18 tube x .25 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 3.15 - 3.23 dia., wall thick. 0.25 - 0.28.
4. Finish weld flush with tube OD. Smooth blend within 3.20 of Weld. Dimensions at blend shall not be more than 0.10 below adjacent surfaces.
5. Finish: Silver plate AMS 2410 0.25 - 0.38 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 mm.
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 +0.13 -0.00	B
-010	50.80*	0.76
-011	52.37	0.76
-012	53.98	0.76
-013	55.58	0.76
-014	57.15*	0.76
-015	58.72	0.76
-016	60.33	0.76
-017	61.93	0.76
-018	63.50*	0.76
-019	65.07	1.52
-020	66.68	1.52
-021	68.28	1.52
-022	69.85*	1.52
-023	71.42	1.52
-024	73.03	1.52
-025	74.63	1.52
-026	76.20*	1.52
-027	77.77	1.52
-028	79.38	1.52
-029	80.98	1.52
-030	82.55	1.52
-031	84.12	1.52
-032	85.73	1.52
-033	87.33	1.52
-034	88.90*	1.52
-035	90.47	1.52
-036	92.08	1.52
-037	93.68	1.52
-038	95.25	1.52
-039	96.82	1.52
-040	98.43	1.52
-041	100.03	1.52
-042	101.60*	1.52
-043	103.17	1.52
-044	104.78	1.52
-045	106.38	1.52
-046	107.95	1.52
-047	109.52	1.52
-048	111.13	1.52

Add to MS Number	A +0.13 -0.00	B
-049	112.73	1.52
-050	114.30*	1.52
-051	115.87	1.52
-052	117.48	1.52
-053	119.08	1.52
-054	120.65	1.52
-055	122.22	1.52
-056	123.83	1.52
-057	125.43	1.52
-058	127.00*	1.52
-059	128.57	2.29
-060	130.18	2.29
-061	131.78	2.29
-062	133.35	2.29
-063	134.92	2.29
-064	136.53	2.29
-065	138.13	2.29
-066	139.70*	2.29
-067	141.27	2.29
-068	142.88	2.29
-069	144.48	2.29
-070	146.05	2.29
-071	147.62	2.29
-072	149.23	2.29
-073	150.83	2.29
-074	152.40*	2.29
-076	155.58	2.29
-078	158.75	2.29
-080	161.93	2.29
-082	165.10	2.29
-084	168.28	2.29
-086	171.45	2.29
-088	174.63	2.29
-090	177.80*	2.29
-092	180.98	2.29
-094	184.15	2.29
-096	187.33	2.29
-098	190.50	2.29
-100	193.68	2.29

Add to MS Number	A +0.13 -0.00	B
-102	196.85	2.29
-104	200.03	2.29
-106	203.20*	2.29
-108	206.38	2.29
-110	209.55	2.29
-112	212.73	2.29
-114	215.90	2.29
-116	219.08	2.29
-118	222.25	2.29
-120	225.43	2.29
-122	228.60*	2.29
-126	234.95	2.29
-130	241.30	2.29
-134	247.65	2.29
-138	254.00*	2.29
-142	260.35	3.18
-146	266.70	3.18
-150	273.05	3.18
-154	279.40*	3.18
-158	285.75	3.18
-162	292.10	3.18
-166	298.45	3.18
-170	304.80*	3.18
-174	311.15	3.81
-178	317.50	3.81
-182	323.85	3.81
-186	330.20	3.81
-190	336.55	3.81
-194	342.90	3.81
-198	349.25	3.81
-202	355.60*	3.81
-206	361.95	4.45
-210	368.30	4.45
-214	374.65	4.45
-218	381.00	4.45
-222	387.35	4.45
-226	393.70	4.45
-230	400.05	4.45
-234	406.40*	4.45

Add to MS Number	A +0.13 -0.00	B
-238	412.75	5.08
-242	419.10	5.08
-246	425.45	5.08
-250	431.80	5.08
-254	438.15	5.08
-258	444.50	5.08
-262	450.85	5.08
-266	457.20*	5.08
-270	463.55	5.08
-274	469.90	5.08
-278	476.25	5.08
-282	482.60	5.08
-286	488.95	6.35
-290	495.30	6.35
-294	501.65	6.35
-298	508.00*	6.35
-306	520.70	6.35
-314	533.40	6.35
-322	546.10	6.35
-330	558.80*	6.35
-338	571.50	12.70
-346	584.20	12.70
-354	596.90	12.70
-362	609.60*	12.70
-370	622.30	12.70
-378	635.00	12.70
-386	647.70	12.70
-394	660.40	12.70
-402	673.10	12.70
-410	685.80	12.70
-418	698.50	12.70
-426	711.20*	12.70
-434	723.90	12.70
-442	736.60	12.70
-450	749.30	12.70
-458	762.00	12.70
-466	774.70	12.70
-474	787.40	12.70
-482	800.10	12.70

Add to MS Number	A +0.13 -0.00	B
-490	812.80*	12.70
-498	825.50	12.70
-506	838.20	12.70
-514	850.90	12.70
-522	863.60	12.70
-530	876.30	12.70
-538	889.00	12.70
-546	901.70	12.70
-554	914.40*	12.70
-562	927.10	12.70
-570	939.80	12.70
-578	952.50	12.70
-586	965.20	12.70
-594	977.90	12.70
-602	990.60	12.70
-610	1003.30	12.70
-618	1016.00*	25.40
-634	1041.40	25.40
-650	1066.80	25.40
-666	1092.20	25.40
-682	1117.60	25.40
-698	1143.00*	25.40
-714	1168.40	25.40
-730	1193.80	25.40
-746	1219.20	25.40
-762	1244.60	25.40
-778	1270.00	25.40

Dimensions in mm

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: (mm) Radial: Axial: #Cycles:

Material: Thickness:

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

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

❏ 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 (Ra µm)	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

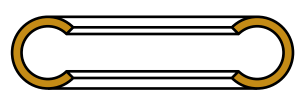
The sealing concept of C-Flex™ metal C-rings is based on the elastic deformation of a metal "C" substrate which, during the compression cycle, gives a contact point on each sealing surface.

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.

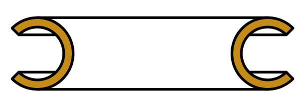
C-FLEX™ Types

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:

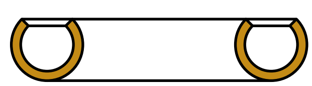
Internal Pressure



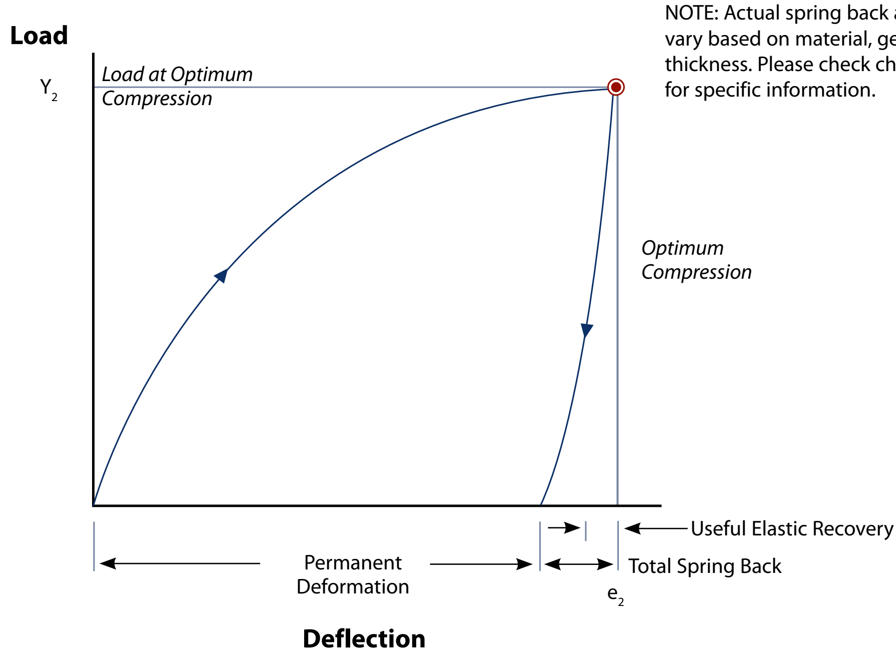
External Pressure



Axial Pressure



C-Flex™ Characteristic Curve



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	Standard	T < 590ºC	Solution heat treat and precipitation harden per AMS 5598
Alloy 718	Optional	T < 650ºC	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	0.03/0.08	T < 260ºC	0.4 - 0.8 µm
Silver	Standard	0.03/0.05	T < 425ºC	0.4 - 1.6 µm
Silver w/ Gold strike	Optional	0.03/0.05	T < 650ºC	0.4 - 1.6 µm
Nickel	Standard	0.03/0.05	T < 870ºC	0.4 - 0.8 µm
None	-	-	-	< 0.4 µm
Other	Contact Applications Engineering			

