

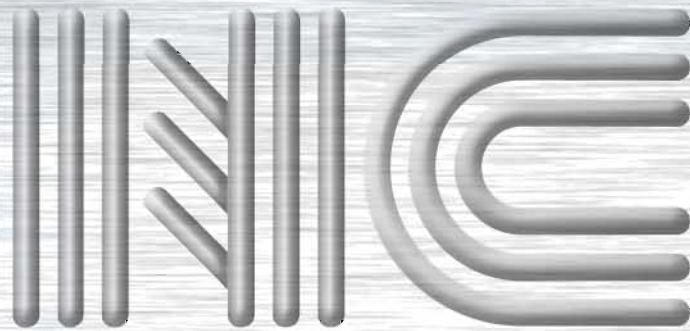
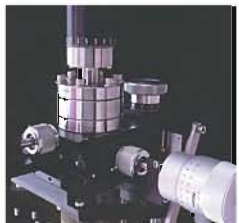


Nor-Cal Products



# Nor-Cal Products

*where technology takes shape*



*vacuum products catalog*

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# Nor-Cal Products

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*In order to meet the changing needs of our customers, we periodically make design revisions to our standard product line. As a result, all dimensions and specifications are subject to change without notice.*





# Nor-Cal Products

## A Source of Experience



*Manufacturing, sales and corporate offices, Yreka, California*

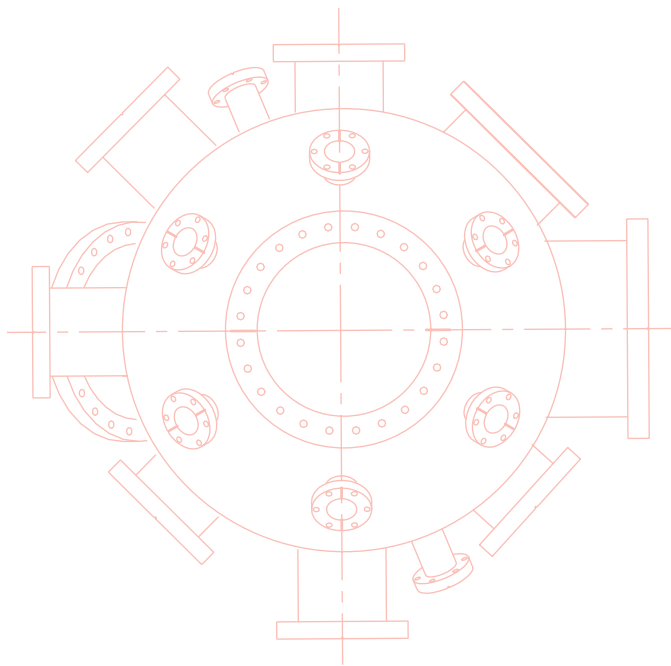
Nor-Cal Products, Inc. was incorporated in 1962 and began fabricating stainless steel flanges, fittings, and custom components exclusively for the then emerging vacuum industry. Nor-Cal's knowledge of welding, machining, forming and cleaning stainless steel allowed us to quickly become the premier supplier to equipment manufacturers and national laboratories. Nor-Cal coauthored the specification for vacuum fittings at Lawrence Livermore National Laboratory that became the standard for vacuum component manufacturers. Our ability to provide consistently high quality and on-time deliveries of OEM components made us the preferred supplier for pump bodies, vacuum chambers and other vacuum subassemblies.

We continued to work with end users on vacuum research systems, while developing our own product lines including foreline traps, isolation valves and electrical feedthroughs. In 1978 we released our own product catalog. During 1997 Nor-Cal began a research and development program for downstream pressure control valves and controllers. Our most recent catalog contains over 4,000 standard items for almost every vacuum application.

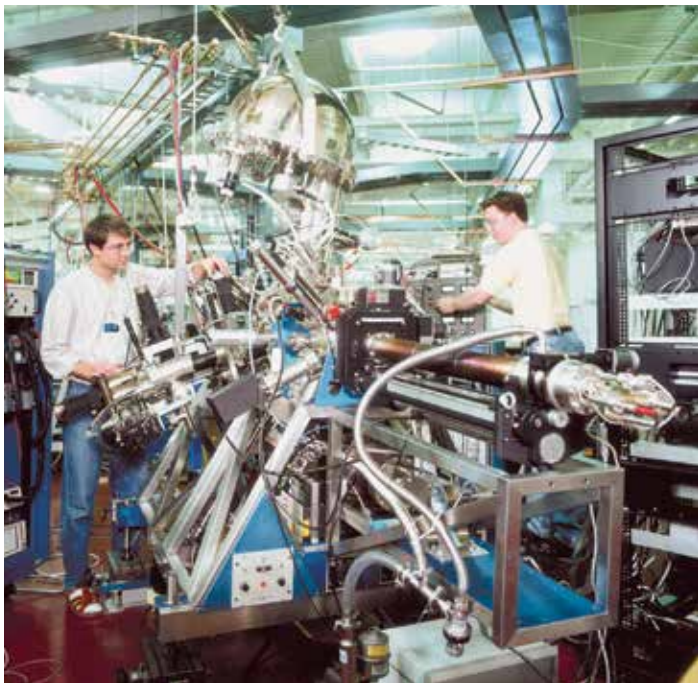


Nor-Cal has long been regarded as an anchor in the vacuum community. We are long time supporters, sponsors or members of the American Vacuum Society (AVS), Society of Vacuum Coaters (SVC), Association of Vacuum Equipment Manufacturers (AVEM) and Semiconductor Equipment and Materials International (SEMI).

Nor-Cal's 85,000 square foot corporate office and manufacturing facility is located in Yreka, California. Sales and service offices are located in Santa Clara, California, Singapore and Korea. Our customers are served by a worldwide network of sales representatives.





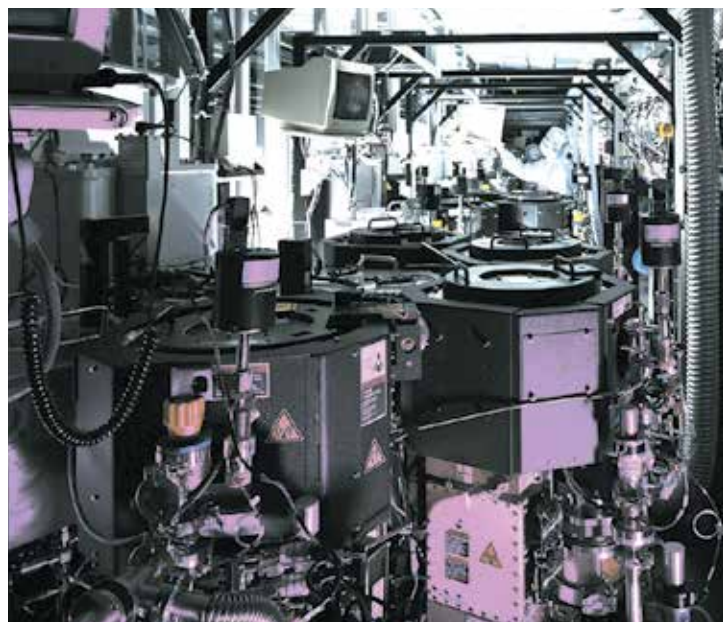


Surface science research end station at Advanced Light Source, Berkeley, California

Over the years Nor-Cal's customer base has been drawn from all segments of the vacuum industry. Our components are used in almost every phase of semiconductor processing. We are a preferred supplier to several semiconductor and compound semiconductor equipment manufacturers. We also supply mechanical contractors during fab construction. Industrial and academic researchers are frequent purchasers of standard, modified standard and custom components for physical, chemical and electrochemical experiments. Other customers who have come to value our experience are instrument manufacturers of surface analysis equipment, thin film deposition system manufacturers for solar or industrial coatings, laser device manufacturers and aerospace industries.



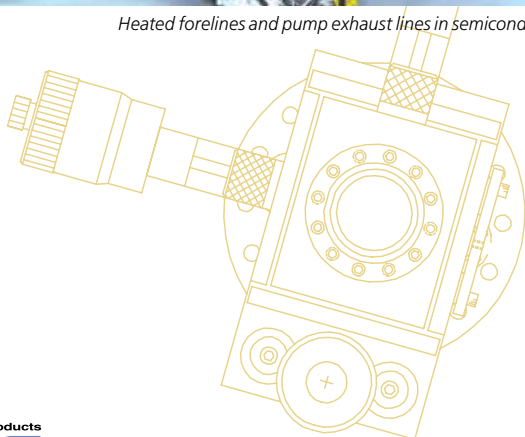
Heated forelines and pump exhaust lines in semiconductor subfab



Semiconductor process equipment in the service chase of a 200mm fab



Thin film deposition systems







# Nor-Cal Products

## Standard Components

### Flanges, Fittings & Hardware

Our flanges are made from 304 stainless steel material, which is specially processed to reduce impurities, grain size and microscopic leak paths. They are available in all commonly used high and ultra-high vacuum flange types, including ASA, NW (ISO-KF), ISO, CF and wire seal flanges. We also offer chain clamps and metal seals to convert a high vacuum NW flange to ultra-high vacuum.

Fittings are available with or without flanges. Weld fittings (without flanges) are typically sold to mechanical contractors for use during the fit up phase of new fab construction.

Nor-Cal Products provides a broad range of adapter fittings in order to connect two dissimilar types of components. They are made from 304 stainless steel and are TIG welded, cleaned and leak checked for vacuum service.

Flexible stainless steel hoses are available in three thicknesses to accommodate many applications and bend radius requirements. Nor-Cal's flexible couplings have more convolutions than comparable products, resulting in greater flexibility and lower spring rates. Plasticized PVC hoses can be used as a low cost rough vacuum line.

Our electrical feedthroughs are manufactured from ultra-high vacuum grade materials, such as high alumina ceramic insulators, OFHC copper and nickel conductors, and 304 stainless steel flanges. Types include thermocouple, instrumentation, medium current, high current, BNC, and MHV feedthroughs.

Nor-Cal Products' liquid and liquid nitrogen feedthroughs are available with or without industry standard Cajon, VCR or Swagelok fittings.

We offer a complete line of UHV compatible flanged viewports, weld stub viewports and viewport shutters. Shutters prevent buildup of process materials on the inside of the viewport window. Glass adapters are useful for mounting glass accessories to metal high vacuum systems, or to attach flange mounted components to glass systems.

### Isolation Valves

Nor-Cal offers vacuum isolation valves for a broad range of sizes, pressures and applications. Our pneumatically actuated poppet valves are standard on semiconductor equipment because of their robust design and edge-welded AM 350 stainless steel bellows, which provide full-opening conductance. Copper seal bonnet and manual all-metal valves are available for UHV applications. N-Series and Genesis modular valves were designed specifically for semiconductor equipment that require million-cycle reliability, small footprint and low-cost soft start and heating options. Additionally, Nor-Cal provides traditional linear as well as low-particulate pendulum style gate valves for isolation of high vacuum pumps and UHV chambers. We now also offer a selection of leak valves, manual butterfly valves and pneumatic and manual ball valves.



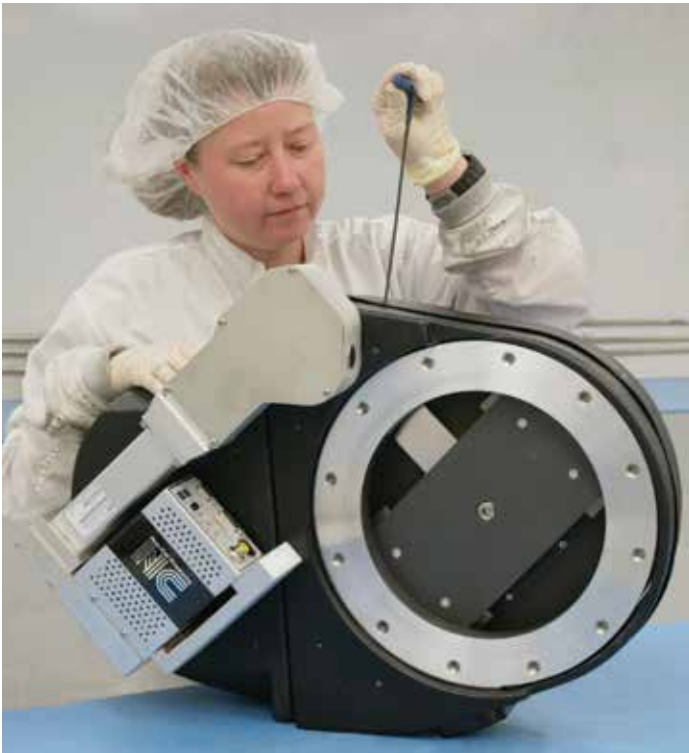
Valve assembly in Class 1000 clean room



Electropolishing weld fittings



CNC machining



*Pendulum valve assembly*



*Leak testing pendulum valves*

### Intellisys Pressure Control Components

Intellisys adaptive pressure controllers and throttle valves reduce time to pressure set-point, while increasing tool throughput with over 100,000 control resolution steps and a 20 times valve speed increase. Sealing and non-sealing butterfly valves are available with or without on-board control. Throttling pendulum valves and SoftShut linear gate valves provide unequalled pressure control as well as isolation for large bore high vacuum pumps. Heated and unheated capacitance diaphragm gauges and heater jackets are available as options.



### Thermal Products

Silicone foam and fiberglass insulated heaters with thermostat or PID control are available to heat our components to temperatures up to 200°C. Typical applications are downstream from CVD or metal etch systems, where unreacted by-products condense on the inside of the vacuum lines, valves and other components. Our thermal engineers can provide entire turn-key heater/control systems for the process tool manufacturer or fab installation.



*Heated foreline system*

### Sample Transfer & Manipulation

Our sample transfer and manipulation devices offer the researcher a series of complimentary components that are manufactured for demanding UHV bakeouts and environments. Standard components include XYZ precision manipulators, magnetic linear/rotary feedthroughs, rotary motion feedthroughs, differentially pumped rotary seals, sample transfer systems, alignment gimbals and rotary wobble sticks.

### Thin Film Deposition

Nor-Cal thin film monitors, crystal sensors and feedthroughs, represent those most commonly used for thermal deposition processes. A variety of feedthrough configurations with NW or CF flanges are available for single or dual crystal sensors, with or without water-cooling and pneumatic shutters. Our standard monitor measures film thickness and rate or frequency from two independent channels.



*Welding foreline trap*

### Foreline Traps

Our traps range in complexity from sealed coaxial traps, which prevent mechanical pump oil from backstreaming to the chamber, to the three-stage LPCVD TEOS trap. We have the largest selection of standard traps, which utilize woven metal, polyester or fiberglass gauze; molecular sieve; a liquid nitrogen reservoir or water-cooled coils to remove contaminants from the vacuum system or chamber.





# Nor-Cal Products

## Custom Components & Services

### Custom Chambers & System Integration

We have developed a reputation at national laboratories, universities and UHV equipment manufacturers for being the premier vacuum chamber fabricator. The quality, appearance and performance of our chambers are unequaled. Our engineering staff can design a chamber from customer sketches or specifications and supply complete manufacturing drawings for customer approval.

On request, Nor-Cal can assemble an entire system including chamber, frame, pumps, gauges, valves, manipulators and other components to customer specifications. Our vacuum technicians can complete a thorough qualification of system performance, including time to base pressure and RGA scan, before the system is back filled with nitrogen and shipped to the customer.

### Weldments

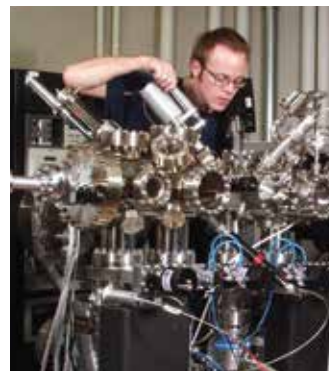
Because Nor-Cal manufactures tees, elbows and other weld fittings in-house, Nor-Cal can fabricate exhaust weldments for semiconductor equipment from a single piece of tubing. Welds and other manufacturing steps are eliminated, improving cleanliness and fit while reducing cost. We have demonstrated as much as 30% savings to our customers using this technique.



Custom exhaust weldments



System integration



Research end station



Water-cooled / particle trap for CVD

### Comprehensive Downstream Solutions

Our experience coupled with a broad product offering enables us to integrate components, providing comprehensive solutions to semiconductor fabs and equipment manufacturers. To improve overall system performance and achieve customer defined goals, a thorough evaluation of the system is conducted. A cost of ownership model can be provided showing payback as a result of increased tool utilization and decreased planned and unplanned maintenance costs.

Traps, thermal products, weldments and isolation and pressure control valves can be integrated as turnkey foreline modules. Thermal and vacuum characterization can be performed at Nor-Cal before the assembly is supplied leak checked, blanked off and clean room packaged.

### Process Specific Traps

We have years of experience designing and building custom foreline traps to protect pumps and eliminate buildup of condensable by-products in forelines and exhaust lines. Examples of these include water cooled and particle traps for LPCVD/TEOS, PECVD, metal CVD, MOCVD and metal etch. Others are particle traps for crystal growers, liquid traps for reclamation of photo resist and oil reclamation traps for industrial applications. Often times our customers see a 200% increase in preventative maintenance intervals after installation of one of these traps.

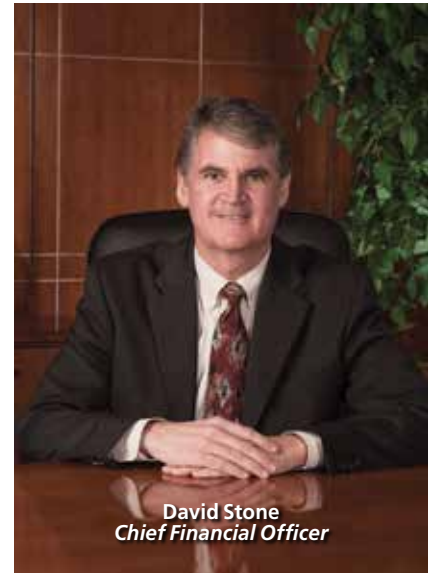


Tom Deany  
President & C.E.O.

*It is our intention to be "The Best In Class" manufacturing company of stainless steel vacuum components, producing the highest quality at competitive prices as well as meeting our customer's required delivery schedule.*

*We endeavor to maintain a stimulating and challenging work environment that recognizes and rewards our employee's contributions.*

*Nor-Cal will also strive to create, design and add new and appropriate components to maintain market and technical leadership.*



David Stone  
Chief Financial Officer



Tim Nilsson  
Vice President of Marketing



Donald Anderson  
Vice President of Operations



George Landreth  
Vice President of Engineering



Sean Mallory  
Vice President of Business Development S. E. Asia





# Nor-Cal Products

## Customer Service

### Sales & Marketing

Our corporate sales, marketing and technical support personnel provide prompt, honest answers to your technical questions and can recommend components for your particular vacuum application. Our experience with semiconductor process equipment allows us to provide customers with comprehensive solutions to extend downstream preventative maintenance intervals and increase throughput dramatically.

Nor-Cal Products sales representatives and stocking distributors are located throughout the United States, Canada, the Pacific Rim and Europe. Their locations, territories and contact information can be found in the back of this catalog or on our website.



**Per Cederstav**  
Business Unit Manager



**Sylvie Bouhier**  
Managing Director  
Nor-Cal Europe Ltd



**Mike Grandinetti**  
Eastern Regional  
Sales Manager



**Martin Semmler**  
Western Regional  
Sales Manager



Back L to R: **Monica Coupens**, Sales Representative; **Melissa MacDonald**, Sales Representative; **Tom Hagarty**, Sales Representative; **Denise Wilson**, Sales Representative Supervisor  
Front L to R: **Adriane Fiorucci**, Sales Representative; **Tami Kohlmann**, Sales Representative; **Diana Tudor**, Sales Manager



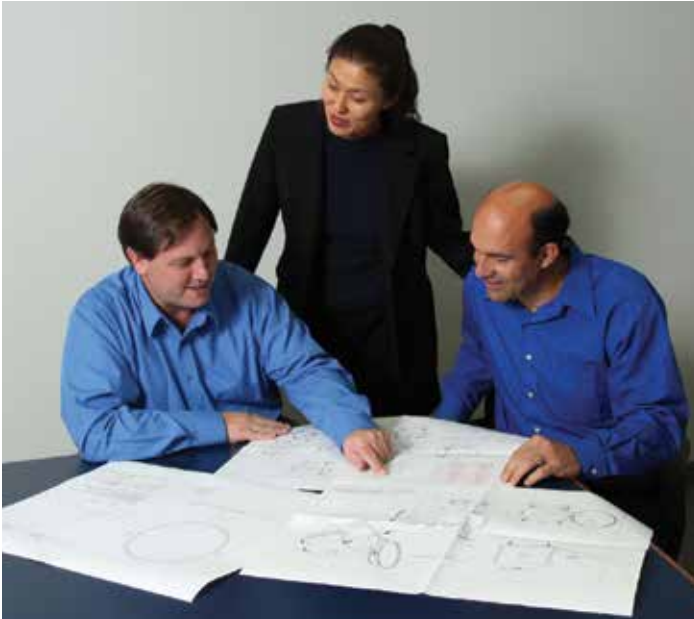
Back L to R: **Jim Crowley**, Product Manager; **Tommy Deany**, Production Control Manager  
Front L to R: **Todd Wilkins**, Business Unit Manager; **Randy Michels**, Business Unit Manager; **Steve Greuel**, Sr. Sales Engineer and UHV Product Manager



### Our Website - [www.n-c.com](http://www.n-c.com)

Our website offers around-the-clock access to the most current Nor-Cal product information. RFQs, pre-sales questions, orders, custom component inquiries and technical support questions are all directed immediately to the appropriate personnel. PDF versions of this catalog are available on-line, so you can search over 4000 standard components.