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

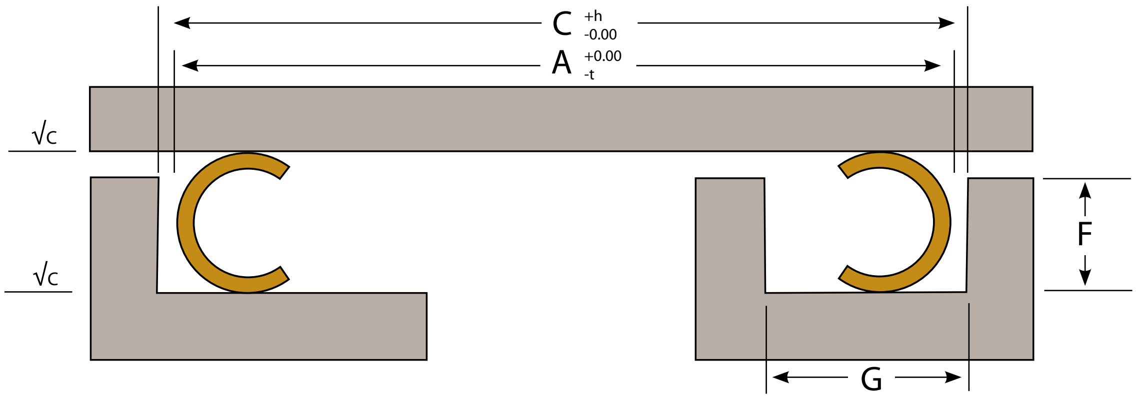
C-Flex™ Characteristic Values

Free Height	Installation Compression e_2	Seal Diameter Range	Material Thickness	Thin (T) Medium (M) Heavy (H)	CHARACTERISTIC VALUES AT 21°C — Alloy X-750 Seating Load Y_2 N/mm	CHARACTERISTIC VALUES AT 21°C — Alloy 718 Seating Load Y_2 N/mm
1.19	0.15	8.26 to 50.80	0.15	T	17	19
			-	M	-	-
			0.20	H	37	43
1.60	0.30	9.53 to 203.20	0.20	T	15	18
			-	M	-	-
			0.25	H	46	53
2.39	0.51	12.70 to 406.40	0.25	T	25	29
			-	M	-	-
			0.38	H	70	81
3.18	0.66	25.40 to 635.00 +	0.25	T	23	26
			0.38	M	42	49
			0.51	H	100	116
3.96	0.81	50.80 to 635.00 +	0.38	T	35	40
			-	M	-	-
			0.64	H	105	121
4.78	0.99	76.20 to 635.00 +	0.51	T	61	72
			-	M	-	-
			0.64	H	-	-
6.35	1.30	101.60 to 635.00 +	0.64	T	55	64
			-	M	-	-
			-	H	-	-

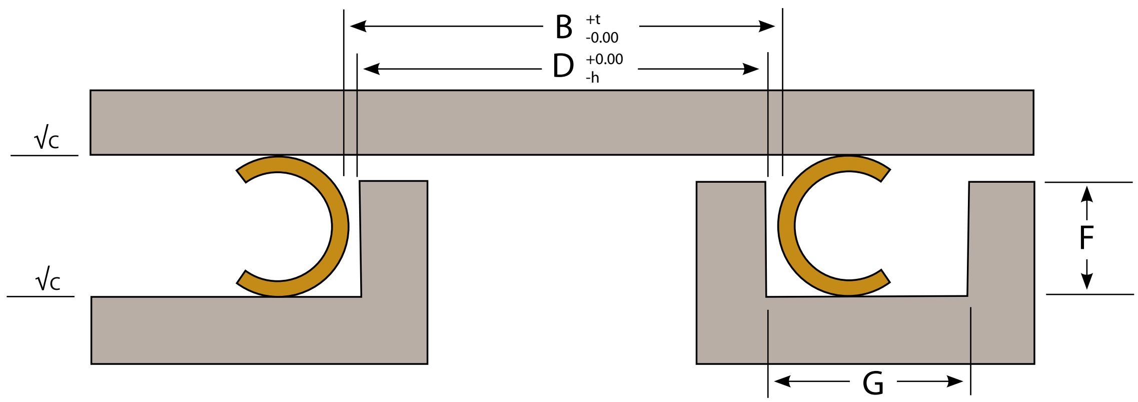
Dimensions in mm

NOTES:
1. Seating load is in Newtons per millimeter of circumference.
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
1.19	8.26 to 50.80	0.15	0.97 ± 0.03	1.40
1.60	9.53 to 203.20	0.18	1.27 ± 0.03	1.91
2.39	12.70 to 406.40	0.20	1.88 ± 0.05	2.67
3.18	25.40 to 635.00 +	0.30	2.54 ± 0.05	3.43
3.96	50.80 to 635.00 +	0.41	3.23 ± 0.05	4.32
4.78	76.20 to 635.00 +	0.46	3.84 ± 0.05	5.08
6.35	101.60 to 635.00 +	0.51	5.08 ± 0.08	6.60

Dimensions in mm

NOTE: Contact Applications Engineering for additional sizes.

Tolerances

Seal Diameter Range	Seal Tolerance t	Groove Tolerance h
6.35 to 25.39	0.05	0.03
25.40 to 50.79	0.05	0.05
50.80 to 76.19	0.08	0.08
76.20 to 101.59	0.08	0.08
101.60 to 126.99	0.10	0.10
127.00 to 177.79	0.15	0.15
177.80 to 253.99	0.18	0.18
250.40 to 380.99	0.30	0.30
381.00 to 507.99	0.38	0.38
508.00 +	Contact Applications Engineering	

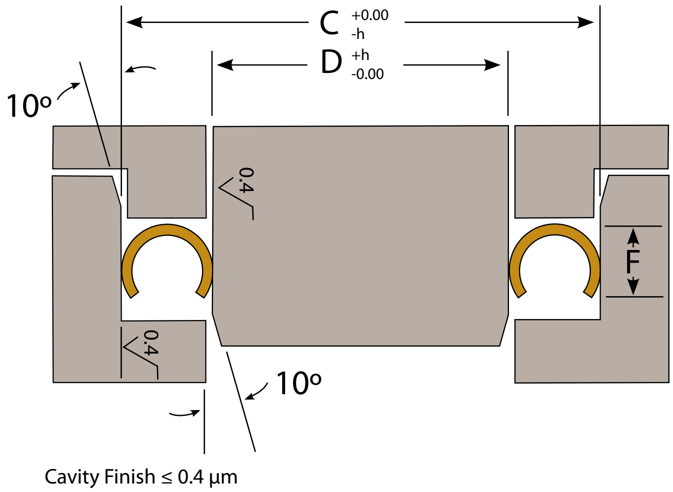
Dimensions in mm

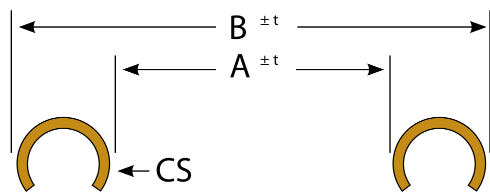
Shaped Seals

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	1.60	2.39	3.18	3.99	4.78	6.35
Minimum Inner Radius	9.53	14.35	25.40	50.30	76.20	101.60

Dimensions in mm





SEAL						CAVITY DIMENSIONS				
Cross Section CS	Material Thickness (Prior to Forming)	Seal ID Range	Axial Length (Max. Ref)	Axial Install Load N/mm	Seal Tolerance t	Cavity OD C	Cavity ID D	Cavity Tolerance h	Cavity Depth F (Min)	Cavity OD/ID Eccentricity (Max.)
1.60	0.20	9.53 to 31.75	1.27	19	0.025	B - 0.08	A + 0.08	0.03	1.91	0.013
	0.20	31.75 to 63.50	1.27	19	0.025	B - 0.10	A + 0.10	0.03	1.91	0.013
	0.25	9.53 to 31.75	1.27	23	0.025	B - 0.08	A + 0.08	0.03	1.91	0.013
	0.25	31.75 to 63.50	1.27	23	0.025	B - 0.10	A + 0.10	0.03	1.91	0.013
2.39	0.25	12.70 to 31.75	1.91	14	0.025	B - 0.08	A + 0.08	0.03	2.67	0.025
	0.25	31.75 to 76.20	1.91	14	0.025	B - 0.10	A + 0.10	0.03	2.67	0.025
	0.38	12.70 to 31.75	1.91	33	0.025	B - 0.08	A + 0.08	0.03	2.67	0.025
	0.38	31.75 to 76.20	1.91	33	0.025	B - 0.10	A + 0.10	0.03	2.67	0.025
3.18	0.38	19.05 to 63.50	2.54	29	0.025	B - 0.08	A + 0.08	0.03	3.43	0.025
	0.38	63.50 to 203.20	2.54	29	0.051	B - 0.15	A + 0.15	0.05	3.43	0.025
	0.51	19.05 to 63.50	2.54	37	0.025	B - 0.08	A + 0.08	0.03	3.43	0.025
	0.51	63.50 to 203.20	2.54	37	0.051	B - 0.15	A + 0.15	0.05	3.43	0.025
3.96	0.38	50.80 to 152.40	3.18	42	0.051	B - 0.15	A + 0.15	0.05	4.32	0.038
	0.38	152.40 to 254.00	3.18	42	0.051	B - 0.18	A + 0.18	0.05	4.32	0.038
	0.64	50.80 to 152.40	3.18	63	0.051	B - 0.15	A + 0.15	0.05	4.32	0.038
	0.64	152.40 to 254.00	3.18	63	0.051	B - 0.18	A + 0.18	0.05	4.32	0.038
4.78	0.51	76.20 to 152.40	3.81	49	0.051	B - 0.18	A + 0.18	0.05	5.08	0.038
	0.51	152.40 to 254.00	3.81	49	0.051	B - 0.20	A + 0.20	0.05	5.08	0.038
6.35	0.64	101.60 to 165.10	5.08	63	0.051	B - 0.20	A + 0.20	0.05	6.60	0.038
	0.64	165.10 to 254.00	5.08	63	0.051	B - 0.23	A + 0.23	0.05	6.60	0.038

Dimensions in mm

NOTES:
1. Axial installation load is in Newtons per millimeter of circumference.
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 21ºC

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
Flow Rate: ____ cc/minute
Other:

Pressure Cycles: ____

Temperature Cycles: ____

FLANGE DETAILS: (Please Provide Drawing)

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

Material: ____ Thickness: ____

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

❑ ANSI Raised Face Size: ____ # Rating: ____ Face Surface Finish: ____ (Ra μm)

❑ 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 (Ra μm) ____ 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

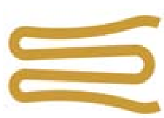
E-Flex™ Metal E-rings are designed to have low load, high spring back performance for high pressure/temperature applications. In service, the E-Flex™ is pressure energized by the system which increases the contact stress and further minimizes leakage. The E-Flex™ geometry can be designed to meet the 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™



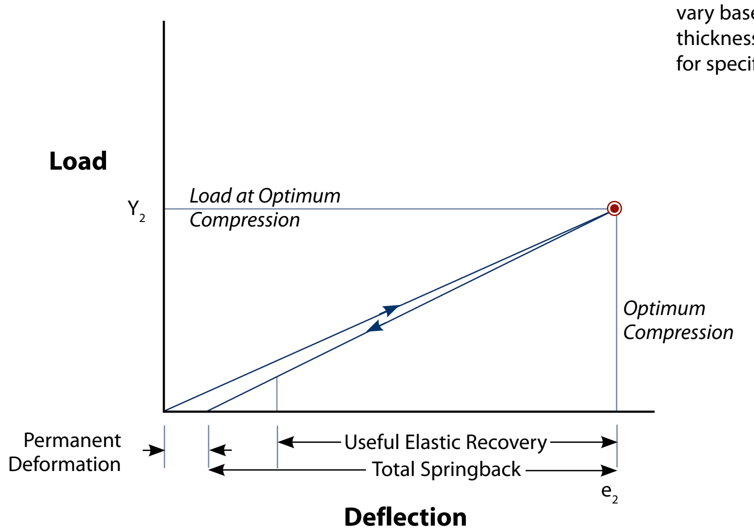
The Super E-Flex™ is designed to have less stress during installation. These seals typically have less load than the traditional E-Flex™ seals and have nearly 100% spring back at room temperature.

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 < 590°C	Solution heat treat and precipitation harden per AMS5598
Alloy 718	Standard	T < 650°C	Solution heat treat and precipitation harden per AMS5596
Waspaloy	Optional	T < 730°C	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 21°C

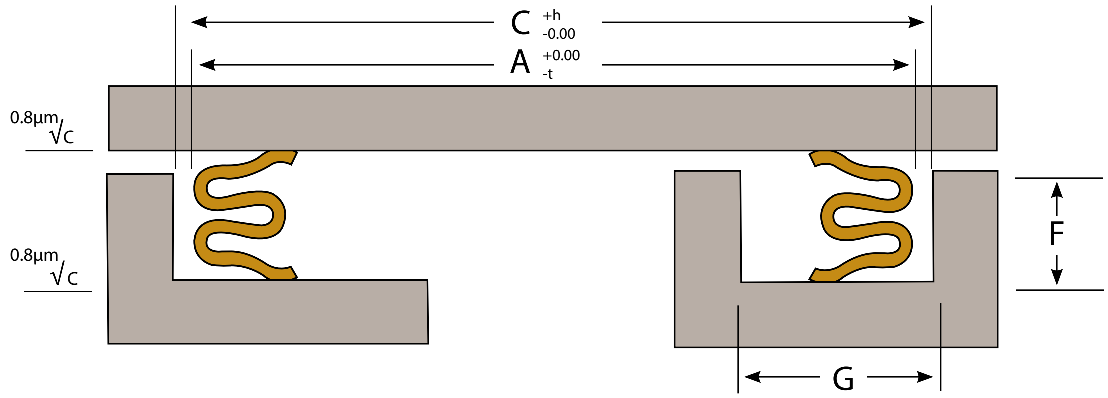
E-Flex™ Type	Free Height	Material Thickness	Seal Diameter	Seating Load Y_2 N/mm	Installation Springback	Installation Compression e_2
E-FLEX™	1.91	0.15	15.88 152.40	7 5	0.23 0.28	0.33
	2.49	0.20	15.88 203.20	18 11	0.33 0.36	0.53
	2.59	0.25	15.88 203.20	16 10	0.28 0.33	0.38
	3.35	0.20	31.75 609.60	6 3	0.33 0.36	0.36
	3.35	0.38	31.75 609.60	9 5	0.33 0.36	0.36
	5.54	0.38	85.73 1016.00	16 14	0.66 0.79	0.94
	6.17	0.25	152.40 1016.00	2 2	1.83 1.85	1.85
	7.49	0.51	152.40 1016.00	15 12	1.17 1.19	1.22
	9.53	0.51	203.20 1524.00	10 8	1.57 1.57	1.57
Super E-FLEX™	2.74	0.24	24.13 1016.00	7 5	0.38 0.53	0.53
	3.56	0.25	44.45 1016.00	4 2	0.56 0.56	0.56
	3.56	0.30	44.45 1016.00	7 4	0.53 0.56	0.56
Multiple Convolution E-FLEX™	5.31	0.18	635.00	5	1.02	1.22
	5.84	0.20	635.00	5	1.65	1.65
	6.17	0.25	635.00	8	1.17	1.45
	6.68	0.15	635.00	5	1.57	1.73
	7.26	0.25	635.00	4	1.55	1.55
	7.62	0.25	635.00	10	1.04	1.40

Dimensions in mm

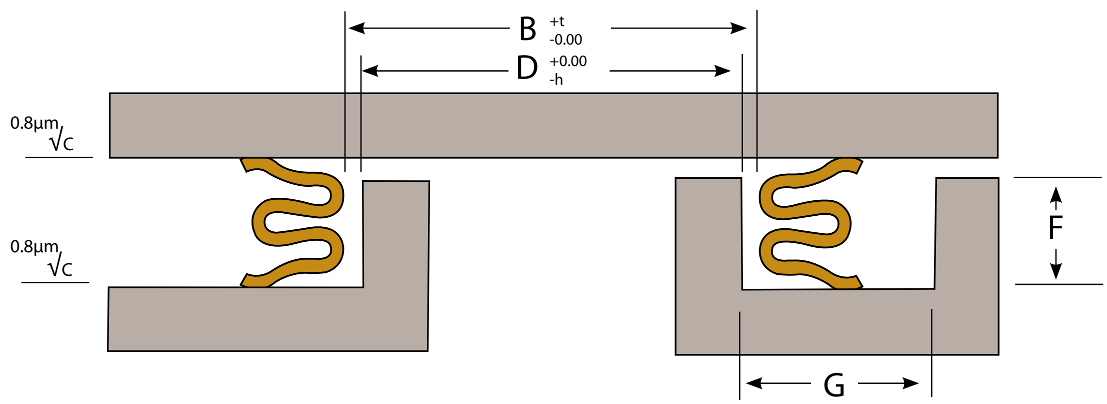
NOTES:
1. Seating load is in Newtons per millimeter of circumference.
2. Seating load (Y_2) is an approximation and may vary based on groove clearance, seal diameter, tolerance and coating thickness. It does not allow for system pressure requirements and should be verified for each application and seal 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	External
A = C-X-2Pmax	B = D + X + 2Pmax

Determining Groove Diameter:

Internal	External
C = A + X + 2Pmax	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™	1.91	0.15	1.68	34.54 to 152.40	30.48 to 152.40	0.08	1.57 ±0.03	2.29	2.29
	2.49	0.20	2.11	50.80 to 254.00	30.48 to 254.00	0.08	1.96 ±0.05	2.79	2.79
	2.59	0.25	2.31	50.80 to 254.00	30.48 to 254.00	0.08	2.21 ±0.03	2.92	2.92
	3.35	0.20	3.05	34.54 to 330.20	63.50 to 330.20	0.08	3.00 ±0.05	3.68	3.68
	3.35	0.38	3.05	34.54 to 330.20	63.50 to 330.20	0.08	3.00 ±0.05	3.68	3.68
	5.54	0.38	4.83	66.04 to 330.20	66.04 to 330.20	0.13	4.60 ±0.05	5.33	5.59
	6.17	0.25	6.60	85.73 to 1016.00	152.40 to 1016.00	0.13	4.32 ±0.08	7.62	8.13
	7.49	0.51	6.76	152.40 to 1524.00	152.40 to 1524.00	0.13	6.27 ±0.08	8.00	8.51
	9.53	0.51	8.64	203.20 to 1524.00	203.20 to 1524.00	0.13	7.95 ±0.08	10.29	10.80
Super E-FLEX™	2.74	0.24	3.68	50.80 to 330.20	63.50 to 330.20	0.08	2.21 ±0.05	4.32	4.57
	3.56	0.25	4.93	63.50 to 330.20	63.50 to 330.20	0.13	3..00 ±0.05	5.59	6.35
	3.56	0.30	4.93	63.50 to 330.20	63.50 to 330.20	0.13	3.00 ±0.05	5.59	6.35
Multiple Convolution E-FLEX™	5.31	0.18	2.95	254.00 to 1016.00	254.00 to 1016.00	0.08	5.05/4.22	4.57	4.57
	5.84	0.20	4.67	254.00 to 1016.00	254.00 to 1016.00	0.08	5.33/4.32	6.48	6.48
	6.17	0.25	3.81	254.00 to 1524.00	254.00 to 1524.00	0.08	5.87/4.85	5.59	5.59
	6.68	0.15	3.81	254.00 to 1016.00	254.00 to 1016.00	0.08	6.30/5.08	5.59	5.59
	7.26	0.25	5.08	254.00 to 1016.00	254.00 to 1016.00	0.08	6.86/5.84	6.86	6.86
	7.62	0.25	3.81	254.00 to 1524.00	254.00 to 1524.00	0.08	7.24/6.22	5.59	5.59

Dimensions in mm

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"
25.40 to 50.77	0.05	0.08	0.05	0.10	-	-
50.80 to 76.17	0.05	0.10	0.08	0.15	-	-
76.20 to 101.57	0.08	0.13	0.10	0.20	-	-
101.60 to 126.97	0.08	0.15	0.10	0.20	-	-
127.00 to 152.37	0.08	0.15	0.13	0.25	-	-
152.40 to 177.77	0.10	0.18	0.15	0.30	-	-
177.80 to 203.17	0.10	0.20	0.18	0.36	-	-
203.20 to 228.57	0.13	0.23	0.20	0.41	-	-
228.60 to 253.97	0.13	0.25	0.23	0.46	-	-
254.00 to 279.37	0.13	0.25	0.25	0.51	0.13	0.05
279.40 to 304.77	0.15	0.28	0.25	0.51	0.15	0.05
304.80 to 330.17	0.15	0.30	0.25	0.51	0.15	0.05
330.20 to 335.57	0.18	0.33	0.25	0.51	0.18	0.05
335.60 +	Contact Applications Engineering					