- Complete online catalog features quick ordering and account management options
- View or download Nor-Cal catalogs, operator manuals and other technical information
- Request print catalogs, CDs, videos and other literature
- Place orders and RFQ's or contact your local Nor-Cal distributor or representative.
- Ask pre-sales or technical questions
- Download CAD drawings and 3D solid models
- Access new product information and technical data
- Subscribe to receive automatic e-mail notification of special offers, new literature and product releases
- Track your Nor-Cal UPS or FedEx shipments
- Obtain a credit application, RMA and other forms



Sean Casarotti, Engineering Manager (left) leads engineering meeting

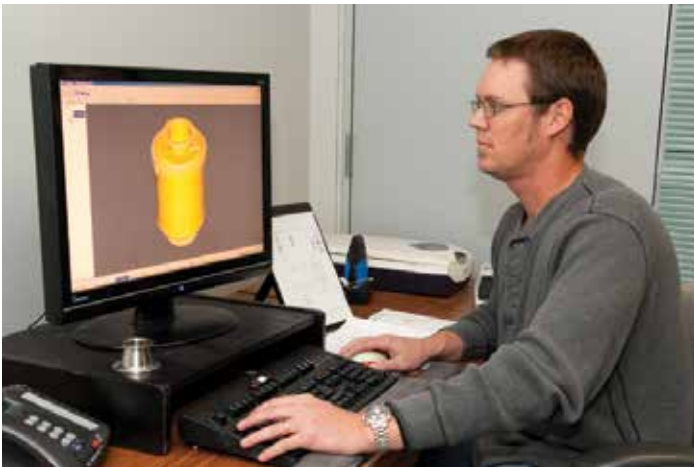
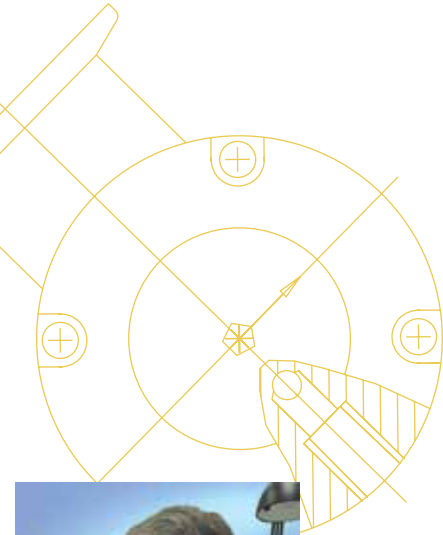
### Engineering

Nor-Cal's engineering staff can design custom components from customer specifications, sketches or drawings and oversee production with in-house tooling and equipment. Our customers benefit from the combined experience of our engineers, whose input during the design phase often results in cost savings during production and a superior product. For our customers who do not have drafting personnel available and require a complex assembly, we will provide complete CAD drawings for approval upon receipt of order.

Nor-Cal's engineering department employs the latest versions of SolidWorks™ drafting and solid modeling software. Drawings may be e-mailed direct to our engineering department at [prints@n-c.com](mailto:prints@n-c.com). Acceptable file formats are IGES, SAT and STEP. You may also request CAD drawings and download 3D models of our most commonly used standard components from our website.

### Research & Development

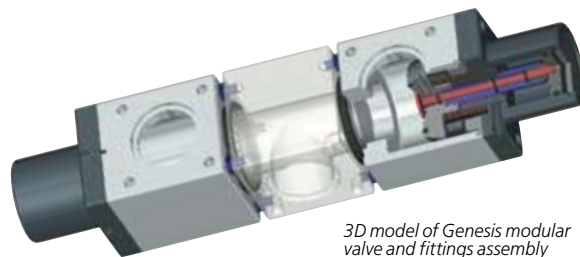
In addition to developing new standard products and improving existing ones, our Research and Development departments design and test customer specified products for equipment manufacturers. Our in-house research and development facility has prototype machining capabilities. We can also perform pressure, conductance and thermal characterization as well as software and electronic development and testing.



3D modeling of foreline trap



Calibration of Intellisys adaptive pressure controllers



3D model of Genesis modular valve and fittings assembly





# Nor-Cal Products Manufacturing

## Delivery

An independent study ranked Nor-Cal Products number one in price and availability out of the five major vacuum component manufacturers. Orders for stock items received in the morning can be shipped that afternoon. Guaranteed overnight delivery is available throughout the continental United States from our corporate headquarters, and also from our stocking distributors' locations. Exceptional service has won us many loyal customers who have had an assembly line down and been surprised to find that we would weld, clean, leak check and ship a non-stock item the same day without an expedite charge.

Nor-Cal employs a lean manufacturing technique that combines bottleneck management and KANBAN with traditional MRP for production scheduling and capacity planning. Small lot sizes and standardized routings maximize scheduling flexibility and increase visibility of jobs in the manufacturing stream, while reducing manufacturing cycle time. Over the years Nor-Cal has added in-house capabilities, such as chem cleaning and electropolishing, in order to eliminate dependence on outside suppliers. Additionally, this has allowed us to shorten lead times and reduce overall manufacturing costs.



Yreka facility stock room



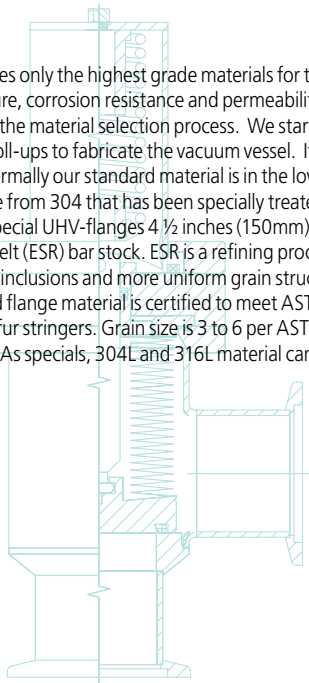
CNC machining center



CNC vertical lathe

## Materials

Nor-Cal Products uses only the highest grade materials for the manufacturing of vacuum components. Vapor pressure, corrosion resistance and permeability are important considerations taken into account during the material selection process. We start with select grade 304 stainless steel tubing, spheres or roll-ups to fabricate the vacuum vessel. If required, 304L, 316, 316L or 316LN can be supplied. Normally our standard material is in the low carbon range for 304. Flanges and baseplates are made from 304 that has been specially treated to remove impurities inherent in 300 series steels. Special UHV-flanges 4 1/2 inches (150mm) OD and smaller can be made from 304 electroslag remelt (ESR) bar stock. ESR is a refining process that produces stainless steel with higher purity, fewer inclusions and more uniform grain structure to eliminate microscopic leak paths. Our standard flange material is certified to meet ASTM A-240 and has less than 0.01% sulfur to prevent sulfur stringers. Grain size is 3 to 6 per ASTM E-112. Maximum inclusion size is 2.5 per ASTM E-45. As specials, 304L and 316L material can be supplied in roll-forged rings.







CNC Machining Center with dual spindles, live tooling and robotic gantry

## Machining

Machining procedures are consistent with good UHV practices. Machine coolant is sulfur free to reduce outgassing. All Nor-Cal components are designed to minimize entrapments, which cause virtual leaks under vacuum. State-of-the-art CNC machining equipment is available to produce parts with consistently high quality.

Nor-Cal pulls ports for fittings, weldments, trap and valve bodies and weldments. This eliminates sharp inside corners that can entrap contaminants, and allows faster pumpdown and lower outgassing. Nor-Cal can pull ports for 1/2 to 8-inch (50-200mm) diameter tubing, while holding the true position of the port within .030 inch (0.762mm).

Nor-Cal employs a CNC tube bender to form 1/2 to 2 inch (13-50mm) diameter elbows and custom exhaust weldments. This allows us to quickly make multiple compound angle bends in a single piece of tubing, while holding .010 inch (0.254mm) tolerance between two bends. Alternate methods of fabrication require welding of several prefabricated parts, resulting in greater incidence of leaks and cumulative tolerance buildup. Using our method, welds and other manufacturing steps are eliminated, improving cleanliness and fit while reducing cost.



GTAW fusion welding



Ball pulled ports



Orbital welding

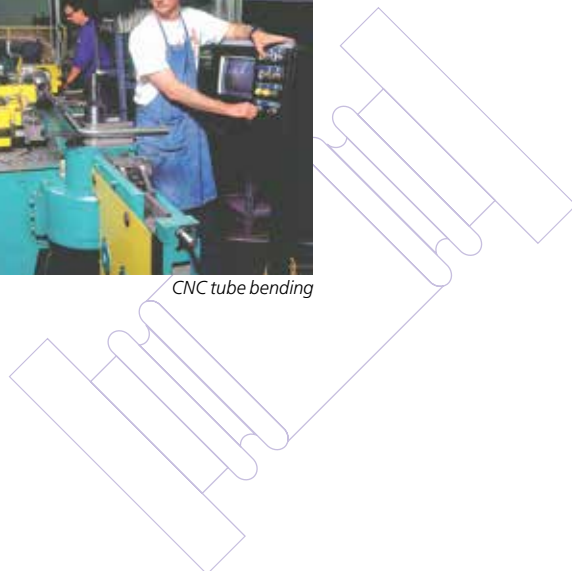
## Welding

GTAW fusion welding is used exclusively for a vacuum-tight metal bond. Purging with an inert gas reduces or eliminates oxygen entrapment and carbide precipitation, which cause outgassing. Whenever possible, welds are made on the inside or are full penetration to eliminate entrapments and virtual leaks.

Inert environment orbital welding is also available for full penetration flange-to-tube bonding. Orbital welding can be performed on any length tube with diameters from 1/8 to 2 inches (3-50mm).



CNC tube bending





### Cleaning

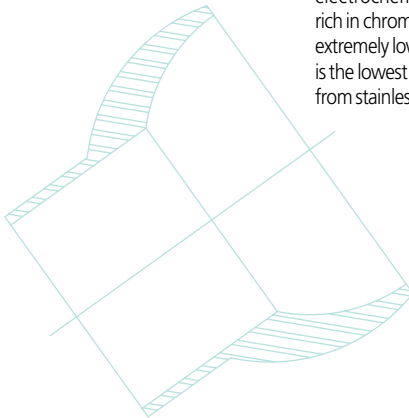
All stainless steel parts are passivated in a light acid solution to remove weld scale and oxide. A biodegradable detergent is used to remove machine lubricants before the parts are washed and rinsed with deionized water. Special cleaning recipes can be provided to our customer's specifications.

Chem cleaning is typically used for production parts such as valve bodies or "process critical" parts fabricated for semiconductor equipment manufacturers. The component is immersed in a series of controlled chemical baths before deionized water rinse and filtered hot air dry. Chem cleaned parts are immediately packaged in sealed clean room bags.

### Surface Treatment

Nor-Cal offers tumbling, bead blasting, chem cleaning and electropolishing of vacuum components in-house. Tumbling in ceramic media deburrs components, such as weld fittings, while providing a uniform finish. Glass shot cleans, hones, polishes and peens while removing scale. Some customers request bead blast on exterior surfaces with electropolish on the interior.

Electropolishing is by far the most desirable cleaning process for stainless steel vacuum components. This electrochemical process benefits the finished part in a number of ways simultaneously. Deburring, passivation and stress relieving are achieved while the machine produced surface roughness is eroded.



Electropolishing attacks the microscopic "peaks" of the surface more rapidly than the "valleys", thereby maintaining critical dimensions while improving surface finishes. Normally .0003 to .0004 inch (0.008-0.01mm) is removed to lower the microfinish from 32 to 8 RMS. Electropolishing results in a 90% friction decrease over a similar microfinish achieved mechanically, while surface area is reduced by a similar amount. This is most important for vacuum chambers because it produces faster pumpdown and higher conductance.

In addition to the improved mechanical properties of the surface, iron is removed electrochemically. This leaves the surface rich in chromium and nickel, which have extremely low vapor pressures. The result is the lowest outgassing rates possible from stainless steel.



*Chem cleaning vacuum chambers*



*Electropolishing vacuum chamber*





Chamber leak testing after mechanical inspection on chamber qualification test bench

Nor-Cal has two clean rooms for assembly and packaging of semiconductor valves, UHV systems and components.

Pressure control and isolation valves as well as sample transfer and manipulation devices are assembled, leak checked, tested and packaged in a 3000 square foot Class 1000 clean room, which is subdivided into five areas for assembly, inventory, leak check and other testing. This allows greater visibility, better inventory control and compresses assembly lead times.

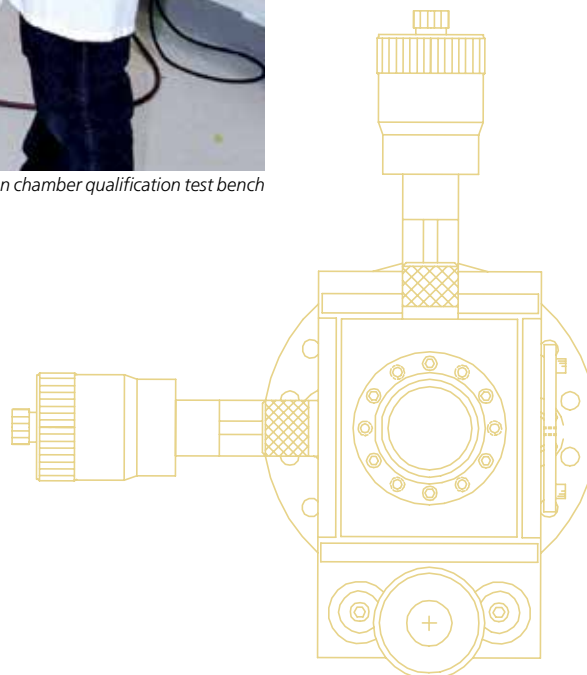
System integration, chamber final assembly, testing and packaging are conducted in a 1000 square foot Class 1000 clean room.



Clean room storage of valve subassemblies



Valve assembly in Class 1000 Clean Room

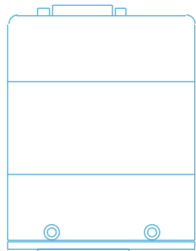






# Nor-Cal Products

## Quality Assurance



After extensive audits, Nor-Cal Products, Inc. received Semitech SSQA Preferred Supplier status from two large semiconductor equipment manufacturers.

An ongoing effort is made to control and improve manufacturing processes. Periodic defect analysis results in process improvements with narrower acceptable limits on subsequent production runs. Our goal is to reach six-sigma process capability. Our quality system is ISO certified, SSQA certified and MIL-Q-9858 and MIL-I-45208 approved.

Every weld is leak checked with a helium mass spectrometer to insure a leak rate of  $10^{-9}$  std. cc/sec or less. Our chamber qualification test benches can be used on components requiring lower leak rates. They were developed for customers who request residual gas analyzer (RGA) scans of their

chambers after a 24 hour vacuum bake. A test bench contains vacuum pumps, gauges, RGA, quartz heaters, nitrogen back fill and a leak detector. Once water and other background are eliminated by the 150°C bakeout, we can provide the customer with customized scans to detect the slightest contamination in the chamber. Whatever the sensitivity of our customer's application, we can guarantee that contaminants will be within acceptable limits.

A coordinate measuring machine (CMM) is used for in-process and final mechanical inspections of vacuum chambers and other complex or close tolerance parts. CMM printouts of chamber final inspections can be furnished upon request.



Mechanical inspection of process chamber with CMM

### Quality Statement

Nor-Cal Products, Inc. is dedicated to continual improvement of our manufactured and purchased goods through the implementation of a carefully planned quality program. Quality improvements at Nor-Cal have been mandated and implemented with the full support of senior management.

It is our belief that quality is built into a product. We will eliminate defects by reducing the variables in all processes relating to manufacturing. We will strive to meet our primary goal of 100% customer acceptance by manufacturing defect-free parts with on-time delivery, competitive pricing and the best possible customer service. Nor-Cal's use of statistical methods in manufacturing, training programs and continuous improvement of equipment are evidence of our commitment to this goal.

While management takes the ultimate responsibility for Nor-Cal quality, service and productivity, each employee can take credit for his or her contribution to our success, and is responsible for the implementation of quality in their particular area. We are all participants in the creation of a "quality ethic." Senior management fosters an atmosphere of cooperation not only throughout Nor-Cal, but also with customers as well as suppliers. Our purpose is to create a team dedicated to the improvement of quality by finding creative solutions to our industries' manufacturing problems.

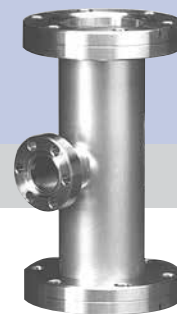
*Building quality into Nor-Cal Products' components is our most important task.*



Dry leak detector for valve inspection

# Flanges & Fittings

## Section Two

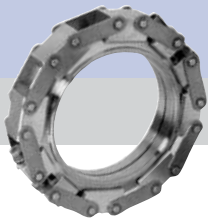


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# Flanges & Fittings

## Chain Clamp Component General Information

### SPECIFICATIONS

#### Tube OD sizes:

$\frac{3}{4}$  to 4 inches (19.05 to 101.6mm)

#### Materials

Flange: 304 stainless steel

Seal: Aluminum

Vacuum range:  $\geq 1 \times 10^{-11}$  mbar - UHV

Temperature range: -270°C to 150°C

All dimensions are in inches and (mm)  
unless otherwise noted



Nor-Cal Products stocks a complete line of chain clamps and aluminum metal seals for converting elastomer seal NW (KF) and ISO flanges to UHV metal seals. They provide a number of benefits over elastomer seals: reduced outgassing, no permeation, no hydrocarbons, resistance to radiation and short half-life. Aluminum seals are used in high-energy physics, other UHV applications and, in some circumstances, cryogenic applications. Aluminum seals are reliable in high vibration or temperature cycling environments. Chain clamps and NW flanges are the standard vacuum flange for many Japanese semiconductor equipment manufacturers. The advantages over using the standard ISO flange are the time and space savings during assembly and the flexibility to form high vacuum or UHV seals.

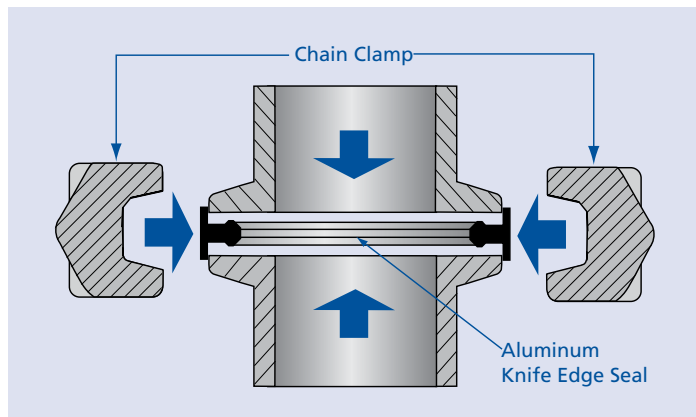
To install a metal seal on an existing NW flange, simply remove the standard clamp, centering ring and O-ring assembly. Replace them with an aluminum knife edge seal and chain clamp. (See diagram.). Standard ISO claw clamps can be used with aluminum seals to convert ISO flanges from high vacuum to UHV. Nor-Cal's large NW flanges are available in 63, 80 and 100 NW sizes from stock. Chain clamps are used to form either elastomer or metal seals with large NW flanges.

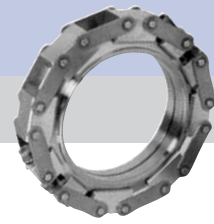
### Aluminum Metal Seals

Aluminum seals locate on the centering ring groove (inner centering) or outside edge of the flange (outer centering) depending on the size. (Inner and outer centering versions are available for all NW flange sizes.) Aluminum knife-edges are compressed by the sealing surfaces of the mating flanges when the chain clamp or ISO claw clamp is tightened. The resultant seal has a helium leak rate of less than  $1 \times 10^{-11}$  standard mbar l/sec and can be baked repeatedly to 150°C. Proper sealing occurs even if the flanges are slightly scratched or misaligned. The aluminum alloy is soft enough to make a good seal with reasonable force but will not flow at moderate temperatures. Seals will even work with aluminum flanges.

### Large NW Flanges

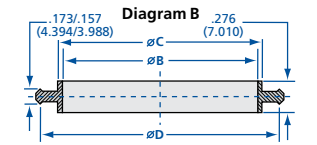
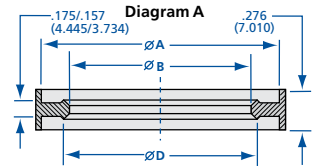
Nor-Cal offers blank and bored NW-63, NW-80 and NW-100 flanges that are compatible with other manufacturers' large QF, KF flanges made to the ISO 2961 specification. They can be used with chain clamps to form elastomer or aluminum metal seals. Elastomer seals are formed with standard ISO centering ring/O-ring assemblies and elastomer chain clamps. UHV connections are formed with aluminum metal seals and chain clamps intended for use with them. NW flanges are made from 304 stainless steel for 2.5 to 4.0 inch (63.5 to 101.6mm) OD tube sizes. Flanges for tube sizes up to 28 inches (711.2mm) OD, metric tube sizes can be supplied.





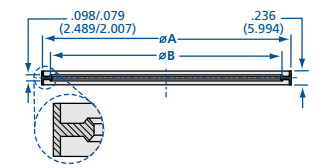
### Aluminum Metal Seals for NW 16-63 Flanges

MODEL NUMBER	DIAGRAM	FLANGE	A	B	C	D
NW-16-MS-A	A	NW-16	1.18 (29.97)	0.63 (16.00)	-	0.91 (23.11)
NW-25-MS-A	A	NW-25	1.58 (40.13)	0.96 (24.38)	-	1.30 (33.02)
NW-40-MS-A	A	NW-40	2.16 (54.86)	1.58 (40.13)	-	1.89 (48.01)
NW-50-MS-A	B	NW-50	-	1.97 (50.04)	2.05 (52.07)	2.32 (58.93)
NW-63-MS-A	B	NW-63	-	2.68 (68.07)	2.76 (70.10)	3.03 (76.96)



### Aluminum Metal Seals for NW 80-100 Flanges

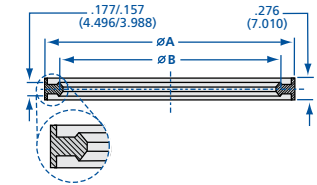
MODEL NUMBER	FLANGE	A	B
NW-80-MS-A	NW-80 Tapered	4.49 (114.05)	4.25 (107.95)
NW-100-MS-A	NW-100 Tapered	5.28 (134.11)	5.04 (128.02)



### Aluminum Metal Seals for ISO Flanges

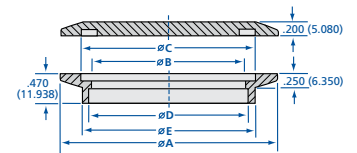
MODEL NUMBER	FLANGE	A	B	TORQUE	NUMBER CLAMPS*
ISO-63-MS-A	ISO-63	3.74 (95.00)	3.47 (88.14)	11.3 Nm	4
ISO-80-MS-A	ISO-80	4.33 (109.98)	4.06 (103.12)	11.3 Nm	6
ISO-100-MS-A	ISO-100	5.12 (130.05)	4.84 (122.94)	11.3 Nm	8

\* Use with Nor-Cal double or single claw clamps.



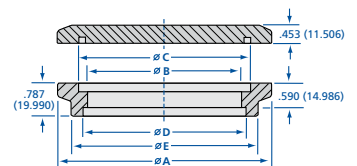
### NW-63 Flanges

MODEL NUMBER	DESCRIPTION	A	B	C	D	E
NW-63-250	Bored for 2 1/2 inch (63mm) tube OD	3.43 (87.12)	2.44 (61.98)	2.76 (70.10)	2.51 (63.75)	2.71 (68.83)
NW-63B	Blank	3.43 (87.12)	-	2.76 (70.10)	-	-

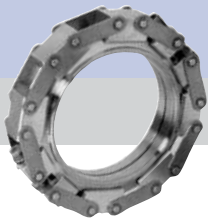


### NW 80-100 Flanges

MODEL NUMBER	DESCRIPTION	A	B	C	D	E
NW-80-300	Bored for 3 inch (75mm) tube OD	4.49 (114.05)	2.87 (72.90)	3.27 (83.06)	3.01 (76.45)	3.82 (97.03)
NW-80B	Blank	4.49 (114.05)	-	3.27 (83.06)	-	-
NW-100-400	Bored for 4 inch (100mm) tube OD	5.28 (134.11)	3.87 (98.30)	4.02 (102.11)	4.01 (101.85)	4.61 (117.09)
NW-100B	Blank	5.28 (134.11)	-	4.02 (102.11)	-	-



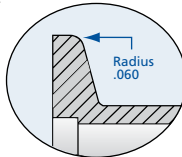




# Flanges & Fittings

## Chain Clamps

Nor-Cal Products stocks chain clamps for NW flanges in two styles: one with Teflon coated aluminum links and an uncoated version. The less expensive uncoated version is the preferred choice for sealing standard NW flanges with aluminum metal seals. The uncoated chain clamps can be used with Nor-Cal or other manufacturers' NW flanges with a radius of approximately .060 of an inch (1.5mm) on the outer edge



of the non-sealing side. Most manufacturers' NW flanges have this feature. If the flanges to be sealed have a sharp edge, the Teflon coated chain clamps are required to ensure adequate sealing force for aluminum metal seals. Both versions use a single, hex head nut for closure. Stainless steel chain clamps and low cost composite chain clamps are available for elastomer NW connections.

Chain clamps for NW-63 flanges are similar to the NW-16 to 50 sizes. The style to use with NW-63 elastomer seals has a single knob for tightening. The clamp used for sealing aluminum metal

seals has a single hex head nut. Both have uncoated aluminum links, although Teflon coated aluminum versions are available.

Chain clamps for 80 to 100mm flanges are stocked in two styles: one with a single knob for elastomer seals and another with two allen head bolts for aluminum metal seals. Although chain clamps are bakeable to 150°C, the knobs should not be baked above 60°C. Chain clamps for tube sizes up to 28 inch (711mm) OD can be supplied on request.

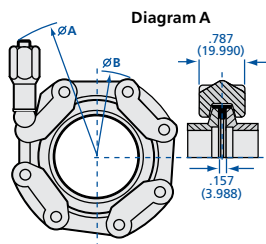


Diagram A

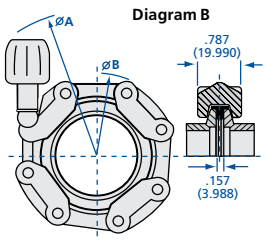


Diagram B

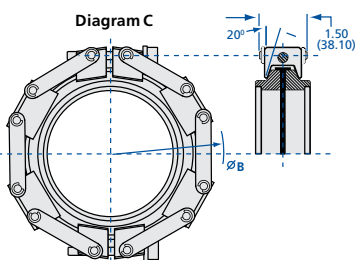


Diagram C

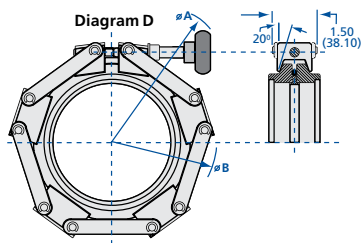


Diagram D

### Chain Clamps for NW-16 to 50 Flanges – Aluminum Links

MODEL NUMBER	DIAGRAM	APPLICATION	A	B	MAXIMUM TEMPERATURE	TORQUE ELASTOMER / METAL
NW-16-CC-AN	A	Metal or Elastomer Seals	4.53 (115.06)	2.36 (59.94)	150°C	1.017 Nm / 2.486 Nm
NW-25-CC-AN	A	Metal or Elastomer Seals	4.92 (124.97)	2.76 (70.10)	150°C	1.469 Nm / 2.938 Nm
NW-40-CC-AN	A	Metal or Elastomer Seals	5.32 (135.13)	3.35 (85.09)	150°C	2.034 Nm / 4.406 Nm
NW-50-CC-AN	A	Metal or Elastomer Seals	5.98 (151.89)	4.13 (104.90)	150°C	2.486 Nm / 4.971 Nm

### Chain Clamps for NW-16 to 50 Flanges - Teflon Coated Links\*

MODEL NUMBER	DIAGRAM	APPLICATION	A	B	MAXIMUM TEMPERATURE	TORQUE ELASTOMER / METAL
NW-16-CC-TN	A	No radius, metal/elastomer	4.53 (115.06)	2.36 (59.94)	150°C	1.017 Nm / 2.486 Nm
NW-25-CC-TN	A	No radius, metal/elastomer	4.92 (124.97)	2.76 (70.10)	150°C	1.469 Nm / 2.938 Nm
NW-40-CC-TN	A	No radius, metal/elastomer	5.32 (135.13)	3.35 (85.09)	150°C	2.034 Nm / 4.406 Nm
NW-50-CC-TN	A	No radius, metal/elastomer	5.98 (151.89)	4.13 (104.90)	150°C	2.486 Nm / 4.971 Nm

\*Not radiation resistant

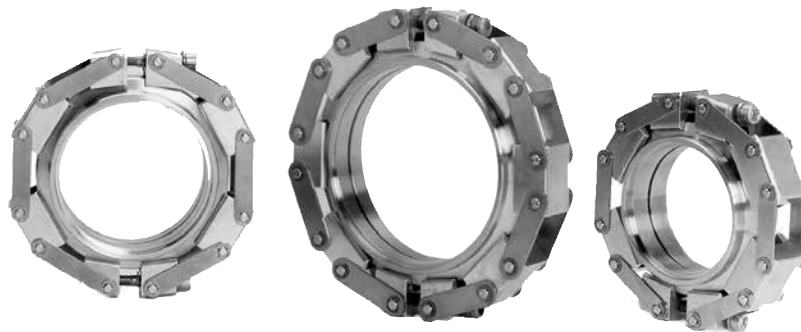
### Chain Clamps for NW-63 Flanges

MODEL NUMBER	DIAGRAM	APPLICATION	A	B	MAXIMUM TEMPERATURE	TORQUE ELASTOMER / METAL
NW-63-CCV-AN	B	Elastomer seals only	6.69 (169.93)	4.72 (119.89)	100°C	-
NW-63-CC-AN	A	Metal or elastomer seals	6.30 (160.02)	4.72 (119.89)	150°C	2.486 Nm / 4.971 Nm

### Chain Clamps for NW-80 to 100 Flanges

MODEL NUMBER	DIAGRAM	APPLICATION	A	B	MAXIMUM TEMPERATURE	TORQUE
NW-80-CCV-AS	D	Elastomer seals only	9.61 (244.09)	6.06 (153.92)	150°C	-
NW-80-CC-TS	C	Metal seals only	-	6.30 (160.02)	150°C	8.474 Nm
NW-100-CCV-AS	D	Elastomer seals only	10.08 (256.03)	6.77 (171.98)	150°C	-
NW-100-CC-TS	C	Metal seals only	-	7.09 (180.09)	150°C	9.943 Nm

All dimensions are in inches and (mm) unless otherwise noted



# Flanges & Fittings

## NW Flange General Information



### SPECIFICATIONS

**Tube OD sizes:** 3/8 to 2 inches (9.53 to 50.8mm)

**Materials**

Flange: 304 or 316L stainless steel  
O-rings: Viton, Buna & silicone

**Fittings**

Tube finishes: Beadblast standard  
(Tumbled & electropolish available)

**Fasteners:** Wing nut, SureSeal, bulkhead & chain clamps

**Vacuum range**

Elastomer seal:  $\geq 1 \times 10^{-8}$  mbar -High vacuum  
Metal seal:  $\geq 1 \times 10^{-11}$  mbar - UHV

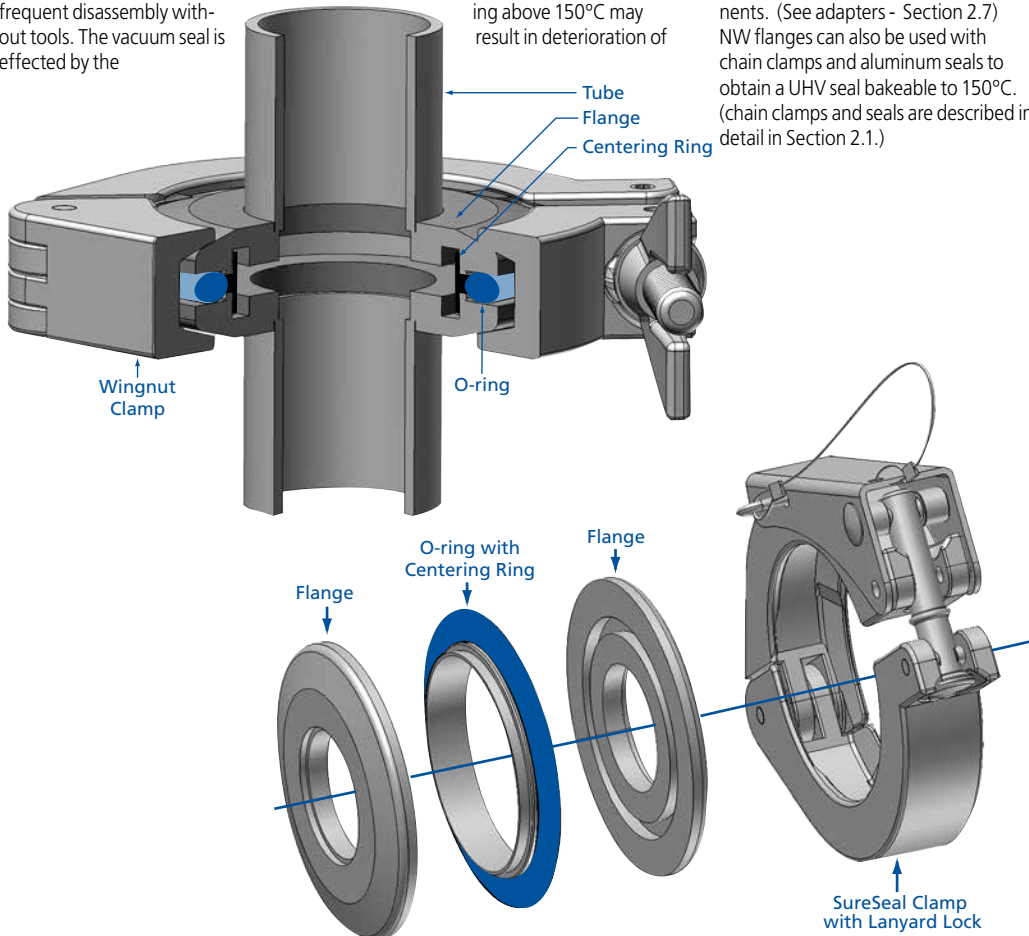
**Temperature range**

Viton: -20°C to 200°C  
Silicone: -50° to 230°C  
Buna: -30°C to 110°C  
Metal seal: -270°C to 150°C

Nor-Cal NW flanges are designed to ISO 2861 specifications for standard USA tube sizes from 3/8 to 2 inches (9.53 to 50.8mm) OD. They are compatible with other manufacturers' ISO-KF style flanges. NW flanges utilize an aluminum clamp with a single wing nut fastener or a lock-over-center clamp allowing frequent disassembly without tools. The vacuum seal is effected by the

application of uniform pressure from the clamp on the 15° surface of the 304 stainless steel flanges. The mating flange surfaces compress a Viton O-ring held in place by a centering ring. The resultant seal can be used in vacuum applications of up to  $10^{-8}$  mbar and baked to 200°C, however sustained baking above 150°C may result in deterioration of

O-rings. Additionally, NW flanges allow components to be rotated before assembly for ease of component alignment. NW flanges are available on virtually all Nor-Cal components and fittings. Nor-Cal manufactures a full line of NW adapters so you can add to or build an entire system with NW components. (See adapters - Section 2.7) NW flanges can also be used with chain clamps and aluminum seals to obtain a UHV seal bakeable to 150°C. (chain clamps and seals are described in detail in Section 2.1.)



### New Products

#### Trapped Centering Rings



Nor-Cal trapped centering rings for NW flanges feature easy assembly with exact centering and are appropriate for vacuum or pressure by externally supporting the sealing ring. Trapped O-rings are intended for use where pressures range from rough vacuum to above atmosphere. Applications include vacuum pump exhaust lines and abatement tools.

All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.

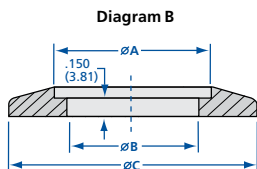
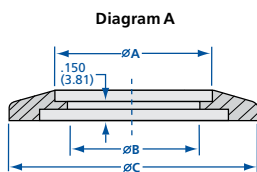




# Flanges & Fittings

## NW Bored Blank Flanges & Blank Off Caps

### NW Bored Blank Flanges (NWB)



MODEL NUMBER	DIAGRAM	TUBE OD	A	B	C
NW-10B-038	A	3/8 (9.53)	0.38 (9.65)	0.326 (8.28)	1.18 (29.97)
NW-10B-050	A	1/2 (12.70)	0.51 (12.95)	0.451 (11.46)	1.18 (29.97)
NW-16B-038	A	3/8 (9.53)	0.38 (9.65)	0.326 (8.28)	1.18 (29.97)
NW-16B-050	A	1/2 (12.70)	0.51 (12.95)	0.451 (11.46)	1.18 (29.97)
NW-16B-075	B	3/4 (19.05)	0.76 (19.30)	0.68 (17.27)	1.18 (29.97)
NW-25B-038	A	3/8 (9.53)	0.38 (9.65)	0.326 (8.28)	1.575 (40.01)
NW-25B-050	A	1/2 (12.70)	0.51 (12.95)	0.451 (11.46)	1.575 (40.01)
NW-25B-075	A	3/4 (19.05)	0.76 (19.30)	0.715 (18.16)	1.575 (40.01)
NW-25B-100	A	1 (25.40)	1.01 (25.65)	0.938 (23.83)	1.575 (40.01)
NW-40B-038	A	3/8 (9.53)	0.38 (9.65)	.326 (8.28)	2.16 (54.86)
NW-40B-050	A	1/2 (12.70)	0.51 (12.95)	0.451 (11.46)	2.16 (54.86)
NW-40B-075	A	3/4 (19.05)	0.76 (19.30)	0.715 (18.16)	2.16 (54.86)
NW-40B-100	A	1 (25.40)	1.01 (25.65)	0.938 (23.83)	2.16 (54.86)
NW-40B-150	A	1 1/2 (38.10)	1.51 (38.35)	1.438 (36.53)	2.16 (54.86)
NW-50B-038	A	3/8 (9.53)	0.38 (9.65)	.326 (8.28)	2.95 (74.93)
NW-50B-050	A	1/2 (12.70)	0.51 (12.95)	0.451 (11.46)	2.95 (74.93)
NW-50B-075	A	3/4 (19.05)	0.76 (19.30)	0.715 (18.16)	2.95 (74.93)
NW-50B-100	A	1 (25.40)	1.01 (25.65)	0.938 (23.83)	2.95 (74.93)
NW-50B-150	A	1 1/2 (38.10)	1.51 (38.35)	1.438 (36.53)	2.95 (74.93)
NW-50B-200	A	2 (50.80)	2.01 (51.05)	1.938 (49.23)	2.95 (74.93)

### NW 316L Stainless Steel Bored Blank Flanges (NWB)

MODEL NUMBER	DIAGRAM	TUBE OD	A	B	C
NW-25B-100-316L	A	1 (25.40)	1.01 (25.65)	0.938 (23.83)	1.575 (40.01)
NW-40B-150-316L	A	1 1/2 (38.10)	1.51 (38.35)	1.438 (36.53)	2.16 (54.86)
NW-50B-200-316L	A	2 (50.80)	2.01 (51.05)	1.938 (49.23)	2.95 (74.93)

#### SPECIFICATIONS

Tube OD sizes: 3/8 to 2 inches (9.53 to 50.8mm)

#### Materials

Flange: 304 or 316L stainless steel  
O-rings: Viton, Buna & silicone

Fasteners: Wing nut, SureSeal, bulkhead & chain clamps

#### Vacuum range

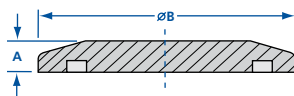
Elastomer seal:  $\geq 1 \times 10^{-8}$  mbar - High vacuum  
Metal seal:  $\geq 1 \times 10^{-11}$  mbar - UHV

#### Temperature range

Viton: -20°C to 200°C  
Silicone: -50° to 230°C  
Buna: -30°C to 110°C  
Metal seal: -270°C to 150°C

All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.