Dimensions in mm

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	25.40	31.72 31.62	24.33	1.02 0.51	2.87 2.62
E-800128 -125	AS1895/7 -125	31.75	38.07 37.97	30.68	1.02 0.51	2.87 2.62
E-800128 -150	AS1895/7 -150	38.10	44.42 44.32	37.03	1.02 0.51	2.87 2.62
E-800128 -175	AS1895/7 -175	44.45	50.77 50.67	43.38	1.02 0.51	2.87 2.62
E-800128 -200	AS1895/7 -200	50.80	57.12 57.02	49.73	1.02 0.51	2.87 2.62
E-800128 -225	AS1895/7 -225	57.15	63.47 63.32	56.08	1.02 0.51	2.87 2.62
E-800128 -250	AS1895/7 -250	63.50	69.82 69.67	62.43	1.02 0.51	2.87 2.62
E-800128 -275	AS1895/7 -275	69.85	76.17 76.02	68.78	1.02 0.51	2.87 2.62
E-800128 -300	AS1895/7 -300	76.20	82.52 82.37	75.13	1.02 0.51	2.87 2.62
E-800128 -325	AS1895/7 -325	82.55	88.87 88.67	81.48	1.02 0.51	2.87 2.62
E-800128 -350	AS1895/7 -350	88.90	95.22 95.02	87.83	1.27 0.76	2.87 2.62
E-800128 -400	AS1895/7 -400	101.60	107.92 107.72	100.53	1.27 0.76	2.87 2.62
E-800128 -450	AS1895/7 -450	114.30	120.62 120.37	113.23	1.27 0.76	2.87 2.62
E-800128 -500	AS1895/7 -500	127.00	133.32 133.07	125.93	1.52 1.02	2.87 2.62
E-800128 -550	AS1895/7 -550	139.70	146.02 145.72	138.63	1.52 1.02	2.87 2.62
E-800128 -600	AS1895/7 -600	152.40	158.72 158.42	151.33	1.52 1.02	2.87 2.62
E-800128 -650	AS1895/7 -650	165.10	171.42 171.07	164.03	1.65 1.14	2.87 2.62
E-800128 -700	AS1895/7 -700	177.80	184.12 183.77	176.73	1.65 1.14	2.87 2.62
E-800128 -750	AS1895/7 -750	190.50	196.82 196.42	189.43	1.65 1.14	2.87 2.62

Dimensions in mm
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: (mm) Radial: Axial: #Cycles:

Material: Thickness:

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

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

❑ 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 (Ra µm) 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:

Garlock Helicoflex®
PERFORMANCE METAL SEALS
an EnPro Industries company

NUCLEAR
Nuclear Reactor Pressure Vessel Seals

Sealing Concept

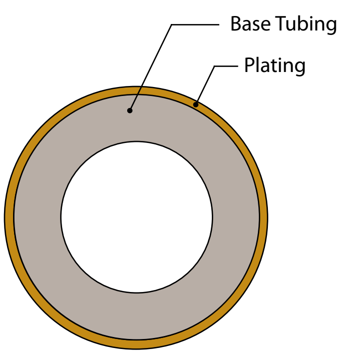
Garlock Helicoflex is the world's leading manufacturer of Nuclear Reactor Pressure Vessel (RPV) Closure Head Seals. In addition, Garlock Helicoflex sealing technology is used extensively as primary seals on spent fuel storage and transportation casks.

O-FLEX™ Metal O-Rings

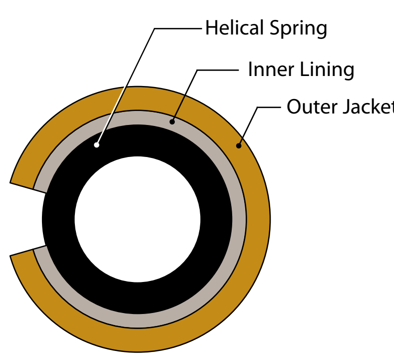
The O-Flex™ is manufactured of Alloy 718 or Stainless Steel 304 tubing. Alloy 718 is the most common and preferred material because it offers optimum strength, spring back and resistance to radiation and corrosion. The base tubing is plated with pure (99.95%) silver. This combination of elastic core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

HELICOFLEX® Spring Energized Seals

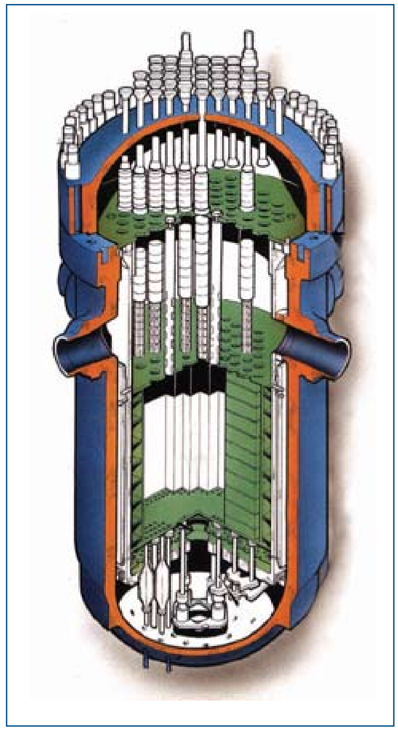
The Helicoflex® seal is a high performance, flexible, metal seal that has exceptional compression and elastic recovery properties. The Helicoflex seal is composed of a close-wound helical spring surrounded by two metal jackets. The spring is selected to have a specific compression resistance. During 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®



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

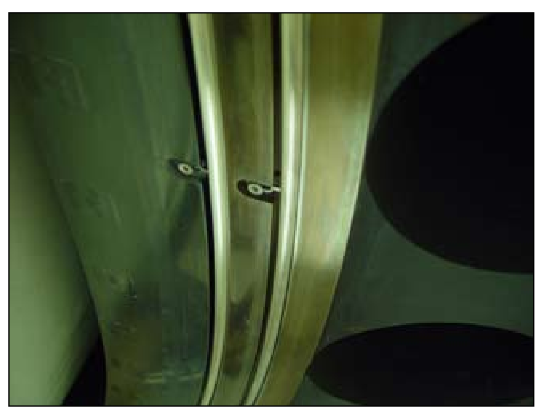
General Services

- 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 Y_2 N/mm	Installation Compression e_2	Installation Compression %	Total Springback (Min.)
9.53	0.97	1016 to 4572		0.76	8%	0.23
				0.94	10%	0.23
				1.14	12%	0.23
			438	**1.52**	**16%**	**0.23**
				1.63	17%	0.23
12.70	1.27	3048 to >4572		1.02	8%	0.38
				1.27	10%	0.38
				1.52	12%	0.38
			438	**2.03**	**16%**	**0.38**
				2.16	17%	0.38
15.88	1.60	3048 to >4572		1.27	8%	0.43
				1.57	10%	0.43
				1.91	12%	0.43
			700	**2.54**	**16%**	**0.43**
				2.69	17%	0.43

Dimensions in mm

NOTE: Recommended compression % for NRPV O-FLEX is 16%

RPV Helicoflex: HN200

			HIGH TEMPERATURE ALLOY SPRING			
Free Height	Wall Thickness	Recommended Diameter Range	Seating Load Y_2 N/mm	Installation Compression e_2	Installation Compression %	Total Springback (Min.)
13.21	N/A	1016 to > 4572	700	1.32	10%	0.43

Dimensions in mm

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 762 mm of seal circumference. This will ensure that the seal is securely held in place.

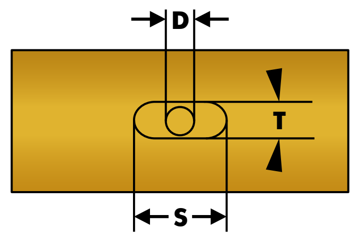
Type I

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™.

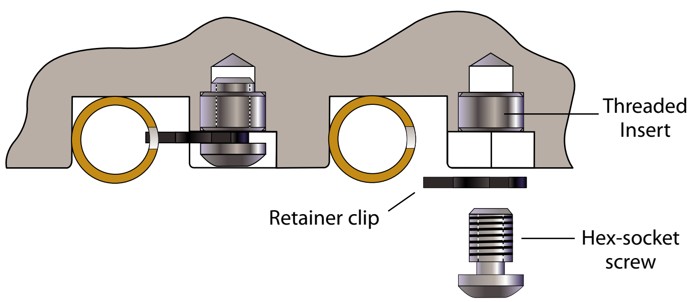
Type I Clip (O-FLEX Only)

Free Height	Wall Thickness	Slot Length S	Slot Width T	Hole Diameter D
9.53	0.97	7.14	3.18	1.78
12.70	1.27	9.53	5.21	2.36
15.88	1.60	11.13	6.50	3.18

Dimensions in mm



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

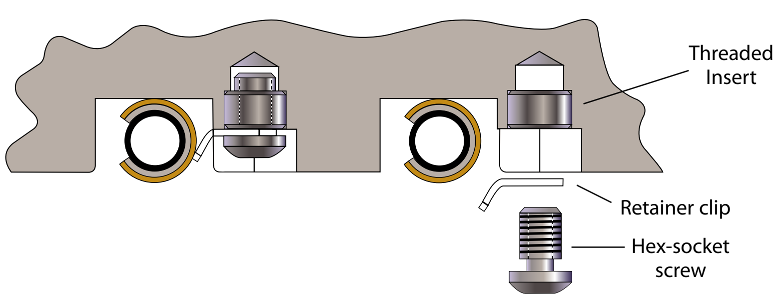


O-FLEX Diameter	Number of Slots
up to 1829	4
1829 to 3658	8
3658 to 5080	12
5080 +	16 or 24