See Section 2.1 for metal seals



### Blank Off Caps

MODEL NUMBER	A	B
NW-10B	0.200 (5.08)	1.18 (29.97)
NW-16B	0.200 (5.08)	1.18 (29.97)
NW-25B	0.200 (5.08)	1.575 (40.01)
NW-40B	0.200 (5.08)	2.16 (54.86)
NW-50B	0.200 (5.08)	2.95 (74.93)

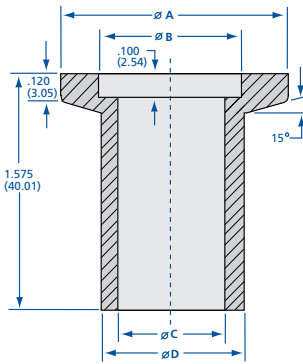
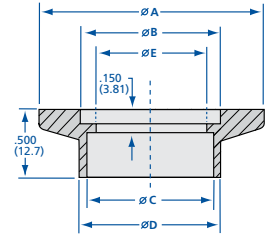
### 316L Blank Off Caps

MODEL NUMBER	A	B
NW-16B-316L	0.200 (5.08)	1.18 (29.97)
NW-25B-316L	0.200 (5.08)	1.575 (40.01)
NW-40B-316L	0.200 (5.08)	2.16 (54.86)
NW-50B-316L	0.200 (5.08)	2.95 (74.93)



### NW Socket Weld Flanges

MODEL NUMBER	TUBE OD	A	B	C	D	E
NW-10-SW	1/2 (12.70)	1.18 (29.97)	0.48 (12.19)	0.51 (12.95)	0.61 (15.49)	-
NW-16-SW	3/4 (19.05)	1.18 (29.97)	0.68 (17.27)	0.76 (19.30)	0.798 (20.27)	-
NW-25-SW	1 (25.40)	1.575 (40.01)	1.031 (26.19)	1.01 (25.65)	1.14 (28.96)	0.938 (23.83)
NW-40-SW	1 1/2 (38.10)	2.16 (54.86)	1.62 (41.15)	1.51 (38.35)	1.64 (41.66)	1.438 (36.53)
NW-50-SW	2 (50.80)	2.95 (74.93)	2.06 (52.32)	2.01 (51.05)	2.14 (54.36)	1.938 (49.23)



### NW Long Weld Neck Flanges

MODEL NUMBER	A	B	C	D
NW-10FL	1.18 (29.97)	0.48 (12.19)	0.38 (9.65)	1/2 (12.70)
NW-16FL	1.18 (29.97)	0.68 (17.27)	0.625 (15.88)	3/4 (19.05)
NW-25FL	1.575 (40.01)	1.031 (26.19)	0.87 (22.10)	1 (25.40)
NW-40FL	2.16 (54.86)	1.62 (41.15)	1.37 (34.80)	1 1/2 (38.10)
NW-50FL	2.95 (74.93)	2.06 (52.32)	1.87 (47.50)	2 (50.80)

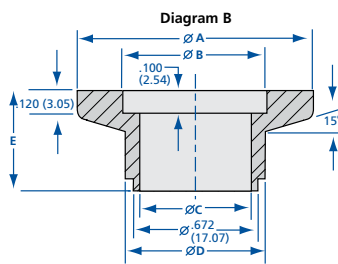
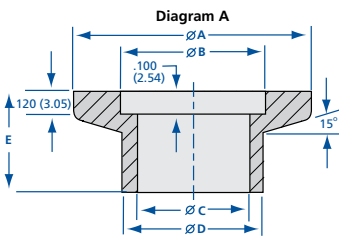
### NW 316L Stainless Steel Long Weld Neck Flanges

MODEL NUMBER	A	B	C	D
NW-25FL-316L	1.575 (40.01)	1.031 (26.19)	0.87 (22.10)	1 (25.40)
NW-40FL-316L	2.16 (54.86)	1.62 (41.15)	1.37 (34.80)	1 1/2 (38.10)
NW-50FL-316L	2.95 (74.93)	2.06 (52.32)	1.87 (47.50)	2 (50.80)



### NW Short Weld Neck Flanges

MODEL NUMBER	DIAGRAM	TUBE OD	A	B	C	D	E
NW-10F	A	1/2 (12.70)	1.18 (29.97)	0.48 (12.19)	0.38 (9.65)	1/2 (12.70)	0.5 (12.70)
NW-16F	B	3/4 (19.05)	1.18 (29.97)	0.68 (17.27)	0.625 (15.88)	3/4 (19.05)	0.56 (14.22)
NW-16FB	A	3/4 (19.05)	1.18 (29.97)	0.68 (17.27)	0.625 (15.88)	3/4 (19.05)	0.5 (12.70)
NW-25F	A	1 (25.40)	1.575 (40.01)	1.031 (26.19)	0.87 (22.10)	1 (25.40)	0.5 (12.70)
NW-40F	A	1 1/2 (38.10)	2.16 (54.86)	1.62 (41.15)	1.37 (34.80)	1 1/2 (38.10)	0.75 (19.05)
NW-50F	A	2 (50.80)	2.95 (74.93)	2.06 (52.32)	1.87 (47.50)	2 (50.80)	0.75 (19.05)



### SPECIFICATIONS

**Tube OD sizes:** 3/8 to 2 inches (9.53 to 50.8mm)

#### Materials

Flange: 304 or 316L stainless steel  
O-rings: Viton, Buna & silicone

**Fasteners:** Wing nut, SureSeal, bulkhead & chain clamps

#### Vacuum range

Elastomer seal:  $\geq 1 \times 10^{-8}$  mbar - High vacuum  
Metal seal:  $\geq 1 \times 10^{-11}$  mbar - UHV

#### Temperature range

Viton: -20°C to 200°C  
Silicone: -50° to 230°C  
Buna: -30°C to 110°C  
Metal seal: -270°C to 150°C

All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.

See Section 2.1 for metal seals



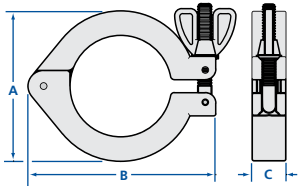
# Flanges & Fittings

## NW Assembly Hardware



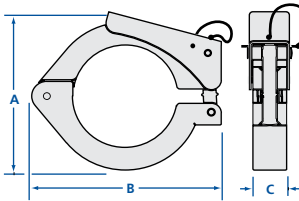
Nor-Cal Wing Nut and SureSeal NW Clamps feature special centering ribs and evenly distributed clamping force to assure uniform O-ring compression and reduce the probability of failure under loads. Additional hinge knuckles and tighter manufacturing tolerances result in precise alignment and reduced side play. Clamp opening is limited to facilitate one-handed installation in hard-to-reach spaces. In addition to the above features, the SureSeal clamp provides instant closure with a fixed geometry to attain optimal O-ring compression. All Nor-Cal NW clamps are designed and manufactured to meet Pneurop specifications for ISO-KF 10 through 50 flanges, so you can be confident of universal compatibility. We also provide chain clamps and metal seals for ISO-KF components to transform them from high vacuum to ultra-high vacuum connections.

### NW Wing Nut Clamps



MODEL NUMBER	A	B	C
NW-10-CP	1.69 (42.93)	2.392 (60.76)	0.625 (15.88)
NW-16-CP	1.69 (42.93)	2.392 (60.76)	0.625 (15.88)
NW-25-CP	2.14 (54.36)	2.796 (71.02)	0.625 (15.88)
NW-40-CP	2.75 (69.85)	3.437 (87.30)	0.625 (15.88)
NW-50-CP	3.50 (88.90)	4.245 (107.82)	0.710 (18.03)

### NW SureSeal Clamps



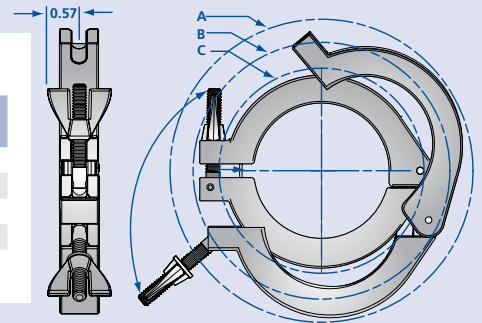
MODEL NUMBER	A	B	C
NW-10-SSC	1.750 (44.45)	2.392 (60.76)	0.741 (18.82)
NW-16-SSC	1.750 (44.45)	2.392 (60.76)	0.741 (18.82)
NW-40-SSC	2.947 (74.85)	3.437 (87.30)	0.741 (18.82)
NW-50-SSC	3.784 (96.11)	4.245 (107.82)	0.836 (21.23)

### NW SureSeal Clamps with Lanyard

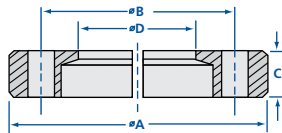
MODEL NUMBER	A	B	C
NW-10-SSC-L	1.750 (44.45)	2.392 (60.76)	0.741 (18.82)
NW-16-SSC-L	1.750 (44.45)	2.392 (60.76)	0.741 (18.82)
NW-40-SSC-L	2.947 (74.85)	3.437 (87.30)	0.741 (18.82)
NW-50-SSC-L	3.784 (96.11)	4.245 (107.82)	0.836 (21.23)

### NW Clamp Clearance Details

CLAMP	FLANGE	MIN. DIA. TO INSTALL A	MAX. DIA. CLOSED B	MIN. DIA. CLOSED C
NW-10-CP	NW-10B	2.86 (72.64)	2.65 (67.31)	1.75 (44.45)
NW-16-CP	NW-16B	2.86 (72.64)	2.65 (67.31)	1.75 (44.45)
NW-25-CP	NW-25B	3.32 (84.33)	3.00 (76.20)	2.24 (56.90)
NW-40-CP	NW-40B	4.00 (101.60)	3.72 (94.49)	2.90 (73.66)
NW-50-CP	NW-50B	5.45 (138.43)	4.62 (117.35)	3.69 (93.73)



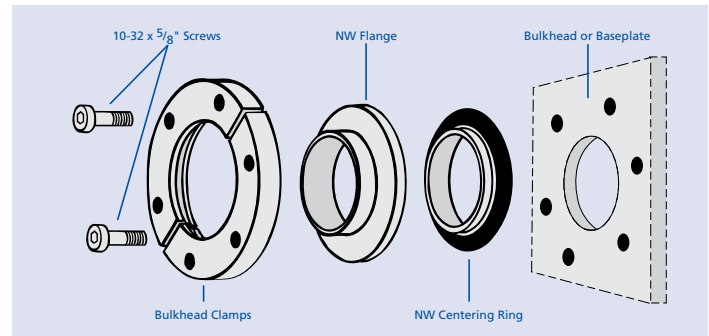
### NW Bulkhead Clamps



MODEL NUMBER	A	B	C	NUMBER OF SCREWS	THROUGH HOLE D
NW-16-BCP	2.00 (50.80)	1.50 (38.10)	0.361 (9.17)	6	0.90 (22.86)
NW-25-BCP	2.37 (60.20)	1.89 (48.01)	.0387 (9.83)	6	1.26 (32.00)
NW-40-BCP	2.94 (74.68)	2.44 (61.98)	0.366 (9.30)	6	1.84(46.74)
NW-50-BCP	3.75 (95.25)	3.25 (82.55)	0.404 (10.26)	8	2.35 (59.69)

Add "-MS" for metric bolts

Bulkhead clamps provide a simple means of fastening an NW flange to a baseplate. Each aluminum clamp is sold with stainless steel socket head cap screws and washers for attachment. Leave 0.075 inch (2mm) minimum between the bottom of the tapped hole and the inside of the chamber wall.



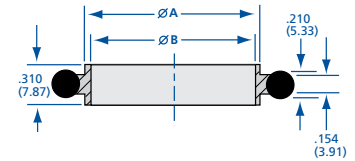
All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.



Nor-Cal offers aluminum and stainless steel centering rings for NW and ISO flanges. Buna, silicone and Viton O-rings are available for NW, while Buna and Viton are stocked for ISO centering rings. Aluminum ISO centering rings are provided with an aluminum spacer ring. Stainless steel ISO centering rings are also provided with aluminum spacer rings as an option.

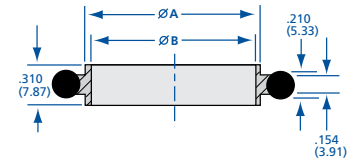
### NW Aluminum Centering Rings with O-ring

MODEL NUMBER	O-RING MATERIAL	A	B
NW-10-CR-AV	Viton	0.478 (12.14)	0.456 (11.58)
NW-10-CR-AB	Buna	0.478 (12.14)	0.456 (11.58)
NW-16-CR-AV	Viton	0.669 (16.99)	0.625 (15.88)
NW-16-CR-AB	Buna	0.669 (16.99)	0.625 (15.88)
NW-25-CR-AV	Viton	1.024 (26.01)	0.984 (24.99)
NW-25-CR-AB	Buna	1.024 (26.01)	0.984 (24.99)
NW-40-CR-AV	Viton	1.614 (41.00)	1.57 (39.88)
NW-40-CR-AB	Buna	1.614 (41.00)	1.57 (39.88)
NW-50-CR-AV	Viton	2.047 (51.99)	1.967 (49.96)
NW-50-CR-AB	Buna	2.047 (51.99)	1.967 (49.96)



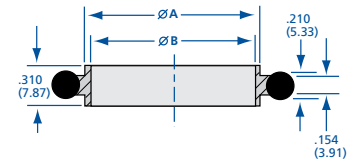
### NW Stainless Steel Centering Rings with O-ring

MODEL NUMBER	O-RING MATERIAL	A	B
NW-10-CR-SV	Viton	0.478 (12.14)	0.456 (11.58)
NW-10-CR-SS	Silicone	0.478 (12.14)	0.456 (11.58)
NW-10-CR-SB	Buna	0.478 (12.14)	0.456 (11.58)
NW-16-CR-SV	Viton	0.669 (16.99)	0.625 (15.88)
NW-16-CR-SS	Silicone	0.669 (16.99)	0.625 (15.88)
NW-16-CR-SB	Buna	0.669 (16.99)	0.625 (15.88)
NW-25-CR-SV	Viton	1.024 (26.01)	0.984 (24.99)
NW-25-CR-SS	Silicone	1.024 (26.01)	0.984 (24.99)
NW-25-CR-SB	Buna	1.024 (26.01)	0.984 (24.99)
NW-40-CR-SV	Viton	1.614 (41.00)	1.570 (39.88)
NW-40-CR-SS	Silicone	1.614 (41.00)	1.570 (39.88)
NW-40-CR-SB	Buna	1.614 (41.00)	1.570 (39.88)
NW-50-CR-SV	Viton	2.047 (51.99)	1.967 (49.96)
NW-50-CR-SS	Silicone	2.047 (51.99)	1.967 (49.96)
NW-50-CR-SB	Buna	2.047 (51.99)	1.967 (49.96)



### NW 316L Stainless Steel Centering Rings with O-ring

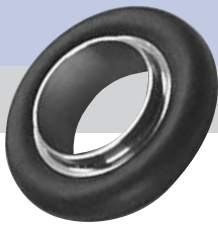
MODEL NUMBER	O-RING MATERIAL	A	B
NW-25-CR-SV-316L	Viton	1.024 (26.01)	0.984 (24.99)
NW-40-CR-SV-316L	Viton	1.614 (41.00)	1.570 (39.88)
NW-50-CR-SV-316L	Viton	2.047 (51.99)	1.967 (49.96)



All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.

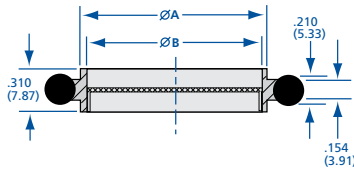
See page 26 for replacement O-rings





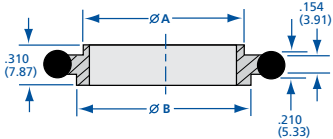
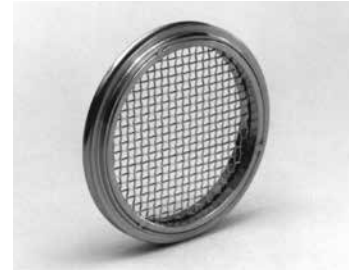
# Flanges & Fittings

## NW Centering Rings & Replacement O-rings



### NW Screened Stainless Steel Centering Rings with Viton O-ring

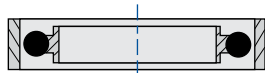
MODEL NUMBER	O-RING MATERIAL	A	B	MESH
NW-25-CR-SV-74	Viton	1.024 (26.01)	0.984 (24.99)	74
NW-40-CR-SV-74	Viton	1.614 (41.00)	1.570 (39.88)	74
NW-50-CR-SV-74	Viton	2.047 (51.99)	1.967 (49.96)	74



### NW Reducer Stainless Steel Centering Rings with Viton O-ring

MODEL NUMBER	O-RING MATERIAL	A	B
NW-10/16-CR	Viton	0.48 (12.19)	0.67 (17.02)
NW-20/25-CR	Viton	0.87 (22.10)	1.02 (25.91)
NW-32/40-CR	Viton	1.34 (34.04)	1.61 (40.89)

Buna and Silicone O-rings available. Call for pricing.

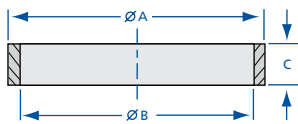


For dimensions refer to the centering ring/O-ring assembly drawing on the previous page and the overpressure ring diagram this page.

### NW Stainless Steel Centering Rings with Viton O-ring and Over Pressure Ring

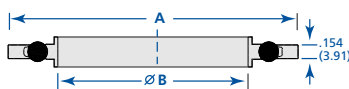
MODEL NUMBER	DESCRIPTION
NW-10-CR-SV-PR	Contains model numbers NW-10-PR and NW-10-CR-SV
NW-16-CR-SV-PR	Contains model numbers NW-16-PR and NW-16-CR-SV
NW-25-CR-SV-PR	Contains model numbers NW-25-PR and NW-25-CR-SV
NW-40-CR-SV-PR	Contains model numbers NW-40-PR and NW-40-CR-SV
NW-50-CR-SV-PR	Contains model numbers NW-50-PR and NW-50-CR-SV

Buna and Silicone O-rings available. Call for pricing.



### NW Stainless Steel Over Pressure Rings

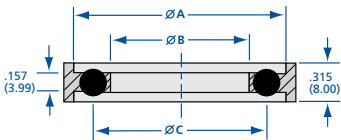
MODEL NUMBER	A	B	C	MAXIMUM PSIG
NW-10-PR	1.25 (31.75)	1.186 (30.12)	0.346 (8.79)	100
NW-16-PR	1.25 (31.75)	1.186 (30.12)	0.346 (8.79)	100
NW-25-PR	1.66 (42.16)	1.583 (40.21)	0.346 (8.79)	100
NW-40-PR	2.25 (57.15)	2.169 (55.09)	0.346 (8.79)	75
NW-50-PR	2.75 (69.85)	2.620 (66.55)	0.145 (3.68)	50



### NW Stainless Steel Captured Centering Rings with Viton O-ring

MODEL NUMBER	O-RING MATERIAL	A	B	MAXIMUM PSIG
NW-16-CRC-SV	Viton	1.25 (31.75)	0.625 (15.88)	100
NW-25-CRC-SV	Viton	1.66 (42.16)	0.984 (24.99)	100
NW-40-CRC-SV	Viton	2.25 (57.15)	1.570 (39.88)	75
NW-50-CRC-SV	Viton	2.75 (69.85)	1.967 (49.96)	50

Buna and Silicone O-rings available. Call for pricing.



NW trapped centering rings are composed of an aluminum outer ring, Viton O-ring, and stainless steel centering ring

### NW Stainless Steel Trapped Centering Rings with O-ring

MODEL NUMBER	O-RING MATERIAL	A	B	C
NW-10/16-CRT-SV	Viton	1.18 (29.97)	0.63 (16.00)	0.91 (23.11)
NW-25-CRT-SV	Viton	1.58 (40.13)	0.95 (24.13)	1.3 (33.02)
NW-40-CRT-SV	Viton	2.17 (55.12)	1.58 (40.13)	1.89 (48.01)
NW-50-CRT-SV	Viton	2.95 (74.93)	1.97 (50.04)	2.32 (58.93)

Buna and Silicone O-rings available. Call for pricing.

### Viton O-Rings

MODEL NUMBER	FLANGE TYPE
NW-10-OR-V	NW-10
NW-16-OR-V	NW-16
NW-25-OR-V	NW-25
NW-40-OR-V	NW-40
NW-50-OR-V	NW-50

### Silicone O-Rings

MODEL NUMBER	FLANGE TYPE
NW-10-OR-S	NW-10
NW-16-OR-S	NW-16
NW-25-OR-S	NW-25
NW-40-OR-S	NW-40
NW-50-OR-S	NW-50

### Buna O-Rings

MODEL NUMBER	FLANGE TYPE
NW-10-OR-B	NW-10
NW-16-OR-B	NW-16
NW-25-OR-B	NW-25
NW-40-OR-B	NW-40
NW-50-OR-B	NW-50

All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.



#### SPECIFICATIONS

**Tube OD sizes:** 1/2 to 2 inches (12.7 to 50.8mm)

#### Materials

Flange: 304 stainless steel  
(316L available upon request)  
O-rings: Viton, Buna & silicone

#### Fittings

Tube finishes: Beadblast standard  
(Tumbled & electropolish available)

**Fasteners:** Wing nut, SureSeal,  
bulkhead & chain clamps

#### Vacuum range

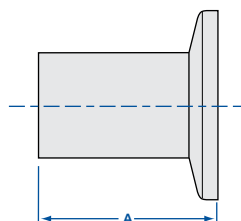
Elastomer seal:  $\geq 1 \times 10^{-8}$  mbar -High vacuum  
Metal seal:  $\geq 1 \times 10^{-11}$  mbar - UHV

#### Temperature range

Viton: -20°C to 200°C  
Silicone: -50° to 230°C  
Buna: -30°C to 110°C  
Metal seal: -270°C to 150°C

See Section 2.1 for metal seals

Nor-Cal manufactures a complete line of NW vacuum fittings. The tube portions are fabricated from 304 stainless steel. 316L stainless steel can be supplied on request. Nor-Cal makes its own elbows, and all tees and crosses are made with the pulled-port technique. This allows smooth, crevice-free butt welds to provide the maximum in cleanliness for UHV applications. Bakeout range is up to 200°C. Nor-Cal fittings are also available with CF, ISO and ASA flanges. Standard finish is bead blasted. Electropolished finish can also be provided as an option. Call for pricing.



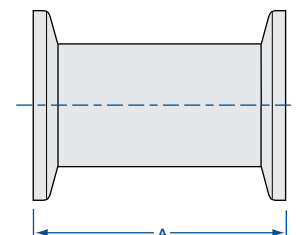
### NW Half Nipples

MODEL NUMBER	TUBE OD	A
<b>1N-NW-10</b>	1/2 (12.70)	1.25 (31.75)
<b>1N-NW-16B</b>	3/4 (19.05)	1.15 (29.21)
<b>1N-NW-25B</b>	1 (25.40)	2.03 (51.56)
<b>1N-NW-40B</b>	1 1/2 (38.10)	2.40 (60.96)
<b>1N-NW-50B</b>	2 (50.80)	3.15 (80.01)



### NW Full Nipples

MODEL NUMBER	TUBE OD	A
<b>2N-NW-10</b>	1/2 (12.70)	2.50 (63.50)
<b>2N-NW-16B</b>	3/4 (19.05)	2.30 (58.42)
<b>2N-NW-25B</b>	1 (25.40)	4.06 (103.12)
<b>2N-NW-40B</b>	1 1/2 (38.10)	4.80 (121.92)
<b>2N-NW-50B</b>	2 (50.80)	6.30 (160.02)



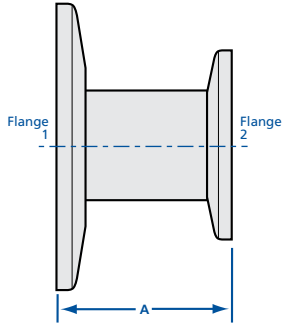
All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.





# Flanges & Fittings

## NW Fittings



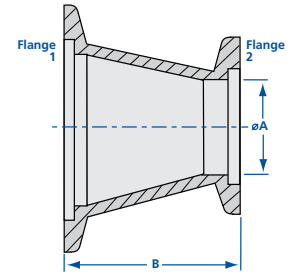
### NW Reducer Nipples

MODEL NUMBER	FLANGE 1	FLANGE 2	TUBE OD	A
2NR-NW-16-10	NW-16	NW-10	1/2 (12.70)	1.40 (35.56)
2NR-NW-25-10	NW-25	NW-10	1/2 (12.70)	1.40 (35.56)
2NR-NW-25-16	NW-25	NW-16	3/4 (19.05)	1.30 (33.02)
2NR-NW-40-10	NW-40	NW-10	1/2 (12.70)	1.40 (35.56)
2NR-NW-40-16	NW-40	NW-16	3/4 (19.05)	1.30 (33.02)
2NR-NW-40-25	NW-40	NW-25	1 (25.40)	2.18 (55.37)
2NR-NW-50-10	NW-50	NW-10	1/2 (12.70)	1.40 (35.56)
2NR-NW-50-16	NW-50	NW-16	3/4 (19.05)	1.30 (33.02)
2NR-NW-50-25	NW-50	NW-25	1 (25.40)	2.18 (55.37)
2NR-NW-50-40	NW-50	NW-40	1 1/2 (38.10)	2.55 (64.77)



### NW Conical Reducer Nipples

MODEL NUMBER	FLANGE 1	FLANGE 2	A	B
2NRC-NW-25-16	NW-25	NW-16	0.62 (15.75)	1.57 (39.88)
2NRC-NW-40-16	NW-40	NW-16	0.62 (15.75)	1.57 (39.88)
2NRC-NW-50-16	NW-50	NW-16	0.62 (15.75)	1.57 (39.88)
2NRC-NW-40-25	NW-40	NW-25	0.87 (22.10)	1.57 (39.88)
2NRC-NW-50-25	NW-50	NW-25	0.87 (22.10)	1.57 (39.88)
2NRC-NW-50-40	NW-50	NW-40	1.38 (35.05)	1.57 (39.88)

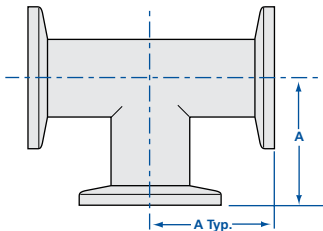


### NW 316L Conical Reducer Nipples

MODEL NUMBER	FLANGE 1	FLANGE 2	A	B
2NRC-NW-40-25-316L	NW-40	NW-25	0.87 (22.10)	1.57 (39.88)
2NRC-NW-50-40-316L	NW-50	NW-40	0.87 (22.10)	1.57 (39.88)

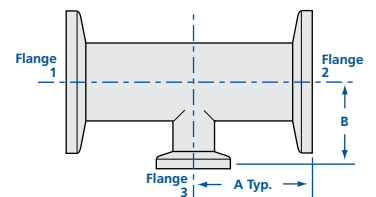
### NW Tees

MODEL NUMBER	TUBE OD	A
3T-NW-10	1/2 (12.70)	1.25 (31.75)
3T-NW-16B	3/4 (19.05)	1.15 (29.21)
3T-NW-25B	1 (25.40)	2.03 (51.56)
3T-NW-40B	1 1/2 (38.10)	2.40 (60.96)
3T-NW-40H	1 1/2 (38.10)	2.56 (65.02)
3T-NW-50B	2 (50.80)	3.15 (80.01)
3T-NW-50H	2 (50.80)	2.76 (70.10)



### NW Reducer Tees

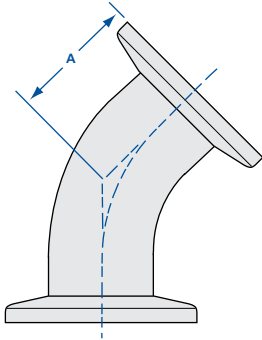
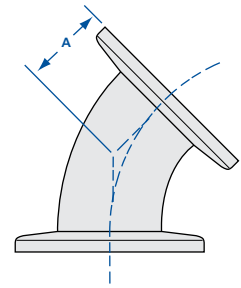
MODEL NUMBER	TUBE 1 & 2 ARM OD	TUBE 3 LEG OD	A	B
3TR-NW-25-16B	1 (25.40)	3/4 (19.05)	2.03 (51.56)	1.27 (32.26)
3TR-NW-40-16B	1 1/2 (38.10)	3/4 (19.05)	2.40 (60.96)	1.53 (38.86)
3TR-NW-40-25B	1 1/2 (38.10)	1 (25.40)	2.40 (60.96)	2.28 (57.91)
3TR-NW-50-16B	2 (50.80)	3/4 (19.05)	3.15 (80.01)	1.78 (45.21)
3TR-NW-50-40B	2 (50.80)	1 1/2 (38.10)	3.15 (80.01)	2.65 (67.31)





### NW 45° Radius Elbows

MODEL NUMBER	TUBE OD	A
2K-NW-25	1 (25.40)	0.77 (19.56)
2K-NW-40	1½ (38.10)	1.08 (27.43)
2K-NW-50	2 (50.80)	1.39 (35.31)



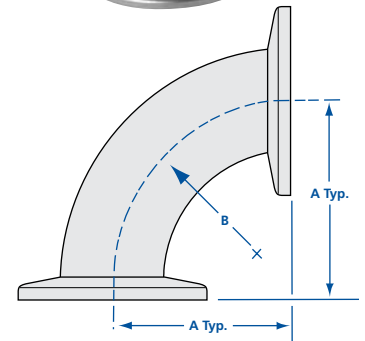
### NW 45° Radius Elbows with Tangents

MODEL NUMBER	TUBE OD	A
2KL-NW-16	¾ (19.05)	0.91 (23.11)
2KL-NW-25	1 (25.40)	1.12 (28.45)
2KL-NW-40	1½ (38.10)	1.68 (42.67)
2KL-NW-50	2 (50.80)	1.99 (50.55)



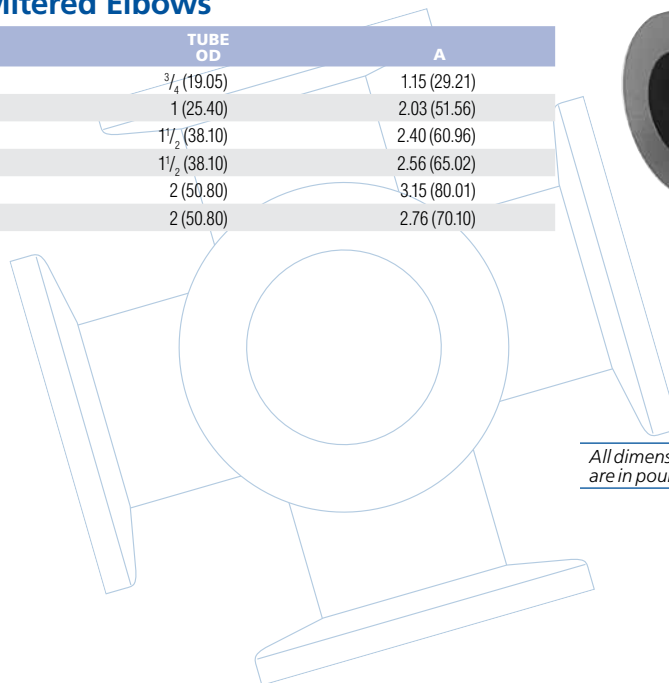
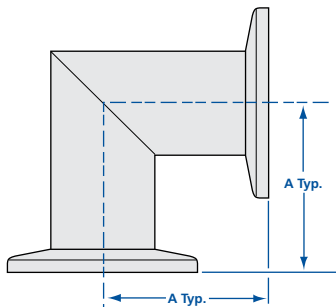
### NW 90° Radius Elbows

MODEL NUMBER	TUBE OD	A	B
2E-NW-10	½ (12.70)	1.25 (31.75)	0.75 (19.05)
2E-NW-16B	¾ (19.05)	1.15 (29.21)	1.00 (25.40)
2E-NW-25B	1 (25.40)	1.65 (41.91)	1.50 (38.10)
2E-NW-40B	1½ (38.10)	2.40 (60.96)	2.25 (57.15)
2E-NW-40H	1½ (38.10)	2.56 (65.02)	2.25 (57.15)
2E-NW-40HL	1½ (38.10)	5.12 (130.05)	2.25 (57.15)
2E-NW-50B	2 (50.80)	3.15 (80.01)	3.00 (76.20)
2E-NW-50HL	2 (50.80)	5.51 (139.95)	3.00 (76.20)



### NW 90° Mitered Elbows

MODEL NUMBER	TUBE OD	A
2E-NW-16MB	¾ (19.05)	1.15 (29.21)
2E-NW-25MB	1 (25.40)	2.03 (51.56)
2E-NW-40MB	1½ (38.10)	2.40 (60.96)
2E-NW-40MH	1½ (38.10)	2.56 (65.02)
2E-NW-50MB	2 (50.80)	3.15 (80.01)
2E-NW-50MH	2 (50.80)	2.76 (70.10)

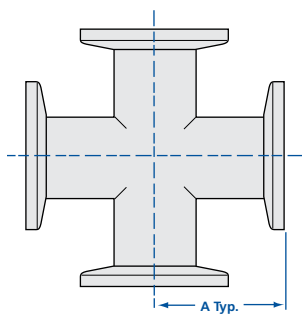


All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.



# Flanges & Fittings

## NW Fittings



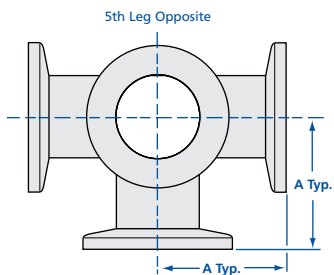
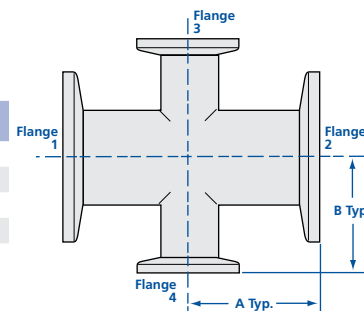
### NW 4-Way Crosses

MODEL NUMBER	TUBE OD	A
4C-NW-10	1/2 (12.70)	1.25 (31.75)
4C-NW-16B	3/4 (19.05)	1.15 (29.21)
4C-NW-25B	1 (25.40)	2.03 (51.56)
4C-NW-40B	1 1/2 (38.10)	2.40 (60.96)
4C-NW-40H	1 1/2 (38.10)	2.56 (65.02)
4C-NW-50B	2 (50.80)	3.15 (80.01)
4C-NW-50H	2 (50.80)	2.76 (70.10)



### NW Reducer Crosses

MODEL NUMBER	TUBE 1 & 2 OD	TUBE 3 & 4 OD	A	B
4CR-NW-25-16B	1 (25.40)	3/4 (19.05)	2.03 (51.56)	1.27 (32.26)
4CR-NW-40-16B	1 1/2 (38.10)	3/4 (19.05)	2.40 (60.96)	1.53 (38.86)
4CR-NW-40-25B	1 1/2 (38.10)	1 (25.40)	2.40 (60.96)	2.28 (57.91)
4CR-NW-50-16B	2 (50.80)	3/4 (19.05)	3.15 (80.01)	1.78 (45.21)
4CR-NW-50-40B	2 (50.80)	1 1/2 (38.10)	3.15 (80.01)	2.65 (67.31)



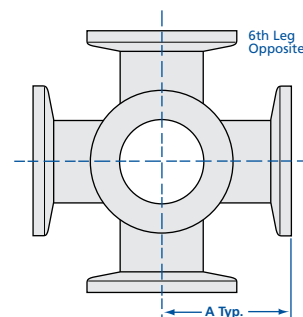
### NW 5-Way Crosses

MODEL NUMBER	TUBE OD	A
5C-NW-16	3/4 (19.05)	1.50 (38.10)
5C-NW-25B	1 (25.40)	2.03 (51.56)
5C-NW-40B	1 1/2 (38.10)	2.40 (60.96)
5C-NW-50B	2 (50.80)	3.15 (80.01)

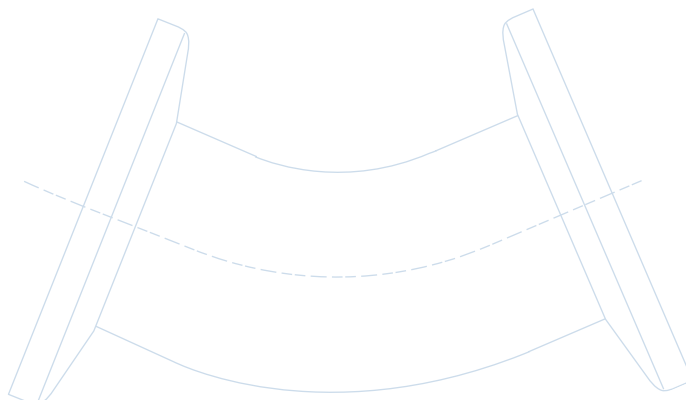


### NW 6-Way Crosses

MODEL NUMBER	TUBE OD	A
6C-NW-16	3/4 (19.05)	1.50 (38.10)
6C-NW-25B	1 (25.40)	2.03 (51.56)
6C-NW-40B	1 1/2 (38.10)	2.40 (60.96)
6C-NW-50B	2 (50.80)	3.15 (80.01)



All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.





# Flanges & Fittings

## ISO Flange General Information



### SPECIFICATIONS

**General:** Optional fastener or nonrotatable flanges with clearance bolt holes

**Nominal OD sizes:** ISO-63 to ISO-500

**Tube OD sizes:** 2 1/2 to 20 inches (63.5-508mm)

#### Materials

Flange: 304 or 316L stainless steel

O-rings: Viton, Buna

Bolts: 18-8 stainless steel

#### Vacuum range

Elastomer seal:  $\geq 1 \times 10^{-8}$  mbar -High vacuum

Metal seal:  $\geq 1 \times 10^{-11}$  mbar - UHV

#### Temperature range

Viton: -20°C to 200°C

Buna: -30°C to 110°C

Metal seal: -270°C to 150°C

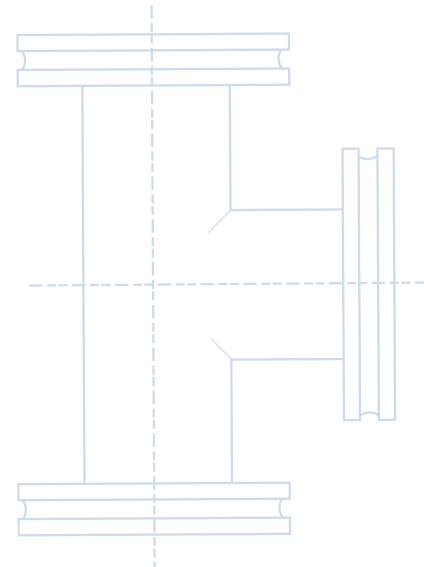
Nor-Cal ISO flanges and hardware are manufactured to the International Standards Organization specification so they can be mated to other manufacturers' ISO flanges. ISO flanges are made from Argon Oxygen Decarburization (AOD) 304 stainless steel. This material is certified to meet ASTM-240 and has less than 0.01% sulfur in order to prevent sulfur stringers. Grain size is 3 to 6 per ASTM E-112.

Maximum inclusion size is 2.5 per ASTM E-45. Normally our standard material is in the low carbon range for 304 stainless steel. For increased corrosion resistance, some sizes are available from stock in 316L stainless steel.

Optional fastener and nonrotatable ISO flanges are available from stock for 2 1/2 to 20 inch (63.5-508mm) tube sizes.

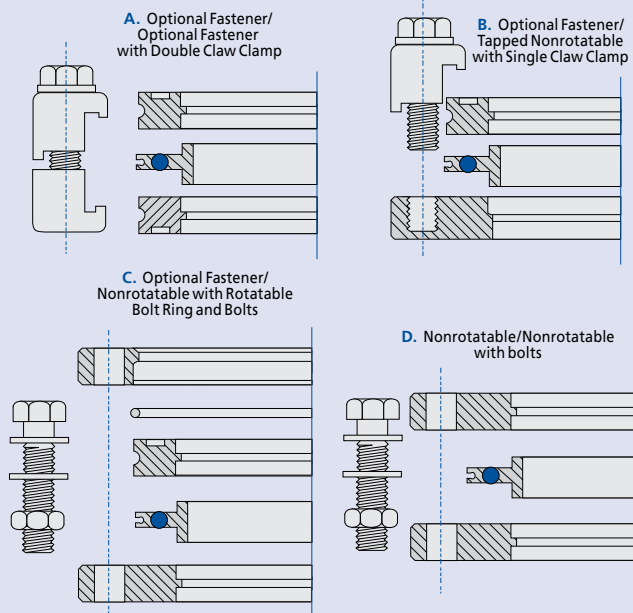
Both use a Viton O-ring, held in place by a centering ring, to effect a seal with a vacuum range of  $10^{-8}$  mbar. ISO components can be baked to 204°C.

ISO flanges can also be used with standard clamps and aluminum seals to obtain a UHV seal bakeable to 150°C. Seals are described in detail in Section 2.1 of this catalog.

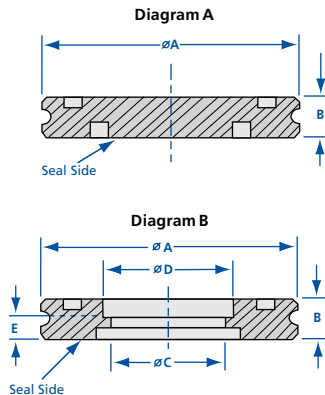


### ISO Flange Assembly Instructions

Optional fastener flanges are joined around the periphery with clamps. Double claw clamps are used when a pair of OF flanges are joined (See diagram A.), or single claw clamps are used to join an OF flange to a tapped nonrotatable on a pump or gate valve. (See diagram B.) This fastening method allows the OF flange to be rotated for ease of component alignment. Additionally, a rotatable bolt ring can be used to fasten an OF flange to a nonrotatable flange using bolts. (See diagram C.) A retainer ring prevents the OF flange from slipping through the bolt ring. Nonrotatable ISO flanges are assembled with bolts. (See diagram D.) They do not allow rotation of bolt holes on mating flanges to align components.



All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.