Dimensions inmm

Type II

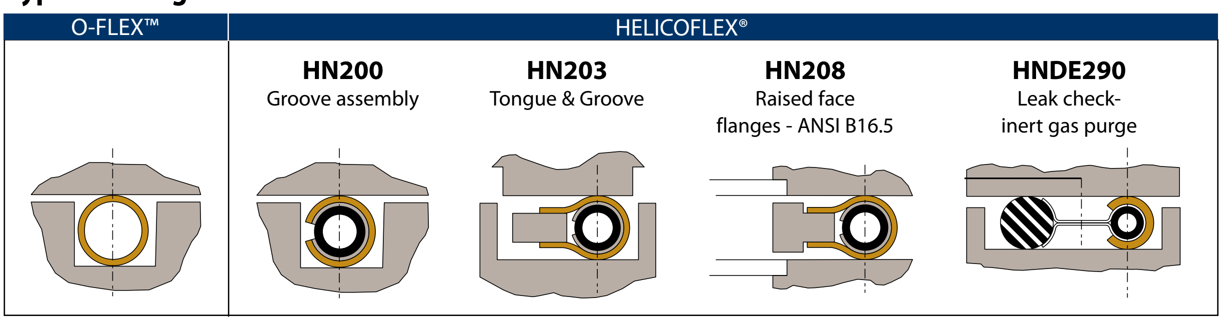
This style clip can be used with either the O-Flex™ or the Helicoflex® RPV seals. It is designed to hold the seal to the outer circumference of the groove without having to penetrate the ring through a slot. This makes seal installation easier since the seal does not require special alignment.



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



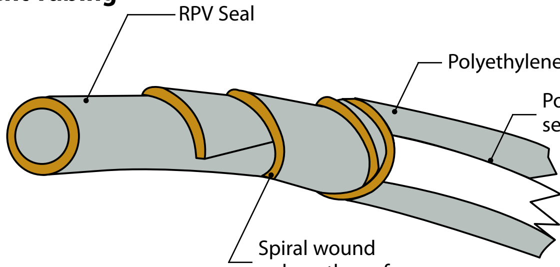
TN-40 Dry Storage Cask

TN-32 Dry Storage Cask

RPV Closure Head Seal Packaging

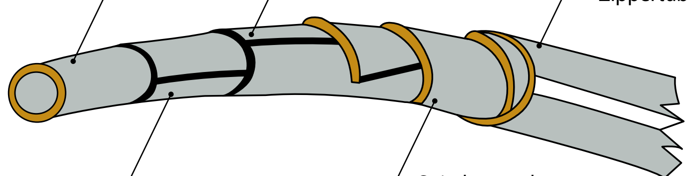
Garlock Helicoflex offers two styles of protective packaging for RPV seals:

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: (mm) Radial: Axial: #Cycles:

Material: Thickness:

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

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

❏ 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 (Ra μm)	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:

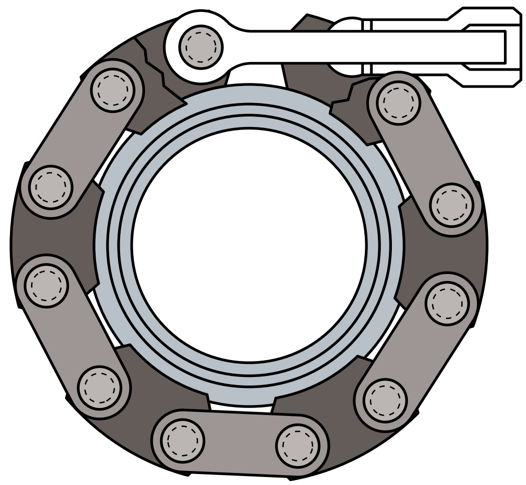
Other:

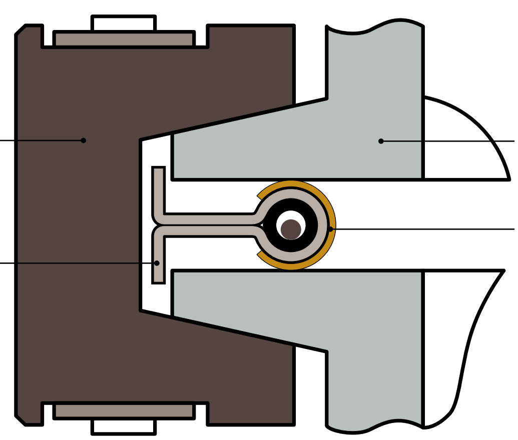
Garlock Helicoflex®
PERFORMANCE METAL SEALS

an EnPro Industries company

Sealing Concept

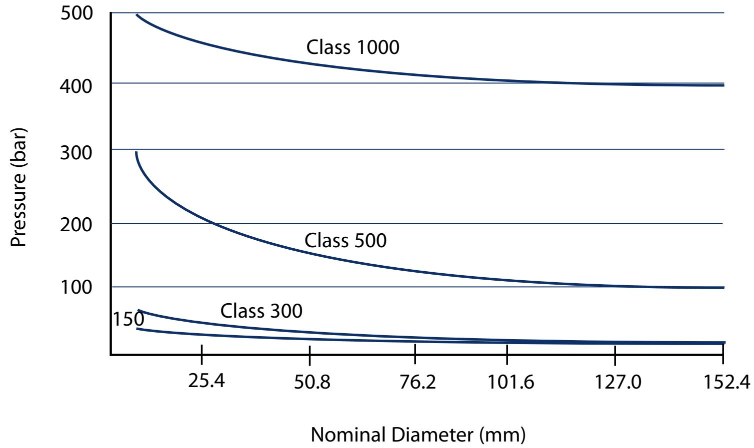
The Quick Disconnect System (QDS®) is designed to be assembled and disassembled quickly while offering space saving features. A typical QDS® requires less space than a traditional bolted assembly and can be easier to install, especially in tight locations where access to bolts and screws may be difficult. 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.





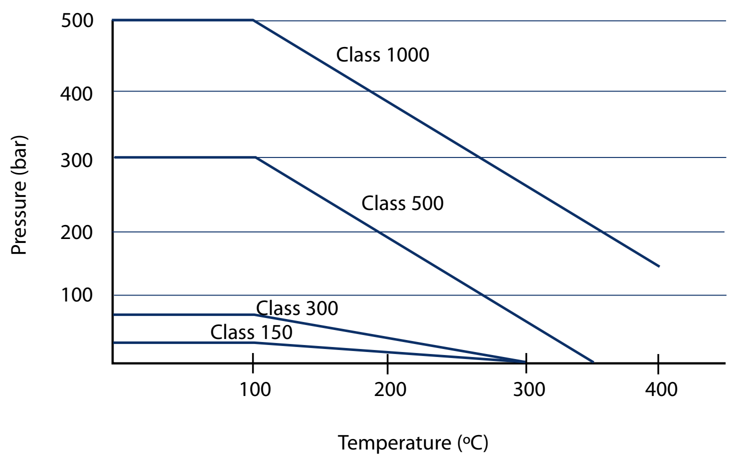
Quick Disconnect System (Section View)

Pressure Limits x Nominal Diameter (21ºC)



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)	**38mm** **Pipe/Tube OD** (Class 300/500)	**1.6mm** **Pipe Schedule** Tube thickness (Class 300/500)	**Short** **Stub Length** (Class 300/500)

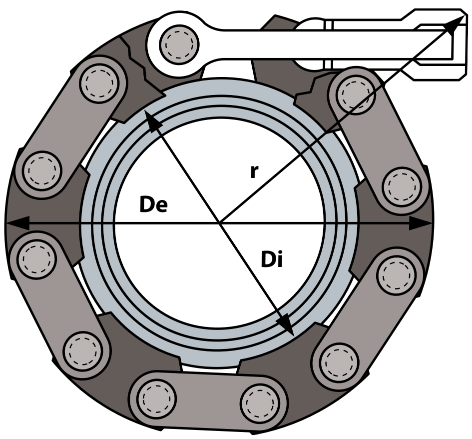
Example:
300KF55 38mm, 1.6mm, short
Class 300
Type KF
Flange OD = 55mm
Pipe OD = 38mm
Pipe thickness = 1.6mm
Stub Length = Short (30mm)

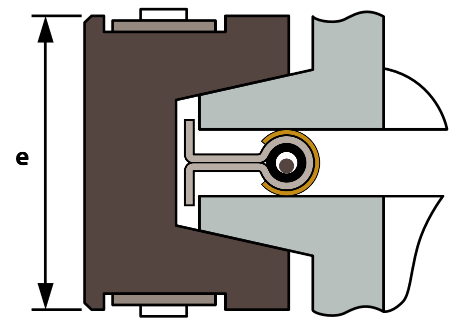
Blind Flanges:
Blind Flanges may be specified by placing a "T" in front of the Reference Number

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

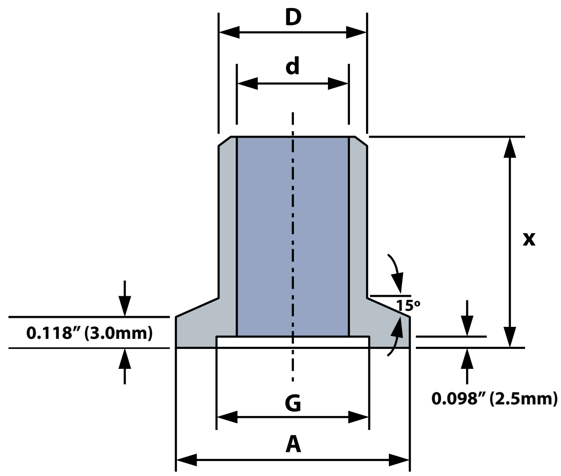
Material:
- Stainless Steel links
- Stainless Steel side-plates
- Steel screw (stainless steel on request)

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 A 30	2.362	60	0.787	20	2.165	55	1.260	32	870	60	53	6
20/25	300 A 40	2.756	70	1.181	30	2.284	58	1.260	32	580	40	89	10
32/40	300 A 55	3.307	84	1.772	45	2.441	62	1.260	32	580	40	124	14
50	300 A 75	3.937	100	2.559	65	2.756	70	1.260	32	290	20	159	18

Flanges: ISO KF

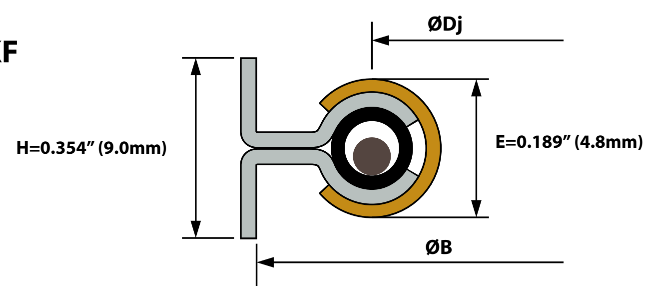


Standard ISO KF Flange per ISO 2861

ISO KF Nominal Diameter	A in	A mm	D in	D mm	d in	d mm	G in	G mm	X-short in	X-short mm	X-long in	X-long mm	Flange ref. number
FLANGE DIMENSIONS													
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

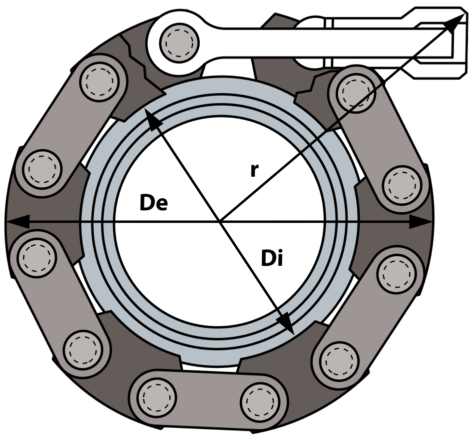


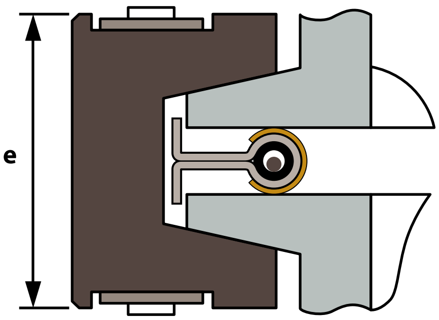
Helicoflex Spring Energized Seal Type: HL290P

ISO KF Nominal Diameter	ØDj in	ØDj mm	ØB in	ØB mm	Seal Type
SEAL DIMENSIONS - ALUMINUM JACKET					
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



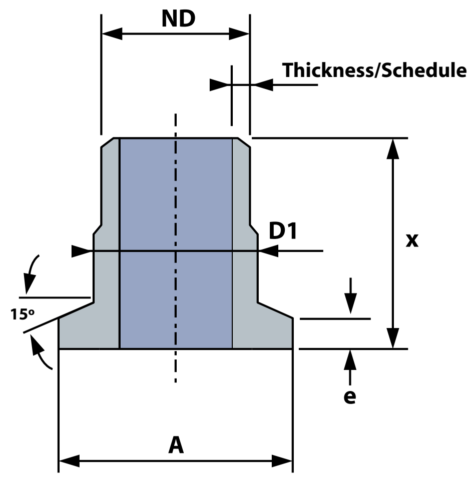


Material:
- Stainless Steel links
- Stainless Steel side-plates
- Steel screw (stainless steel on request)

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

Clamp Reference	Tube OD (Max)		Clamp Dimensions De		Di		r		e		Pressure (Max)	Torque (Max)
	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

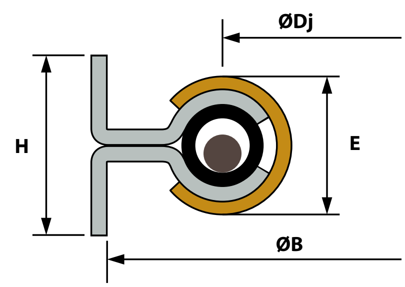
Flanges: Class 300



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

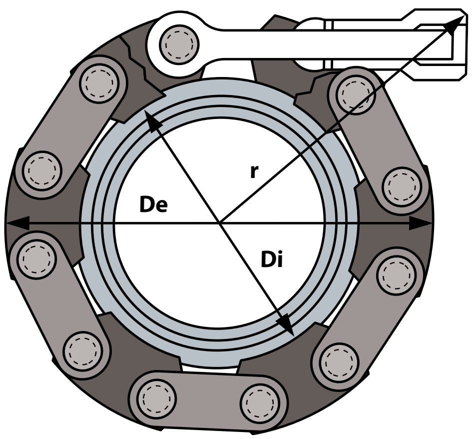
Seals: Class 300

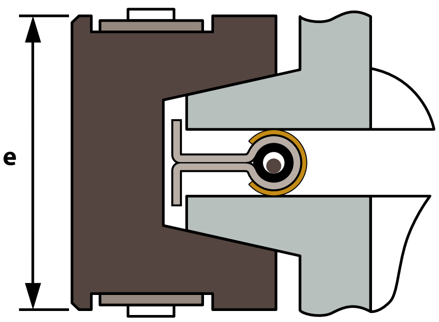


Helicoflex Spring Energized Seal Type: HL290P

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



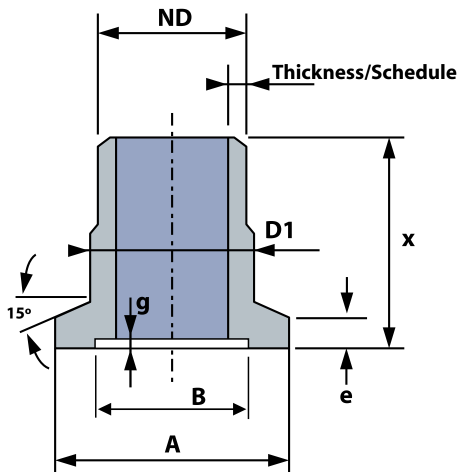


Material:
- Stainless Steel links
- Stainless Steel side-plates
- Steel screw

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

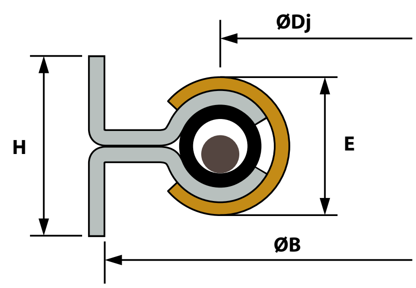
Clamp Reference	Tube OD (Max)		Clamp Dimensions								Pressure (Max)	Torque (Max)
			De		Di		r		e			
	in	mm	in	mm	in	mm	in	mm	in	mm	psi	ft.lb
500 A 30	0.709	18	2.362	60	0.787	20	2.165	55	1.260	32	4350	13
500 A 40	1.102	28	2.756	70	1.181	30	2.283	58	1.260	32	2900	13
500 A 55	1.693	43	3.307	84	1.772	45	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										Flange Reference
	A		B		D1		g		e		
	in	mm	in	mm	in	mm	in	mm	in	mm	
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								Seal Reference
	ØB		ØDj		E		H		
	in	mm	in	mm	in	mm	in	mm	
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: ______________ (Ra µm)

Flange Material ______________________

❑ Special

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

Flange Material = ___________

Ø D = ___________

Ø A = ___________

Flange Thickness h = ___________

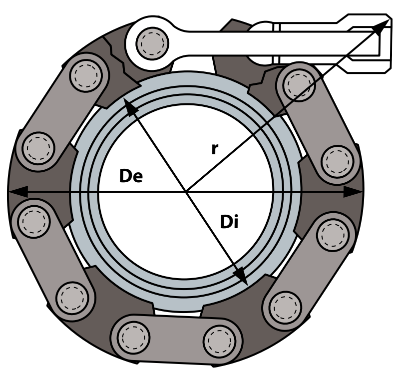
Flange Angle ∝ = ___________

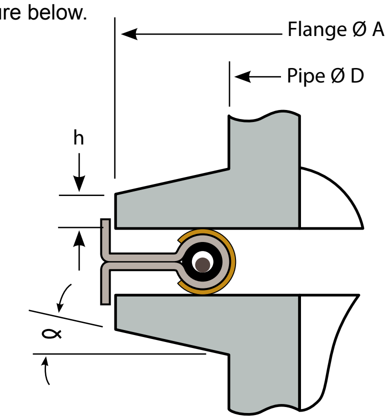
Clamp Width/Thickness = ___________

Clamp Clearance De = ___________

Bolt Clearance r = ___________

Flange Stub Length = ___________





PIPE DETAILS

Size: ______________________ Material Grade: ______________________

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

COMMENTS / NOTES

____

____

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.

Garlock Helicoflex makes no warranty, express or implied, that utilization of the technology or products disclosed herein will not infringe any industrial or intellectual property rights of third parties.

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.

All technical data, specifications and other information contained herein is deemed to be the proprietary intellectual property of Garlock Helicoflex. No reproduction, copy or use thereof may be made without the express written consent of Garlock Helicoflex.

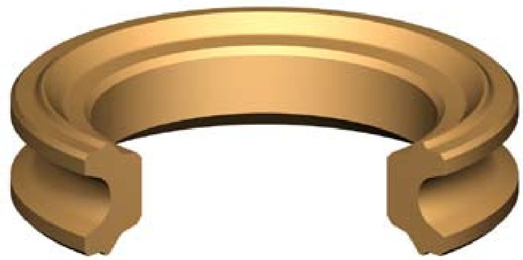
Garlock Helicoflex®
PERFORMANCE METAL SEALS

an EnPro Industries company

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.