### ISO Optional Fastener Flanges

MODEL NUMBER	DIAGRAM	NOMINAL ID	A	B	C	D	E
ISO-63-000-OF	A	-	3.74 (95.00)	0.47 (11.94)	-	-	-
ISO-63-250-OF	B	2 1/2 (63.50)	3.74 (95.00)	0.47 (11.94)	2.438 (61.93)	2.510 (63.75)	0.25 (6.35)
ISO-80-000-OF	A	-	4.331 (110.01)	0.47 (11.94)	-	-	-
ISO-80-300-OF	B	3 (76.20)	4.331 (110.01)	0.47 (11.94)	2.938 (74.63)	3.010 (76.45)	0.25 (6.35)
ISO-100-000-OF	A	-	5.118 (130.00)	0.47 (11.94)	-	-	-
ISO-100-400-OF	B	4 (101.60)	5.118 (130.00)	0.47 (11.94)	3.910 (99.31)	4.010 (101.85)	0.25 (6.35)
ISO-160-000-OF	A	-	7.087 (180.00)	0.47 (11.94)	-	-	-
ISO-160-600-OF	B	6 (152.40)	7.087 (180.01)	0.47 (11.94)	5.875 (149.23)	6.020 (152.91)	0.375 (9.53)
ISO-200-000-OF	A	-	9.449 (240.00)	0.47 (11.94)	-	-	-
ISO-200-800-OF	B	8 (203.20)	9.449 (240.00)	0.47 (11.94)	7.875 (200.03)	8.020 (203.71)	0.375 (9.53)
ISO-250-000-OF	A	-	11.417 (289.99)	0.47 (11.94)	-	-	-
ISO-250-1000-OF	B	10 (254.00)	11.417 (289.99)	0.47 (11.94)	9.875 (250.83)	10.020 (254.51)	0.375 (9.53)
ISO-320-000-OF	A	-	14.567 (370.00)	0.67 (17.02)	-	-	-
ISO-320-1200-OF	B	12 (304.80)	14.567 (370.00)	0.67 (17.02)	11.760 (298.70)	12.020 (305.31)	0.375 (9.53)
ISO-320-1275-OF	B	12 (304.80)	14.567 (370.00)	0.67 (17.02)	12.420 (315.47)	12.770 (324.36)	0.375 (9.53)
ISO-400-000-OF	A	-	17.716 (449.99)	0.67 (17.02)	-	-	-
ISO-400-1600-OF	B	16 (406.40)	17.716 (449.99)	0.67 (17.02)	15.624 (396.85)	16.020 (406.91)	0.375 (9.53)
ISO-500-000-OF	A	-	21.653 (549.99)	0.67 (17.02)	-	-	-
ISO-500-2000-OF	B	20 (508.00)	21.653 (549.99)	0.67 (17.02)	19.624 (498.45)	20.02 (508.51)	0.375 (9.53)

### ISO 316L Optional Fastener Flanges

MODEL NUMBER	DIAGRAM	NOMINAL ID	A	B	C	D	E
ISO-63-250-OF-316L	B	2 1/2 (63.05)	3.740 (95.00)	0.47 (11.94)	2.438 (61.93)	2.510 (63.75)	0.25 (6.35)
ISO-80-300-OF-316L	B	3 (76.20)	4.331 (110.01)	0.47 (11.94)	2.938 (74.63)	3.010 (76.45)	0.25 (6.35)
ISO-100-400-OF-316L	B	4 (101.60)	5.118 (130.00)	0.47 (11.94)	3.910 (99.31)	4.010 (101.85)	0.25 (6.35)



### ISO Rotatable Bolt Ring and Retainer Ring

MODEL NUMBER	FLANGE SIZE	A	B	C
ISO-63-BR	ISO-63	4.331 (110.01)	5.118 (130.00)	0.472 (11.99)
ISO-80-BR	ISO-80	4.921 (124.99)	5.709 (145.01)	0.472 (11.99)
ISO-100-BR	ISO-100	5.709 (145.01)	6.496 (165.00)	0.472 (11.99)
ISO-160-BR	ISO-160	7.874 (200.00)	8.858 (224.99)	0.630 (16.00)
ISO-200-BR	ISO-200	10.236 (259.99)	11.220 (284.99)	0.630 (16.00)
ISO-250-BR	ISO-250	12.205 (310.01)	13.189 (335.00)	0.630 (16.00)
ISO-320-BR	ISO-320	15.551 (395.00)	16.732 (424.99)	0.787 (19.99)
ISO-400-BR	ISO-400	18.898 (480.01)	20.079 (510.01)	0.787 (19.99)
ISO-500-BR	ISO-500	22.835 (580.01)	24.016 (610.01)	0.787 (19.99)

#### SPECIFICATIONS

**General:** Optional fastener or nonrotatable flanges with clearance bolt holes

**Nominal OD sizes:** ISO-63 to ISO-500

**Tube OD sizes:** 2 1/2 to 20 inches (63.5-508mm)

#### Materials

Flange: 304 or 316L stainless steel  
O-rings: Viton, Buna  
Bolts: 18-8 stainless steel

#### Vacuum range

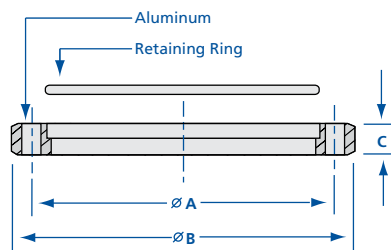
Elastomer seal:  $\geq 1 \times 10^{-8}$  mbar - High vacuum  
Metal seal:  $\geq 1 \times 10^{-11}$  mbar - UHV

#### Temperature range

Viton: -20°C to 200°C  
Silicone: -50° to 230°C  
Buna: -30°C to 110°C  
Metal seal: -270°C to 150°C

All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.

See Section 2.1 for metal seals



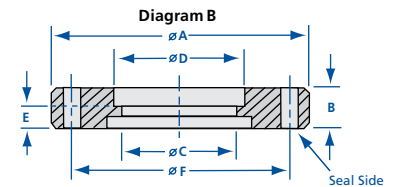
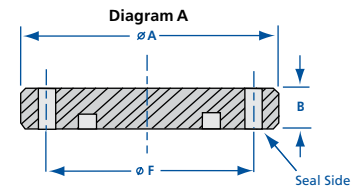
### Replacement Retainer Ring

MODEL NUMBER
ISO-63-RR
ISO-80-RR
ISO-100-RR
ISO-160-RR
ISO-200-RR
ISO-250-RR
ISO-320-RR
ISO-400-RR
ISO-500-RR



### ISO Nonrotatable Flanges

MODEL NUMBER	DIAGRAM	NOMINAL ID	A	B	C	D	E	F	BOLT HOLES	BOLT DIAMETER
ISO-63-000N	A	-	5.118 (130.00)	0.472 (11.99)	-	-	-	4.331 (110.01)	4	0.359 (9.12)
ISO-63-250N	B	2 1/2 (63.50)	5.118 (130.00)	0.472 (11.99)	2.438 (61.93)	2.510 (63.75)	0.250 (6.35)	4.331 (110.01)	4	0.359 (9.12)
ISO-80-000N	A	-	5.709 (145.01)	0.472 (11.99)	-	-	-	4.921 (124.99)	8	0.359 (9.12)
ISO-80-300N	B	3 1/2 (88.90)	5.709 (145.01)	0.472 (11.99)	2.938 (74.63)	3.010 (76.45)	0.250 (6.35)	4.921 (124.99)	8	0.359 (9.12)
ISO-100-000N	A	-	6.496 (165.00)	0.472 (11.99)	-	-	-	5.709 (145.01)	8	0.359 (9.12)
ISO-100-400N	B	4 (101.06)	6.496 (165.00)	0.472 (11.99)	3.910 (99.32)	4.010 (101.85)	0.250 (6.35)	5.709 (145.01)	8	0.359 (9.12)
ISO-160-000N	A	-	8.858 (224.99)	0.630 (16.00)	-	-	-	7.874 (200.00)	8	0.438 (11.13)
ISO-160-600N	B	6 (152.40)	8.858 (224.99)	0.630 (16.00)	5.875 (149.23)	6.020 (152.91)	0.375 (9.53)	7.874 (200.00)	8	0.438 (11.13)
ISO-200-000N	A	-	11.220 (284.99)	0.630 (16.00)	-	-	-	10.236 (259.99)	12	0.438 (11.13)
ISO-200-800N	B	8 (203.20)	11.220 (284.99)	0.630 (16.00)	7.875 (200.03)	8.020 (203.71)	0.375 (9.53)	10.236 (259.99)	12	0.438 (11.13)
ISO-250-000N	A	-	13.189 (335.00)	0.630 (16.00)	-	-	-	12.205 (310.01)	12	0.438 (11.13)
ISO-250-1000N	B	10 (254.00)	13.189 (335.00)	0.630 (16.00)	9.875 (250.83)	10.020 (254.51)	0.375 (9.53)	12.205 (310.01)	12	0.438 (11.13)
ISO-320-000N	A	-	16.732 (424.99)	0.787 (19.99)	-	-	-	15.551 (395.00)	12	0.551 (14.00)
ISO-320-1200N	B	12 (304.80)	16.732 (424.99)	0.787 (19.99)	11.760 (298.70)	12.020 (305.31)	0.375 (9.53)	15.551 (395.00)	12	0.551 (14.00)
ISO-320-1275N	B	12 (304.80)	16.732 (424.99)	0.787 (19.99)	12.420 (315.47)	12.770 (324.36)	0.375 (9.53)	15.551 (395.00)	12	0.551 (14.00)
ISO-400-000N	A	-	20.079 (510.01)	0.787 (19.99)	-	-	-	18.898 (480.01)	16	0.551 (14.00)
ISO-400-1600N	B	16 (406.80)	20.079 (510.01)	0.787 (19.99)	15.642 (397.31)	16.020 (406.91)	0.375 (9.53)	18.898 (480.01)	16	0.551 (14.00)
ISO-500-000N	A	-	24.016 (610.01)	0.787 (19.99)	-	-	-	22.835 (580.01)	16	0.551 (14.00)
ISO-500-2000N	B	20 (508.00)	24.016 (610.01)	0.787 (19.99)	19.642 (498.91)	20.020 (508.51)	0.375 (9.53)	22.835 (580.01)	16	0.551 (14.00)



### SPECIFICATIONS

**General:** Optional fastener or nonrotatable flanges with clearance bolt holes

**Nominal OD sizes:** ISO-63 to ISO-500

**Tube OD sizes:** 2 1/2 to 20 inches (63.5-508mm)

#### Materials

Flange: 304 or 316L stainless steel

O-rings: Viton, Buna

Bolts: 18-8 stainless steel

#### Vacuum range

Elastomer seal:  $\geq 1 \times 10^{-8}$  mbar - High vacuum

Metal seal:  $\geq 1 \times 10^{-11}$  mbar - UHV

#### Temperature range

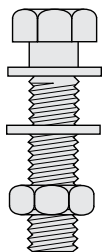
Viton: -20°C to 200°C

Buna: -30°C to 110°C

Metal seal: -270°C to 150°C

*All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.*

*See Section 2.1 for metal seals*



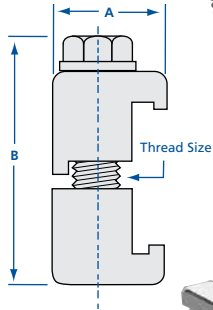
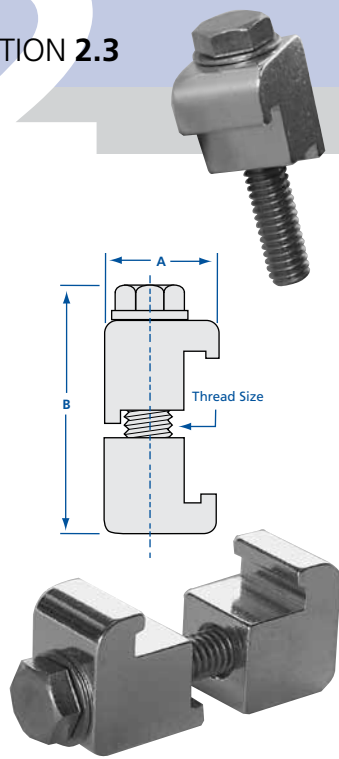
### ISO Bolt Kits-Metric

MODEL NUMBER	DESCRIPTION
B-ISO-63	(4) SS bolts, nuts & washers, M8 x 40mm
B-ISO-80	(8) SS bolts, nuts & washers, M8 x 40mm
B-ISO-100	(8) SS bolts, nuts & washers, M8 x 40mm
B-ISO-160	(8) SS bolts, nuts & washers, M10 x 50mm
B-ISO-200	(12) SS bolts, nuts & washers, M10 x 50mm
B-ISO-250	(12) SS bolts, nuts & washers, M10 x 50mm
B-ISO-320	(12) SS bolts, nuts & washers, M12 x 60mm
B-ISO-400	(16) SS bolts, nuts & washers, M12 x 60mm
B-ISO-500	(16) SS bolts, nuts & washers, M12 x 60mm



# Flanges & Fittings

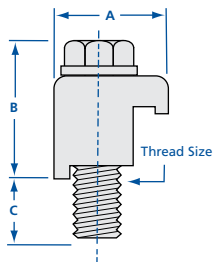
## ISO Clamps



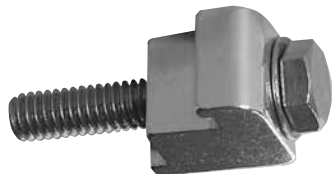
### ISO Double Claw Aluminum Clamps

MODEL NUMBER	FLANGE SIZE	A	B	THREAD SIZE	CLAMPS REQUIRED
<b>ISO-63-DCP</b>	ISO-63	0.94 (23.88)	1.96 (49.78)	5/16-18	4
<b>ISO-80-DCP</b>	ISO-80	0.94 (23.88)	1.96 (49.78)	5/16-18	8
<b>ISO-100-DCP</b>	ISO-100	0.94 (23.88)	1.96 (49.78)	5/16-18	8
<b>ISO-160-DCP</b>	ISO-160	1.10 (27.94)	1.96 (49.78)	5/16-18	8
<b>ISO-200-DCP</b>	ISO-200	1.10 (27.94)	1.96 (49.78)	5/16-18	12
<b>ISO-250-DCP</b>	ISO-250	1.10 (27.94)	1.96 (49.78)	5/16-18	12
<b>ISO-320-DCP</b>	ISO-320	1.34 (34.04)	2.50 (63.50)	7/16-14	12
<b>ISO-400-DCP</b>	ISO-400	1.34 (34.04)	2.50 (63.50)	7/16-14	16
<b>ISO-500-DCP</b>	ISO-500	1.34 (34.04)	2.50 (63.50)	7/16-14	16

### ISO Single Claw Aluminum Clamps



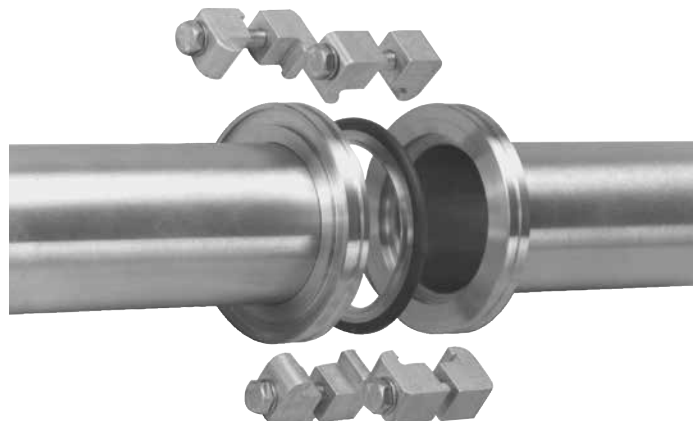
MODEL NUMBER	FLANGE SIZE	A	B	C	THREAD SIZE	CLAMPS REQUIRED
<b>ISO-63-SCP</b>	ISO-63	0.94 (23.88)	1.18 (29.97)	0.52 (13.21)	5/16-18	4
<b>ISO-80-SCP</b>	ISO-80	0.94 (23.88)	1.18 (29.97)	0.52 (13.21)	5/16-18	8
<b>ISO-100-SCP</b>	ISO-100	0.94 (23.88)	1.18 (29.97)	0.52 (13.21)	5/16-18	8
<b>ISO-160-SCP</b>	ISO-160	1.10 (27.94)	1.18 (29.97)	0.52 (13.21)	5/16-18	8
<b>ISO-200-SCP</b>	ISO-200	1.10 (27.94)	1.18 (29.97)	0.52 (13.21)	5/16-18	12
<b>ISO-250-SCP</b>	ISO-250	1.10 (27.94)	1.18 (29.97)	0.52 (13.21)	5/16-18	12
<b>ISO-320-SCP</b>	ISO-320	1.34 (34.04)	1.46 (37.08)	0.88 (22.35)	7/16-14	12
<b>ISO-400-SCP</b>	ISO-400	1.34 (34.04)	1.46 (37.08)	0.88 (22.35)	7/16-14	16
<b>ISO-500-SCP</b>	ISO-500	1.34 (34.04)	1.46 (37.08)	0.88 (22.35)	7/16-14	16

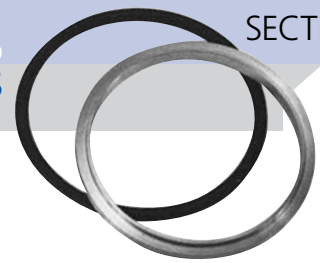


### ISO Single Claw Aluminum Clamps – Metric

MODEL NUMBER	FLANGE SIZE	A	B	C	METRIC THREAD SIZE	CLAMPS REQUIRED
<b>ISO-63-SCP-M</b>	ISO-63	0.94 (23.88)	1.20 (30.48)	0.40 (10.16)	M8 x 1.25	4
<b>ISO-80-SCP-M</b>	ISO-80	0.94 (23.88)	1.20 (30.48)	0.40 (10.16)	M8 x 1.25	8
<b>ISO-100-SCP-M</b>	ISO-100	0.94 (23.88)	1.20 (30.48)	0.40 (10.16)	M8 x 1.25	8
<b>ISO-160-SCP-M</b>	ISO-160	1.10 (27.94)	1.20 (30.48)	0.40 (10.16)	M10 x 1.50	8
<b>ISO-200-SCP-M</b>	ISO-200	1.10 (27.94)	1.20 (30.48)	0.40 (10.16)	M10 x 1.50	12
<b>ISO-250-SCP-M</b>	ISO-250	1.10 (27.94)	1.20 (30.48)	0.40 (10.16)	M10 x 1.50	12
<b>ISO-320-SCP-M</b>	ISO-320	1.34 (34.04)	1.48 (37.59)	0.79 (20.07)	M12 x 1.75	12
<b>ISO-400-SCP-M</b>	ISO-400	1.34 (34.04)	1.48 (37.59)	0.79 (20.07)	M12 x 1.75	16
<b>ISO-500-SCP-M</b>	ISO-500	1.34 (34.04)	1.48 (37.59)	0.79 (20.07)	M12 x 1.75	16

All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.

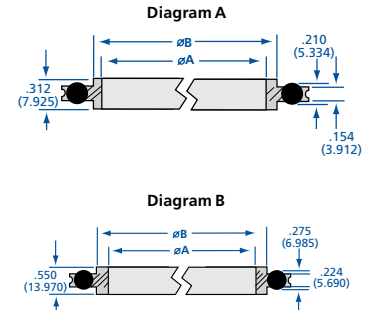




### ISO Aluminum Centering Rings with O-ring and Aluminum Spacer Ring

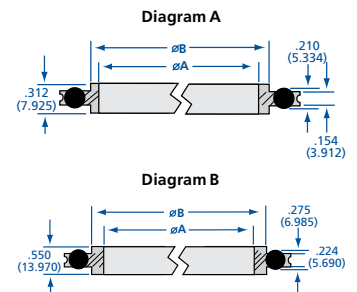
MODEL NUMBER	DIAGRAM	O-RING MATERIAL	A	B
ISO-63-CR-AV*	A	Viton	2.63 (66.80)	2.74 (69.60)
ISO-63-CR-AB*	A	Buna	2.63 (66.80)	2.74 (69.60)
ISO-80-CR-AV	A	Viton	3.14 (79.76)	3.25 (82.55)
ISO-80-CR-AB	A	Buna	3.14 (79.76)	3.25 (82.55)
ISO-100-CR-AV	A	Viton	3.89 (98.81)	4.00 (101.60)
ISO-100-CR-AB	A	Buna	3.89 (98.81)	4.00 (101.60)
ISO-160-CR-AV	A	Viton	5.90 (149.86)	6.01 (152.65)
ISO-160-CR-AB	A	Buna	5.90 (149.86)	6.01 (152.65)
ISO-200-CR-AV	A	Viton	8.26 (209.80)	8.37 (212.60)
ISO-200-CR-AB	A	Buna	8.26 (209.80)	8.37 (212.60)
ISO-250-CR-AV	A	Viton	10.14 (257.56)	10.25 (260.35)
ISO-250-CR-AB	A	Buna	10.14 (257.56)	10.25 (260.35)
ISO-320-CR-AV	B	Viton	12.32 (312.93)	12.51 (317.75)
ISO-320-CR-AB	B	Buna	12.32 (312.93)	12.51 (317.75)
ISO-400-CR-AV	B	Viton	15.55 (394.97)	15.75 (400.05)
ISO-400-CR-AB	B	Buna	15.55 (394.97)	15.75 (400.05)
ISO-500-CR-AV	B	Viton	19.53 (496.06)	19.72 (500.89)
ISO-500-CR-AB	B	Buna	19.53 (496.06)	19.72 (500.89)

\*Machined centering ring.