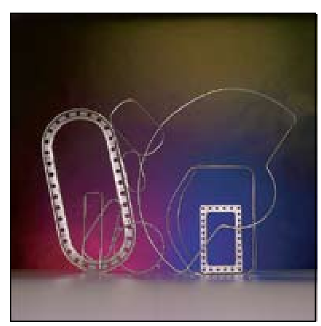


U-Flex™

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: (mm) Radial: Axial: #Cycles:

Material: Thickness:

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

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

❏ 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 (Ra µm) 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 1093ºC for 3 minutes
Nickel: Anneal at 718ºC 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/in^3 (g/cm^3)	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 (540ºC)	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 (650ºC).	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 (590ºC).	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 (730ºC).	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.

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

Garlock Helicoflex®
PERFORMANCE METAL SEALS
an EnPro Industries company

Performance of Resilient Metal Seals

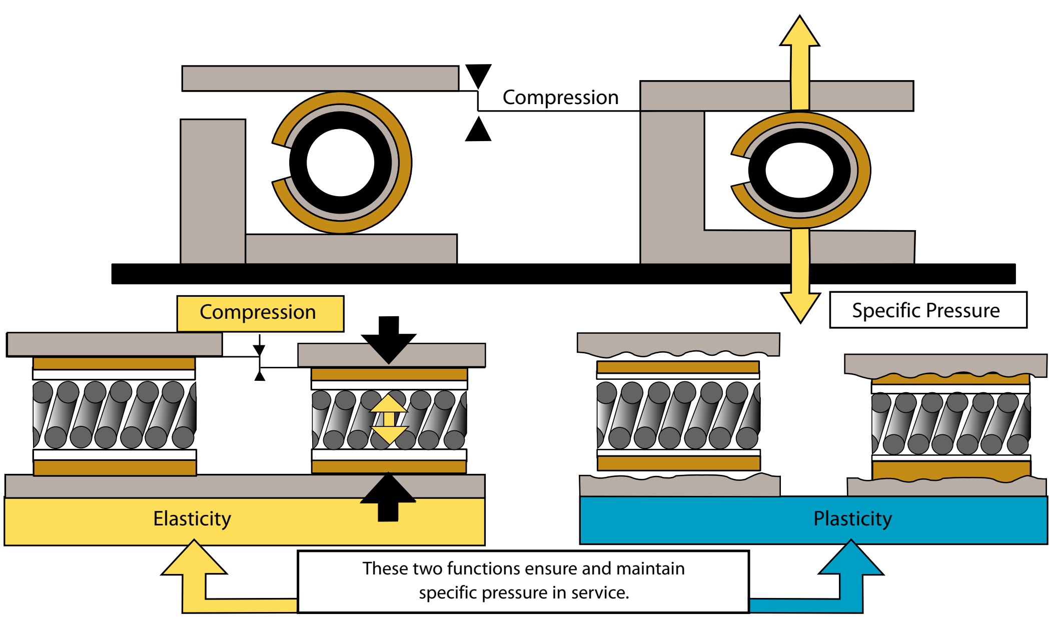
The performance of a resilient metal seal depends on two basic factors: elasticity and plasticity. The concept is similar to an elastomer seal such as Viton or Buna. The difference is that the elastomer compound serves both functions where a metal seal must use two components: a substrate and a soft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

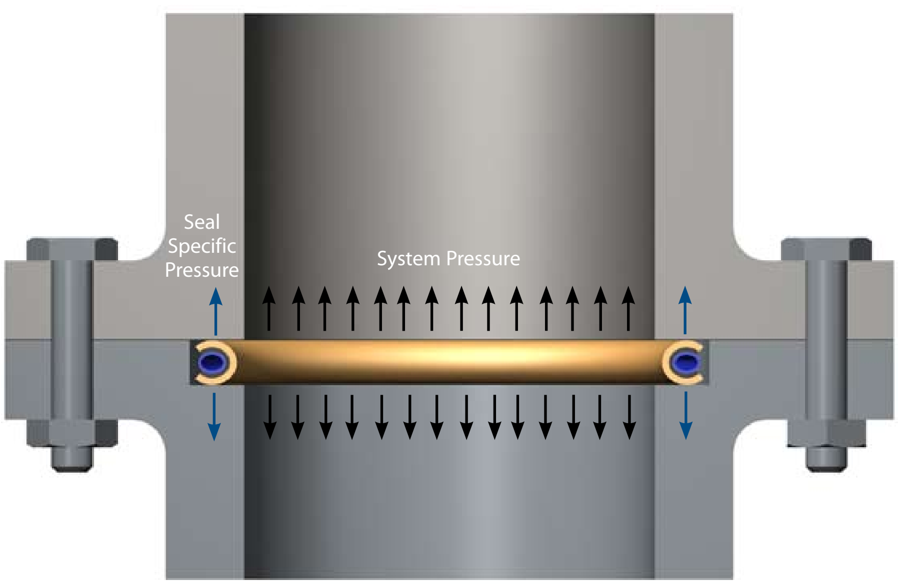
A bolted joint is an assembly that relies on each component to work properly. The performance and success of the bolted joint depends on the quality and design of each of these components. There are three major components of every bolted joint:

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 Newtons per millimeter of circumference.

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 = 100 mm, CS = 3.18 mm, wall thickness = 0.51mm
Y_2 = 200 N/mm

Operating Conditions:
Pressure: 3.45 MPa, Temperature: 21ºC

Seating Load = 100 mm x π x 200 N/mm = 62832 N
Hydrostatic Load = 3.45 MPa x (π/4) x (100 mm)^2 = 27096 N

Total Bolt Load Estimate ≥ 62832 N + 27096 N + 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 (N-m)
K*= dynamic coefficient of friction (i.e. minimum = .15 (dry-zinc plated))
P= total bolt load / number of bolts (N)
D= nominal bolt diameter (mm)

(* 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. <u>The customer is responsible for the flange design and for ensuring that the flanges, bolts and bolt loads are sufficient for the application.</u> Please refer to Section VIII of the ASME Boiler and Pressure Vessel Code for code requirements.

Typical Bolt / Fastener Information

Size	Nominal Diameter mm	Tensile Stress Area mm²	207 MPa Stress		310 MPa Stress		414 MPa Stress	
			Fastener Preload N	Torque Req'd K= .15 (N.m)	Fastener Preload N	Torque Req'd K= .15 (N.m)	Fastener Preload N	Torque Req'd K= .15 (N.m)
M1.6 x 035	1.6	1.27	263	0.06	394	0.09	526	0.13
M2 x 0.4	2.0	2.07	428	0.13	642	0.19	857	0.26
M2.5 x 0.45	2.5	3.39	702	0.26	1051	0.39	1403	0.53
M3 x 0.5	3.0	5.03	1041	0.47	1559	0.70	2082	0.94
M4 x 0.7	4.0	8.78	1817	1.09	2722	1.63	3635	2.18
M5 x 0.8	5.0	14.20	2939	2.2	4402	3.3	5879	4.4
M6 x 1	6.0	20.10	4161	3.7	6231	5.6	8321	7.5
M8 x 1.25	8.0	36.60	7576	9.1	11346	13.6	15152	18.2
M10 x 1.5	10.0	58.00	12006	18.0	17980	27.0	24012	36.0
M12 x 1.75	12.0	84.30	17450	31.4	26133	47.0	34900	62.8
M16 x 2	16.0	157.00	32499	78	48670	117	64998	156
M20 x 2.5	20.0	245.00	50715	152	75950	228	101430	304
M24 x 3	24.0	353.00	73071	263	109430	394	146142	526
M30 x 3.5	30.0	561.00	116127	523	173910	783	232254	1045
M36 x 4	36.0	817.00	169119	913	253270	1368	338238	1826

NOTES:

1. Contact Applications Engineering for other sizes.
2. These values/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.

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.

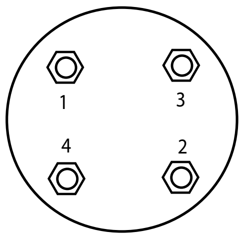
Note: Large seals (> 915 mm) should be supported every three feet of circumference to prevent bending or crimping.

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.

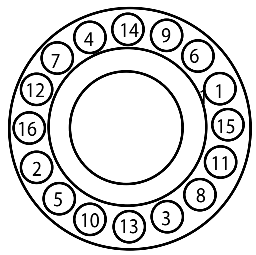
Bolt Tightening Bolts should be tightened using a star pattern (see diagram). Number the bolts with an indelible marker to make the process easier. First, tighten the nuts until "finger tight". Then, tighten bolts in one-third increments, according to the proper star bolting pattern. Make a final check 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.

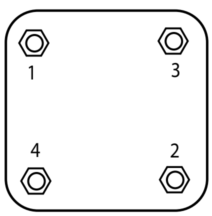
Correct Bolting Patterns



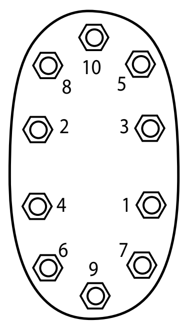
Circular Four-Bolt



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 0.30 mm to 0.51 mm thick where Silver plating is approximately 0.03 mm to 0.05 mm 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.

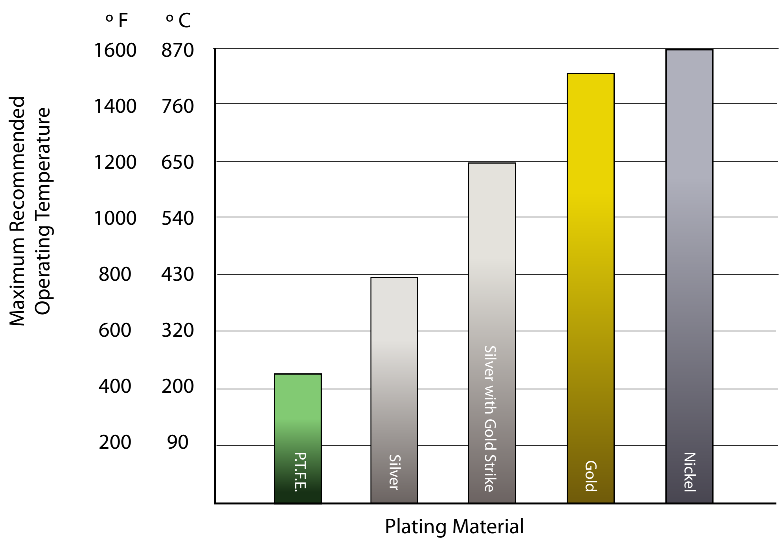
The Helicoflex seal spring is specifically designed for each jacket material to ensure plastic deformation is achieved.