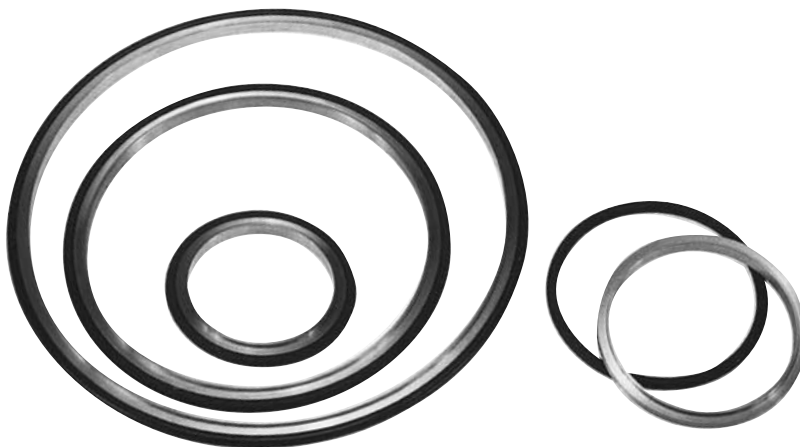
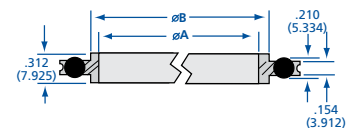
### ISO Stainless Steel Centering Rings with O-ring and Aluminum Spacer Ring

MODEL NUMBER	DIAGRAM	O-RING MATERIAL	A	B
ISO-63-CR-SV	A	Viton	2.63 (66.80)	2.74 (69.60)
ISO-80-CR-SV	A	Viton	3.14 (79.76)	3.25 (82.55)
ISO-100-CR-SV	A	Viton	3.89 (98.81)	4.00 (101.60)
ISO-160-CR-SV	A	Viton	5.90 (149.86)	6.01 (152.65)
ISO-200-CR-SV	A	Viton	8.26 (209.80)	8.37 (212.60)
ISO-250-CR-SV	A	Viton	10.14 (257.56)	10.25 (260.35)
ISO-320-CR-SV	B	Viton	12.36 (313.94)	12.52 (318.01)
ISO-400-CR-SV	B	Viton	15.55 (394.97)	15.75 (400.05)



### ISO 316L Stainless Steel Centering Rings with O-ring and Aluminum Spacer Ring

MODEL NUMBER	O-RING MATERIAL	A	B
ISO-63-CR-SV-316L	Viton	2.63 (66.80)	2.74 (69.60)
ISO-80-CR-SV-316L	Viton	3.14 (79.76)	3.25 (82.55)
ISO-100-CR-SV-316L	Viton	3.89 (98.81)	4.00 (101.60)



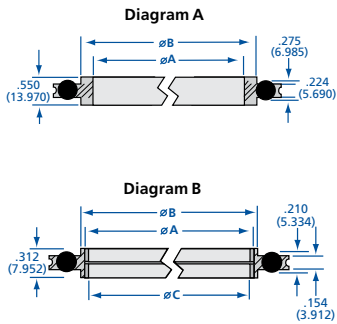
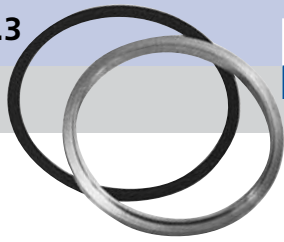
All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.

See next page for replacement O-rings

See Section 2.1 for metal seals

# Flanges & Fittings

## ISO Centering Rings

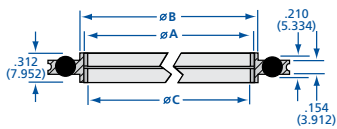


### ISO Stainless Steel Centering Rings with O-ring

MODEL NUMBER	DIAGRAM	O-RING MATERIAL	A	B
ISO-63-CR	A	Viton	2.63 (66.80)	2.74 (69.60)
ISO-80-CR	A	Viton	3.14 (79.76)	3.25 (82.55)
ISO-100-CR	A	Viton	3.89 (98.81)	4.00 (101.60)
ISO-160-CR	A	Viton	5.90 (149.86)	6.01 (152.65)
ISO-200-CR	A	Viton	8.26 (209.80)	8.37 (212.60)
ISO-250-CR	A	Viton	10.14 (257.56)	10.25 (260.35)
ISO-320-CR	B	Viton	12.32 (312.93)	12.52 (318.01)
ISO-400-CR	B	Viton	15.55 (394.97)	15.74 (399.80)

See below for replacement O-rings.

### ISO Screened Stainless Steel Centering Rings with O-ring and Aluminum Spacer Ring



MODEL NUMBER	O-RING MATERIAL	A	B	C	MESH (sq./in.)
ISO-63-CR-SV-16	Viton	2.63 (66.80)	2.74 (69.60)	2.38 (60.45)	16
ISO-80-CR-SV-16	Viton	3.14 (79.76)	3.25 (82.55)	2.87 (72.90)	16
ISO-100-CR-SV-16	Viton	3.89 (98.81)	4.00 (101.60)	3.50 (88.90)	16
ISO-160-CR-SV-16	Viton	5.90 (149.86)	6.01 (152.65)	5.50 (139.70)	16

Includes O-ring. See below for replacement O-rings.



### Viton O-Rings

MODEL NUMBER	FLANGE TYPE
ISO-63-OR-V	ISO-63
ISO-80-OR-V	ISO-80
ISO-100-OR-V	ISO-100
ISO-160-OR-V	ISO-160
ISO-200-OR-V	ISO-200
ISO-250-OR-V	ISO-250
ISO-320-OR-V	ISO-320
ISO-400-OR-V	ISO-400
ISO-500-OR-V	ISO-500

### Buna O-Rings

MODEL NUMBER	FLANGE TYPE
ISO-63-OR-B	ISO-63
ISO-80-OR-B	ISO-80
ISO-100-OR-B	ISO-100
ISO-160-OR-B	ISO-160
ISO-200-OR-B	ISO-200
ISO-250-OR-B	ISO-250
ISO-320-OR-B	ISO-320
ISO-400-OR-B	ISO-400
ISO-500-OR-B	ISO-500



All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.

See Section 2.1 for metal seals





Nor-Cal Products manufactures a complete line of ISO vacuum fittings with optional fastener or nonrotatable flanges. The tube portions are fabricated from 304 stainless steel. For increased resistance to corrosion in downstream semiconductor processes, some ISO flanges and fittings are available in 316L stainless steel. Nor-Cal makes its own elbows, and all tees and crosses are made with the pulled-port technique. This allows smooth, crevice-free butt welds to provide the maximum in cleanliness for UHV applications. Fittings are shown with OF flanges only. To order a fitting with nonrotatable flanges substitute “-N” for “-OF” in the model number. Fittings are also available with CF (Conflat style), NW (ISO-KF compatible) and ASA flanges. Standard finish is bead blasted. Electropolished finish also available. Call for pricing.



#### SPECIFICATIONS

**General:** Optional fastener or nonrotatable flanges with clearance bolt holes

**Nominal OD sizes:** ISO-63 to ISO-500

**Tube OD sizes:** 2½ to 20 inches (63.5-508mm)

**Tube finish:** Beadblast, tumbled, or electropolish

#### Materials

**Flange:** 304 or 316L stainless steel

**O-rings:** Viton, Buna

**Bolts:** 18-8 stainless steel

#### Vacuum range

**Elastomer seal:** ≥1 x 10<sup>-8</sup> mbar - High vacuum

**Metal seal:** ≥1 x 10<sup>-11</sup> mbar - UHV

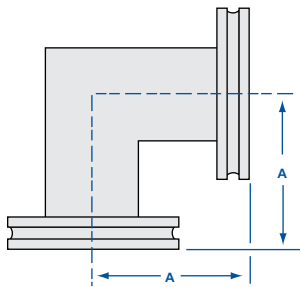
#### Temperature range

**Viton:** -20°C to 200°C

**Buna:** -30°C to 110°C

**Metal seal:** -270°C to 150°C

See Section 2.1 for metal seals



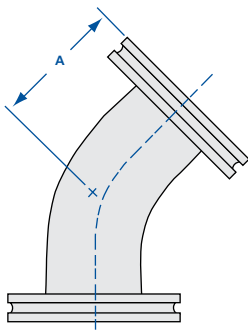
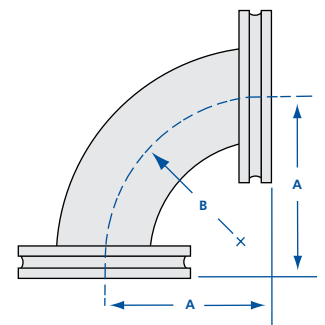
#### ISO 90° Mitered Elbows

MODEL NUMBER	TUBE OD	A
2E-ISO-63-OF-M	2½ (63.50)	3.25 (82.55)
2E-ISO-80-OF-M	3 (76.20)	3.50 (88.90)
2E-ISO-100-OF-M	4 (101.60)	4.13 (104.90)
2E-ISO-160-OF-M	6 (152.40)	5.38 (136.65)
2E-ISO-200-OF-M	8 (203.20)	7.38 (187.45)
2E-ISO-250-OF-M	10 (254.00)	9.88 (250.95)



#### ISO 90° Radius Elbows

MODEL NUMBER	TUBE OD	A	B
2E-ISO-63-OF	2½ (63.50)	4.00 (101.60)	3.75 (95.25)
2E-ISO-80-OF	3 (76.20)	4.75 (120.65)	4.50 (114.30)
2E-ISO-100-OF	4 (101.60)	6.25 (158.75)	6.00 (152.40)
2E-ISO-160-OF	6 (152.40)	9.38 (238.25)	9.00 (228.60)
2E-ISO-200-OF	8 (203.20)	12.38 (314.45)	12.00 (304.80)
2E-ISO-250-OF	10 (254.00)	15.38 (390.65)	15.00 (381.00)



#### ISO 45° Elbows with Tangents

MODEL NUMBER	TUBE OD	A
2KL-ISO-63-OF	2½ (63.50)	3.25 (82.55)
2KL-ISO-80-OF	3 (76.20)	3.93 (99.82)
2KL-ISO-100-OF	4 (101.60)	5.03 (127.76)



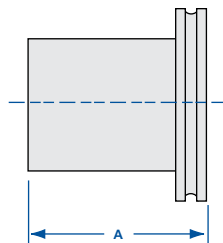
All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.



# Flanges & Fittings

## ISO Fittings

### ISO Half Nipples



MODEL NUMBER	TUBE OD	A
1N-ISO-63-OF	2½ (63.50)	3.25 (82.55)
1N-ISO-63-OF-V	2½ (63.50)	4.00 (101.60)
1N-ISO-63-OF-H	2½ (63.50)	3.94 (100.08)
1N-ISO-80-OF	3 (76.20)	3.50 (88.90)
1N-ISO-80-OF-H	3 (76.20)	3.94 (100.08)
1N-ISO-100-OF	4 (101.60)	4.13 (104.90)
1N-ISO-100-OF-V	4 (101.60)	5.12 (130.05)
1N-ISO-100-OF-H	4 (101.60)	3.94 (100.08)
1N-ISO-160-OF	6 (152.40)	5.38 (136.65)
1N-ISO-160-OF-V	6 (152.40)	6.44 (163.58)
1N-ISO-160-OF-H	6 (152.40)	3.94 (100.08)
1N-ISO-200-OF	8 (203.20)	7.38 (187.45)
1N-ISO-250-OF	10 (254.00)	9.88 (250.95)
1N-ISO-320-OF	12 (304.80)	9.88 (250.95)
1N-ISO-400-OF	16 (406.40)	9.88 (250.95)
1N-ISO-500-OF	20 (508.00)	9.88 (250.95)



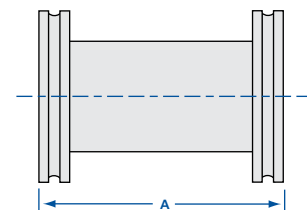
### ISO 316L Half Nipples

MODEL NUMBER	TUBE OD	A
1N-ISO-63-OF-316L	2½ (63.50)	3.25 (82.55)
1N-ISO-80-OF-316L	3 (76.20)	3.50 (88.90)
1N-ISO-100-OF-316L	4 (101.60)	4.13 (104.90)



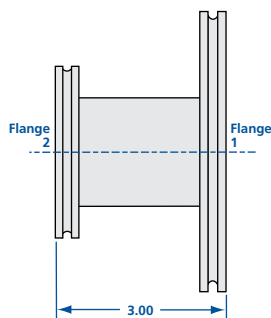
### ISO Full Nipples

MODEL NUMBER	TUBE OD	A
2N-ISO-63-OF	2½ (63.50)	6.50 (165.10)
2N-ISO-80-OF	3 (76.20)	7.00 (177.80)
2N-ISO-100-OF	4 (101.60)	8.26 (209.80)
2N-ISO-160-OF	6 (152.40)	10.76 (273.30)
2N-ISO-200-OF	8 (203.20)	14.76 (374.90)
2N-ISO-250-OF	10 (254.00)	19.76 (501.90)
2N-ISO-320-OF	12 (304.80)	19.76 (501.90)
2N-ISO-400-OF	16 (406.40)	19.76 (501.90)
2N-ISO-500-OF	20 (508.00)	19.76 (501.90)



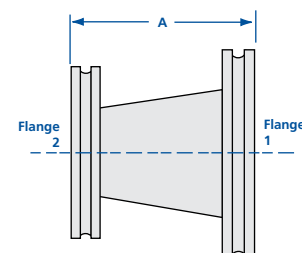
### ISO Reducer Nipples

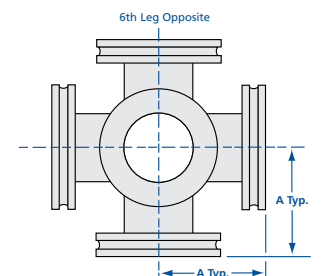
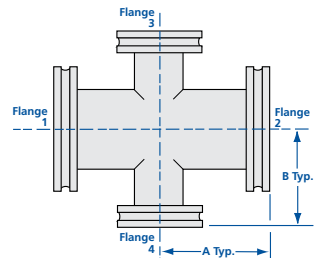
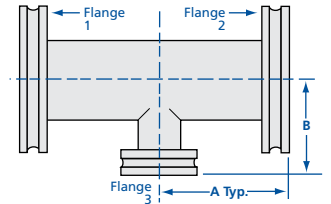
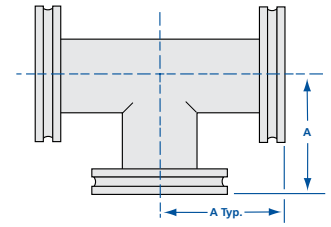
MODEL NUMBER	FLANGE 1	FLANGE 2	TUBE OD
2NR-ISO-80-63-OF	ISO-80	ISO-63	2½ (63.50)
2NR-ISO-100-63-OF	ISO-100	ISO-63	2½ (63.50)
2NR-ISO-100-80-OF	ISO-100	ISO-80	3 (76.20)
2NR-ISO-160-63-OF	ISO-160	ISO-63	2½ (63.50)
2NR-ISO-160-80-OF	ISO-160	ISO-80	3 (76.20)
2NR-ISO-160-100-OF	ISO-160	ISO-100	4 (101.60)
2NR-ISO-200-63-OF	ISO-200	ISO-63	2½ (63.50)
2NR-ISO-200-80-OF	ISO-200	ISO-80	3 (76.20)
2NR-ISO-200-100-OF	ISO-200	ISO-100	4 (101.60)
2NR-ISO-200-160-OF	ISO-200	ISO-160	6 (152.40)
2NR-ISO-250-63-OF	ISO-250	ISO-63	2½ (63.50)
2NR-ISO-250-80-OF	ISO-250	ISO-80	3 (76.20)
2NR-ISO-250-100-OF	ISO-250	ISO-100	4 (101.60)
2NR-ISO-250-160-OF	ISO-250	ISO-160	6 (152.40)
2NR-ISO-250-200-OF	ISO-250	ISO-200	8 (203.20)



### ISO Conical Reducer Nipples

MODEL NUMBER	FLANGE 1 TYPE	TUBE OD	FLANGE 2 TYPE	TUBE OD	A
2NRC-ISO-80-63-OF	ISO-80	3 (76.2)	ISO-63	2½ (63.50)	4.12 (104.65)
2NRC-ISO-100-63-OF	ISO-100	4 (101.6)	ISO-63	2½ (63.50)	4.12 (104.65)
2NRC-ISO-100-80-OF	ISO-100	4 (101.6)	ISO-80	3 (76.20)	4.12 (104.65)



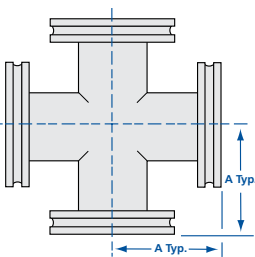


### ISO Tees

MODEL NUMBER	TUBE OD	A
3T-ISO-63-OF	2 1/2 (63.50)	3.25 (82.55)
3T-ISO-80-OF	3 (76.20)	3.50 (88.90)
3T-ISO-100-OF	4 (101.60)	4.13 (104.90)
3T-ISO-160-OF	6 (152.40)	5.38 (136.65)
3T-ISO-200-OF	8 (203.20)	7.38 (187.45)
3T-ISO-250-OF	10 (254.00)	9.88 (250.95)

### ISO Reducer Tees

MODEL NUMBER	FLANGE 1 & 2		FLANGE 3		A	B
	TYPE	ARM OD	TYPE	LEG OD		
3TR-ISO-80-63-OF	ISO-80	3 (76.2)	ISO-63	2 1/2 (63.50)	3.50 (88.90)	3.50 (88.90)
3TR-ISO-100-63-OF	ISO-100	4 (101.6)	ISO-63	2 1/2 (63.50)	4.13 (104.90)	4.00 (101.60)
3TR-ISO-100-80-OF	ISO-100	4 (101.6)	ISO-80	3 (76.20)	4.13 (104.90)	4.00 (101.60)
3TR-ISO-160-63-OF	ISO-160	6 (152.4)	ISO-63	2 1/2 (63.50)	5.38 (136.65)	5.00 (127.00)
3TR-ISO-160-80-OF	ISO-160	6 (152.4)	ISO-80	3 (76.20)	5.38 (136.65)	5.00 (127.00)
3TR-ISO-160-100-OF	ISO-160	6 (152.4)	ISO-100	4 (101.60)	5.38 (136.65)	5.13 (130.30)
3TR-ISO-200-63-OF	ISO-200	8 (203.2)	ISO-63	2 1/2 (63.50)	7.38 (187.45)	6.00 (152.40)
3TR-ISO-200-80-OF	ISO-200	8 (203.2)	ISO-80	3 (76.20)	7.38 (187.45)	6.00 (152.40)
3TR-ISO-200-100-OF	ISO-200	8 (203.2)	ISO-100	4 (101.60)	7.38 (187.45)	6.13 (155.70)
3TR-ISO-200-160-OF	ISO-200	8 (203.2)	ISO-160	6 (152.40)	7.38 (187.45)	6.38 (162.05)

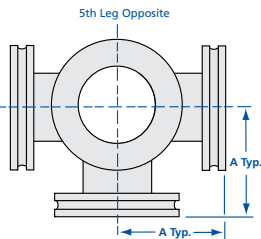


### ISO 4-Way Crosses

MODEL NUMBER	TUBE OD	A
4C-ISO-63-OF	2 1/2 (63.50)	3.25 (82.55)
4C-ISO-80-OF	3 (76.20)	3.50 (88.90)
4C-ISO-100-OF	4 (101.60)	4.13 (104.90)
4C-ISO-160-OF	6 (152.40)	5.38 (136.65)
4C-ISO-200-OF	8 (203.20)	7.38 (187.45)
4C-ISO-250-OF	10 (254.00)	9.88 (250.95)

### ISO 4-Way Reducer Crosses

MODEL NUMBER	FLANGES 1 & 2		FLANGES 3 & 4		A	B
	TYPE	ARM OD	TYPE	LEG OD		
4CR-ISO-80-63-OF	ISO-80	3	ISO-63	2 1/2 (63.50)	3.50 (88.90)	3.50 (88.90)
4CR-ISO-100-63-OF	ISO-100	4	ISO-63	2 1/2 (63.50)	4.13 (104.90)	4.00 (101.60)
4CR-ISO-100-80-OF	ISO-100	4	ISO-80	3 (76.20)	4.13 (104.90)	4.00 (101.60)
4CR-ISO-160-63-OF	ISO-160	6	ISO-63	2 1/2 (63.50)	5.38 (136.65)	5.00 (127.00)
4CR-ISO-160-80-OF	ISO-160	6	ISO-80	3 (76.20)	5.38 (136.65)	5.00 (127.00)
4CR-ISO-160-100-OF	ISO-160	6	ISO-100	4 (101.60)	5.38 (136.65)	5.13 (130.30)
4CR-ISO-200-160-OF	ISO-200	8	ISO-160	6 (152.40)	7.38 (187.45)	6.38 (162.05)



### ISO 5-Way Crosses

MODEL NUMBER	TUBE OD	A
5C-ISO-63-OF	2 1/2 (63.50)	3.25 (82.55)
5C-ISO-80-OF	3 (76.20)	3.50 (88.90)
5C-ISO-100-OF	4 (101.60)	4.13 (104.90)
5C-ISO-160-OF	6 (152.40)	5.38 (136.65)
5C-ISO-200-OF	8 (203.20)	7.38 (187.45)
5C-ISO-250-OF	10 (254.00)	9.88 (250.95)



### ISO 6-Way Crosses

MODEL NUMBER	TUBE OD	A
6C-ISO-63-OF	2 1/2 (63.50)	3.25 (82.55)
6C-ISO-80-OF	3 (76.20)	3.50 (88.90)
6C-ISO-100-OF	4 (101.60)	4.13 (104.90)
6C-ISO-160-OF	6 (152.40)	5.38 (136.65)
6C-ISO-200-OF	8 (203.20)	7.38 (187.45)
6C-ISO-250-OF	10 (254.00)	9.88 (250.95)





# Flanges & Fittings

## ASA Flange General Information

### SPECIFICATIONS

**General:** Rotatable or nonrotatable flanges

**Nominal OD sizes:** 5 to 16 inches  
(125-400mm)

**Tube OD sizes:** 2 to 12 inches (50-320mm)

#### Materials

Flange: 304 stainless steel

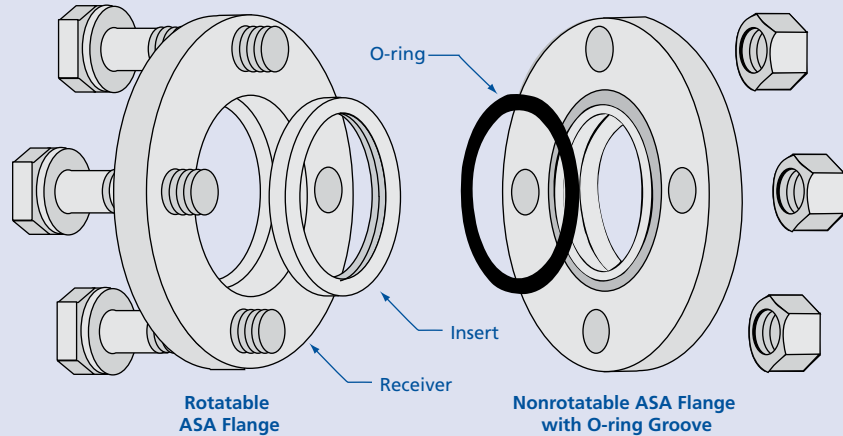
O-rings: Viton

Bolts: 18-8 stainless steel

**Vacuum range:**  $\geq 1 \times 10^{-8}$  mbar - High vacuum

**Temperature range:** -20° to 204°C  
Sustained: -20°C to 150°C

All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.