Platings/Coatings Platings and coatings are applied directly to the seal substrate. Typically these treatments are very thin and are usually 0.03/0.05 mm 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: 1.60 mm to 3.99 mm = minimum load of 70 N per mm of circumference.
Cross sections: 4.78 mm to 6.35 mm = minimum load of 140 N per mm of circumference.

Maximum Recommended Operating Temperatures for Platings and Coatings



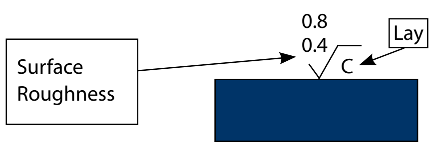
Contact Applications Engineering for additional platings and coatings.

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.

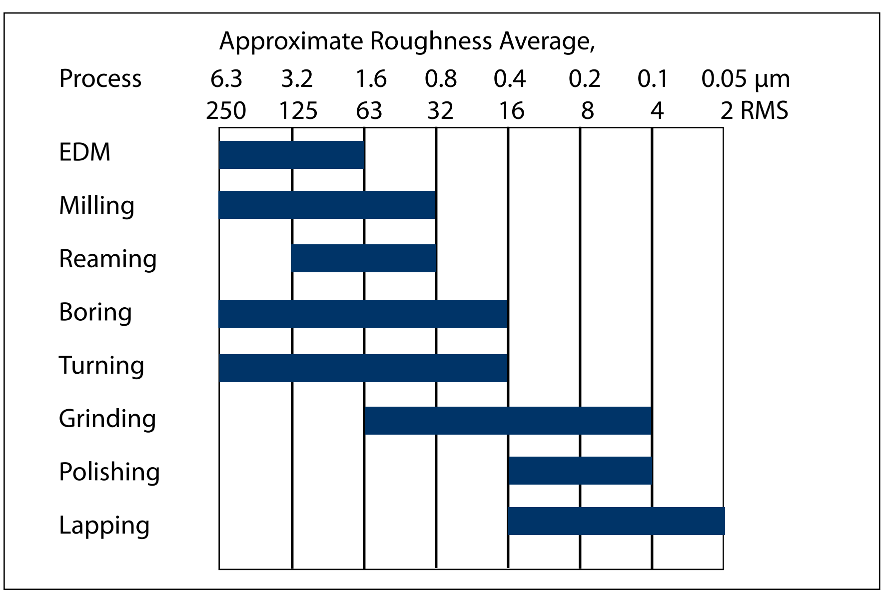
Surface roughness is usually specified with a "check mark" symbol on a drawing as shown in the figure below. Surface roughness is typically indicated in Ra Micrometers (Raμm) and is located on the left side of the symbol above the check mark. In the example below the roughness value is 0.8 μm maximum and 0.4 μm 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.

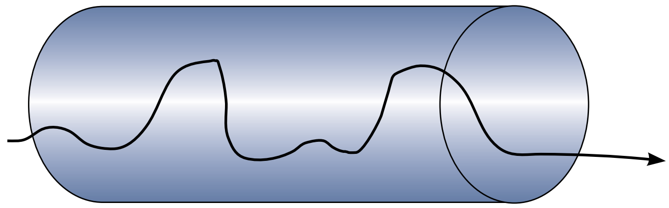
Helicoflex designs and manufactures a wide range of seals to satisfy a broad range of sealing requirements including leakage rate. Therefore, it is necessary to establish leakage rate criteria so that a suitable seal can be selected or designed. A specification that defines a "no leak" or "zero leakage" 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

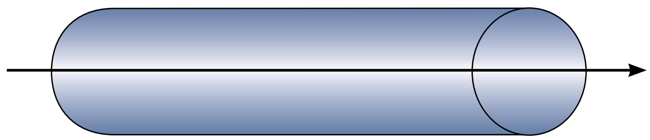
Gas flow is used in characterizing leakage and performing leakage testing. Even at very low pressures, gases behave and flow like fluids. Gas flow is categorized into different types of flow modes as follows:

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}

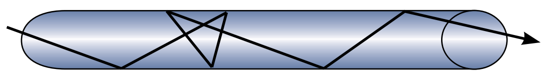
Note: Both turbulent flow and laminar flow are types of viscous flow.



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	$\leq 1 \times 10^{-11}$ std.cc/sec He	**Seal Load:** Wall Thickness or Spring Load
Helium	$\leq 1 \times 10^{-9}$ std.cc/sec He	**Surface Finish:** Seal and Cavity
Bubble	$\leq 1 \times 10^{-4}$ 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

Multiply \ To Obtain		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

Multiply \ To Obtain		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

Multiply \ To Obtain		$torr.l.s^{-1}$	$atm.cm^3.s^{-1}$	$mbar.l.s^{-1}$	$Pa.m^3.s^{-1}$
$torr.l.s^{-1}$	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

Multiply \ To Obtain		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

Multiply \ To Obtain		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

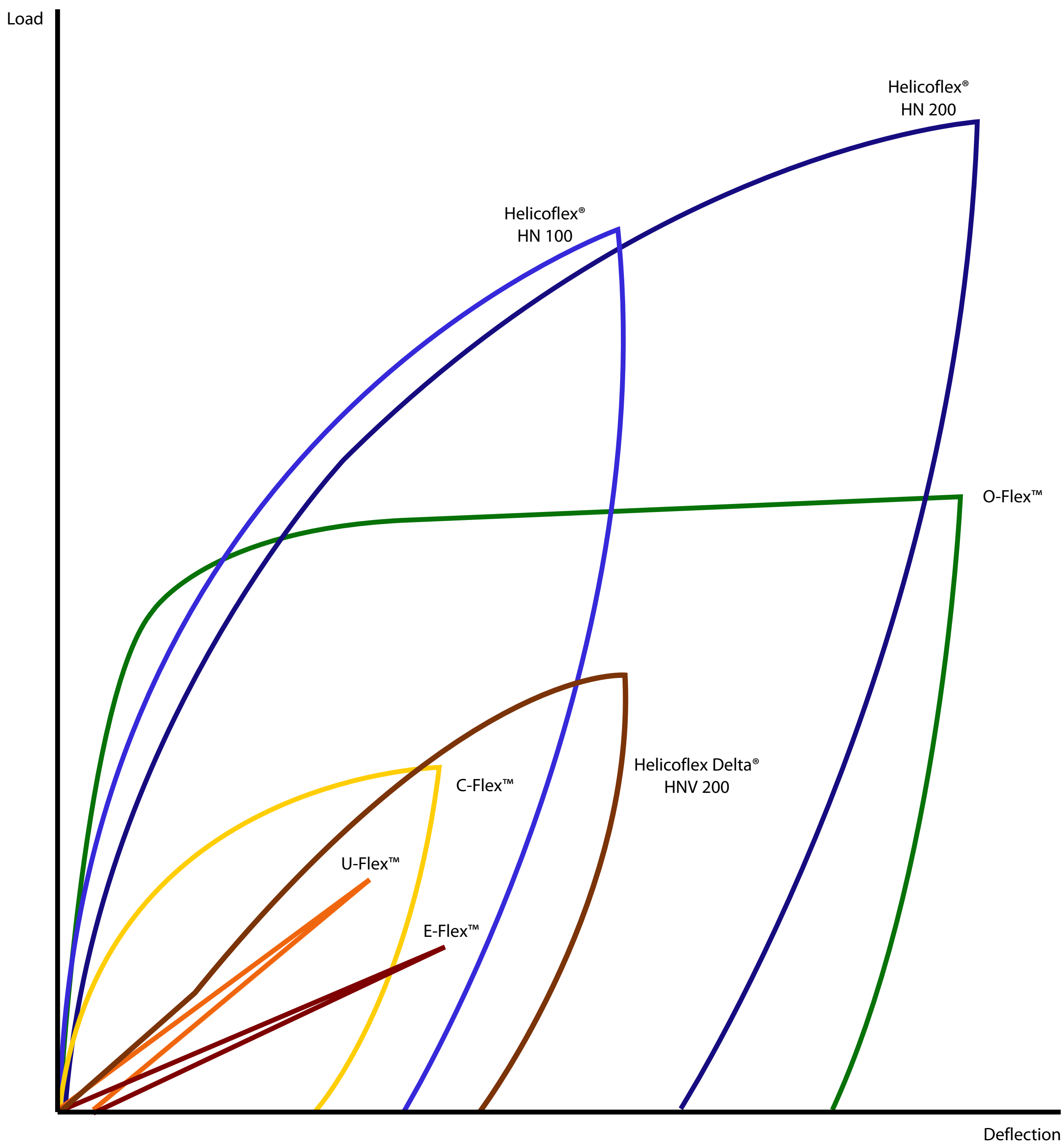
Units of Load/Unit Length

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™
Helicoflex Delta®
HNV 200
C-Flex™
U-Flex™
E-Flex™
Deflection

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.

Garlock Helicoflex makes no warranty, express or implied, that utilization of the technology or products disclosed herein will not infringe any industrial or intellectual property rights of third parties.

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.

All technical data, specifications and other information contained herein is deemed to be the proprietary intellectual property of Garlock Helicoflex. No reproduction, copy or use thereof may be made without the express written consent of Garlock Helicoflex.

Garlock Helicoflex®
PERFORMANCE METAL SEALS

an EnPro Industries company