Nor-Cal's ASA flanges are manufactured from specially treated 304 stainless steel. These flanges mate with standard 150 lb. ASA flanges or 150 ANSI flanges. They are available from stock for standard tube sizes from 2 to 12 inches (50.8 to 304.8mm). Larger sizes are available upon request.

#### ASA TO ANSI CONVERSION CHART

ASA	ANSI
5.0	1.5
6.0	2.0
7.5	3.0
9.0	4.0
11.0	6.0
13.5	8.0
16.0	10.0

Nuts and bolts are used to apply pressure between the mating flanges and a seal is effected when a Viton O-ring is compressed. ASA flanges can be baked to 204°C and have a vacuum range of up to  $10^{-8}$  mbar. Besides being sold separately, they are available as standards on nipples, adapters, tees, crosses, elbows and valves.

### Rotatable Flange Option

When components of several systems are used interchangeably, use of rotatable flanges is recommended. Assembly is facilitated by rotation of mating flanges, to align bolt holes. Nonrotatable ASA flanges, unlike rotatable, contain both sealing surface and bolt holes in one unit rather than two. This makes the nonrotatable flange less expensive, and therefore the preferred choice when mating component orientation is not a concern. All fittings are priced with nonrotatable flanges. For fittings with rotatable flanges, add the difference between a nonrotatable and rotatable flange of the desired size. Multiply by the number of rotatable flanges required. Be sure to specify the flange numbers which are rotatable.

### O-Ring Groove Option

One of each pair of mating ASA flanges requires an O-ring groove. When ordering flanges with grooves indicate this by adding "-G" to the flange model number. An example would be a rotatable ASA-11 flange bored out for six inch (152.4mm) OD tubing with a groove. The model number would be ASA-11-600R-G. The same rule applies when ordering a fitting or adapter flange with only one ASA flange. An example would be adapter flange model number ASA-6-338-200Z-G. When a fitting has more than one ASA flange, such as a four-way cross, indicate which flanges are desired with grooves by using the flange numbers on the drawing. If, for example, you desired a cross with ASA-9 flanges and a six inch (160mm) tube OD with grooved flanges on the left and bottom ports, the model number would be 4C-ASA-9-600-G1-G3. Add the appropriate amount for each O-ring groove to the price of the fitting.



### ASA Flanges - 5 to 9 Inch (125-225mm) OD

One of each pair of mating ASA flanges requires an O-ring groove. To specify grooved flanges refer to the instructions below.

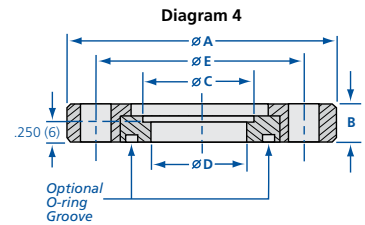
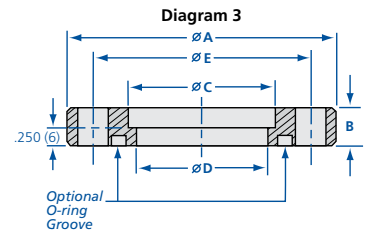
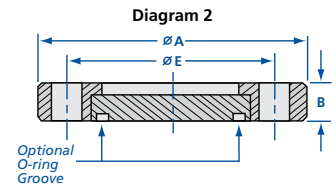
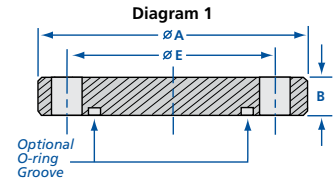
MODEL NUMBER	TYPE	DIAGRAM	A	B	C	D	E	BOLT HOLES	
								NO.	SIZE
ASA-5-000N	Blank	1	5.00 (127.00)	0.500 (12.70)	-	-	3.880 (98.55)	4	0.625 (15.8)
ASA-5-200N	Bored	3	5.00 (127.00)	0.500 (12.70)	2.01 (51.05)	1.938 (49.23)	3.880 (98.55)	4	0.625 (15.8)
ASA-5-250N	Bored	3	5.00 (127.00)	0.500 (12.70)	2.51 (63.75)	2.438 (61.93)	3.880 (98.55)	4	0.625 (15.8)
ASA-5-000R	Blank	2	5.00 (127.00)	0.500 (12.70)	-	-	3.880 (98.55)	4	0.625 (15.8)
ASA-5-200R	Bored	4	5.00 (127.00)	0.500 (12.70)	2.01 (51.05)	1.938 (49.23)	3.880 (98.55)	4	0.625 (15.8)
ASA-5-250R	Bored	4	5.00 (127.00)	0.500 (12.70)	2.51 (63.75)	2.438 (61.93)	3.880 (98.55)	4	0.625 (15.8)
ASA-6-000N	Blank	1	6.00 (152.40)	0.500 (12.70)	-	-	4.750 (120.65)	4	0.750 (19.05)
ASA-6-300N	Bored	3	6.00 (152.40)	0.500 (12.70)	3.01 (76.45)	2.938 (74.63)	4.750 (120.65)	4	0.750 (19.05)
ASA-6-350N	Bored	3	6.00 (152.40)	0.500 (12.70)	3.51 (89.15)	3.438 (87.33)	4.750 (120.65)	4	0.750 (19.05)
ASA-6-000R	Blank	2	6.00 (152.40)	0.612 (15.54)	-	-	4.750 (120.65)	4	0.750 (19.05)
ASA-6-300R	Bored	4	6.00 (152.40)	0.612 (15.54)	3.01 (76.45)	2.938 (74.63)	4.750 (120.65)	4	0.750 (19.05)
ASA-6-350R	Bored	4	6.00 (152.40)	0.612 (15.54)	3.51 (89.15)	3.438 (87.33)	4.750 (120.65)	4	0.750 (19.05)
ASA-7.5-000N	Blank	1	7.50 (190.50)	0.500 (12.70)	-	-	6.000 (152.40)	4	0.750 (19.05)
ASA-7.5-400N	Bored	3	7.50 (190.50)	0.500 (12.70)	4.01 (101.85)	3.910 (99.31)	6.000 (152.40)	4	0.750 (19.05)
ASA-7.5-000R	Blank	2	7.50 (190.50)	0.612 (15.54)	-	-	6.000 (152.40)	4	0.750 (19.05)
ASA-7.5-400R	Bored	4	7.50 (190.50)	0.612 (15.54)	4.01 (101.85)	3.910 (99.31)	6.000 (152.40)	4	0.750 (19.05)
ASA-9-000N	Blank	1	9.00 (228.60)	0.500 (12.70)	-	-	7.500 (190.50)	8	0.750 (19.05)
ASA-9-400N	Bored	3	9.00 (228.60)	0.500 (12.70)	4.01 (101.85)	3.910 (99.31)	7.500 (190.50)	8	0.750 (19.05)
ASA-9-600N	Bored	3	9.00 (228.60)	0.500 (12.70)	6.02 (152.91)	5.875 (149.23)	7.500 (190.50)	8	0.750 (19.05)
ASA-9-000R	Blank	2	9.00 (228.60)	0.612 (15.54)	-	-	7.500 (190.50)	8	0.750 (19.05)
ASA-9-400R	Bored	4	9.00 (228.60)	0.612 (15.54)	4.01 (101.85)	3.910 (99.31)	7.500 (190.50)	8	0.750 (19.05)
ASA-9-600R	Bored	4	9.00 (228.60)	0.612 (15.54)	6.02 (152.91)	5.875 (149.23)	7.500 (190.50)	8	0.750 (19.05)

**Model Number Definitions**  
**N** = Nonrotatable **R** = Rotatable

### O-ring Groove Option

Indicate grooved flanges by adding “-G” to the end of the main part number. Add the appropriate cost for each grooved flange.

**Example:** ASA-9-000R-G



### ASA Flange Hardware

MODEL NUMBER	FLANGE SIZE	DESCRIPTION
BA-5	ASA-5	(4) SS bolts (9/16-12 x 1.5) nuts and washers
OR-2-231	ASA-5	(1) Viton O-ring
BA-6	ASA-6	(4) SS bolts (5/8-11 x 1.5) nuts and washers
OR-2-238	ASA-6	(1) Viton O-ring
BA-7.5	ASA-7.5	(4) SS bolts (5/8-11 x 1.5) nuts and washers
OR-2-243	ASA-7.5	(1) Viton O-ring
BA-9	ASA-9	(8) SS bolts (5/8-11 x 1.5) nuts and washers
OR-2-259	ASA-9	(1) Viton O-ring

### ASA Hardware for Mating to Gate Valves

MODEL NUMBER	FLANGE SIZE	DESCRIPTION
BA-6GV	ASA-6	(4) SS bolts (3/8-16x1.0) & reducer bushings (3/8 x 3/4)
BA-7.5GV	ASA-7.5	(4) SS bolts (3/8-16x1.0) & reducer bushings (3/8 x 3/4)
BA-9GV	ASA-9	(8) SS bolts (3/8-16x1.0) & reducer bushings (3/8 x 3/4)

### SPECIFICATIONS

**General:** Rotatable and nonrotatable

#### Materials

Flanges: 304 stainless steel  
 Gaskets: Viton  
 Bolts: 18-8 stainless steel

**Torque:** 21.5 Nm

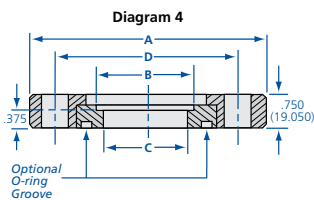
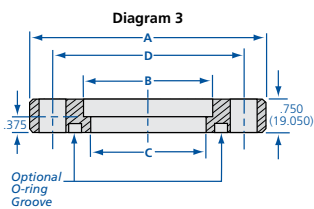
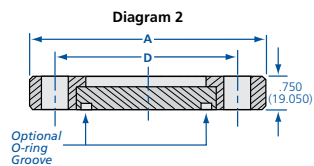
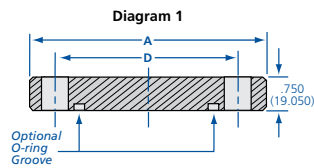
**Vacuum range:**  $\geq 1 \times 10^{-8}$  mbar - High vacuum

**Temperature range:** -20° to 204°C  
 Sustained: -20°C to 150°C



# Flanges & Fittings

## ASA Flanges & Hardware

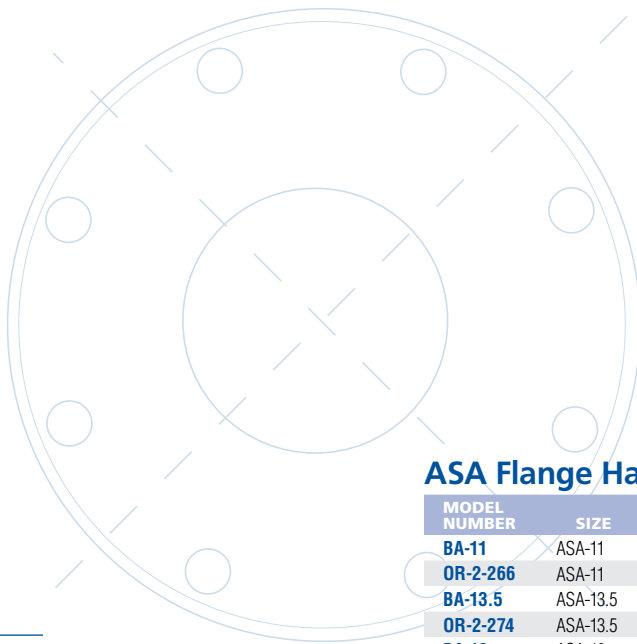


### ASA Flanges - 11 to 16 Inch (285-400mm) OD

One of each pair of mating ASA flanges requires an O-ring groove. To specify grooved flanges refer to the instructions below.

MODEL NUMBER	TYPE	DIAGRAM	A	B	C	D	BOLT HOLES NO.	BOLT HOLES SIZE
<b>ASA-11-000N</b>	Blank	1	11.00 (279.40)	-	-	9.500 (251.3)	8	0.812 (20.62)
<b>ASA-11-600N</b>	Bored	3	11.00 (279.40)	6.02 (152.91)	5.875 (149.225)	9.500 (251.3)	8	0.812 (20.62)
<b>ASA-11-800N</b>	Bored	3	11.00 (279.40)	8.02 (203.71)	7.875 (200.025)	9.500 (251.3)	8	0.812 (20.62)
<b>ASA-11-000R</b>	Blank	2	11.00 (279.40)	-	-	9.500 (251.3)	8	0.812 (20.62)
<b>ASA-11-600R</b>	Bored	4	11.00 (279.40)	6.02 (152.91)	5.875 (149.225)	9.500 (251.3)	8	0.812 (20.62)
<b>ASA-11-800R</b>	Bored	4	11.00 (279.40)	8.02 (203.71)	7.875 (200.025)	9.500 (251.3)	8	0.812 (20.62)
<b>ASA-13.5-000N</b>	Blank	1	13.50 (343.90)	-	-	11.750 (298.45)	8	0.812 (20.62)
<b>ASA-13.5-800N</b>	Bored	3	13.50 (343.90)	8.02 (203.71)	7.875 (200.025)	11.750 (298.45)	8	0.812 (20.62)
<b>ASA-13.5-1000N</b>	Bored	3	13.50 (343.90)	10.03 (254.76)	9.875 (250.825)	11.750 (298.45)	8	0.812 (20.62)
<b>ASA-13.5-000R</b>	Blank	2	13.50 (343.90)	-	-	11.750 (298.45)	8	0.812 (20.62)
<b>ASA-13.5-800R</b>	Bored	4	13.50 (343.90)	8.02 (203.71)	7.875 (200.025)	11.750 (298.45)	8	0.812 (20.62)
<b>ASA-13.5-1000R</b>	Bored	4	13.50 (343.90)	10.03 (254.76)	9.875 (250.825)	11.750 (298.45)	8	0.812 (20.62)
<b>ASA-16-000N</b>	Blank	1	16.00 (406.40)	-	-	14.250 (361.95)	12	0.812 (20.62)
<b>ASA-16-1000N</b>	Bored	3	16.00 (406.40)	10.03 (254.76)	9.875 (250.825)	14.250 (361.95)	12	0.812 (20.62)
<b>ASA-16-1200N</b>	Bored	3	16.00 (406.40)	12.03 (305.56)	11.875 (301.625)	14.250 (361.95)	12	0.812 (20.62)
<b>ASA-16-000R</b>	Blank	2	16.00 (406.40)	-	-	14.250 (361.95)	12	0.812 (20.62)
<b>ASA-16-1000R</b>	Bored	4	16.00 (406.40)	10.03 (254.76)	9.875 (250.825)	14.250 (361.95)	12	0.812 (20.62)
<b>ASA-16-1200R</b>	Bored	4	16.00 (406.40)	12.03 (305.56)	11.875 (301.625)	14.250 (361.95)	12	0.812 (20.62)

**Model Number Definitions**  
**N** = Nonrotatable **R** = Rotatable



### O-ring Groove Option

Indicate grooved flanges by adding “-G” to the end of the main part number. Add the appropriate cost for each grooved flange.  
**Example: ASA-9-000R-G**

#### SPECIFICATIONS

**General:** Rotatable and nonrotatable

#### Material

Flanges: 304 stainless steel  
 Gaskets: Viton  
 Bolts: 18-8 stainless steel

**Torque:** 21.5 Nm

**Vacuum range:**  $\geq 1 \times 10^{-8}$  mbar - High vacuum

**Temperature range:** -20° to 204°C  
 Operating: -20°C to 150°C

All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.

### ASA Flange Hardware

MODEL NUMBER	SIZE	DESCRIPTION
<b>BA-11</b>	ASA-11	(8) SS bolts (3/4-10 x 2.25) nuts and washers
<b>OR-2-266</b>	ASA-11	(1) Viton O-ring
<b>BA-13.5</b>	ASA-13.5	(8) SS bolts (3/4-10 x 2.25) nuts and washers
<b>OR-2-274</b>	ASA-13.5	(1) Viton O-ring
<b>BA-16</b>	ASA-16	(12) SS bolts (3/4-10 x 2.25) nuts and washers
<b>OR-2-278</b>	ASA-16	(1) Viton O-ring

### ASA Hardware for Mating to Gate Valves

MODEL NUMBER	SIZE	DESCRIPTION
<b>BA-11GV</b>	ASA-11	(8) SS bolts (3/8-16 x 1.0)
<b>BA-16GV</b>	ASA-16	(12) SS bolts (3/8-16 x 1.0)





Nor-Cal manufactures a complete line of flanged vacuum component fittings. The tube portions are fabricated from 304 stainless steel. On request, 316 stainless steel can be supplied. Nor-Cal makes its own elbows, and all tees and crosses are made with the pulled-port technique. This allows smooth, crevice-free butt welds to provide the maximum in cleanliness for UHV applications. Bake-out range is up to 200°C. Nor-Cal fittings are also available with CF (Conflat style), NW and ISO flanges.

#### SPECIFICATIONS

**General:** Rotatable and nonrotatable

#### Materials

Flanges: 304 stainless steel  
Gaskets: Viton  
Bolts: 18-8 stainless steel

**Torque:** 21.5 Nm

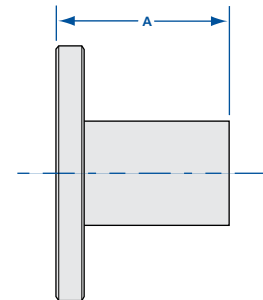
**Vacuum range:**  $\geq 1 \times 10^{-8}$  mbar - High vacuum

**Temperature range:** -20° to 204°C  
Sustained: -20°C to 150°C

### ASA Half Nipples

One of each pair of mating ASA flanges requires an O-ring groove. To specify grooved flanges refer to the instructions below.

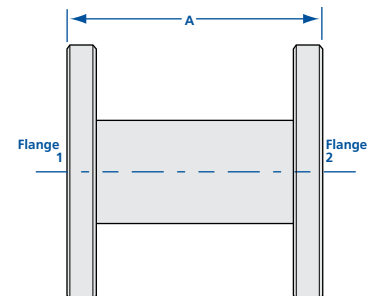
MODEL NUMBER	FLANGE OD	TUBE OD	A
1N-ASA-5-200	5.00 (127.00)	2 (50.80)	3.25 (82.55)
1N-ASA-5-250	5.00 (127.00)	2½ (63.50)	3.25 (82.55)
1N-ASA-5-250V	5.00 (127.00)	2½ (63.50)	4.00 (101.60)
1N-ASA-6-300	6.00 (152.40)	3 (76.20)	3.50 (88.90)
1N-ASA-7.5-400	7.50 (190.50)	4 (101.60)	4.13 (104.90)
1N-ASA-7.5-400V	7.50 (190.50)	4 (101.60)	5.12 (130.05)
1N-ASA-9-400	9.00 (228.60)	4 (101.60)	4.13 (104.90)
1N-ASA-9-400V	9.00 (228.60)	4 (101.60)	5.12 (130.05)
1N-ASA-9-600	9.00 (228.60)	6 (152.40)	2.25 (57.15)
1N-ASA-9-600V	9.00 (228.60)	6 (152.40)	6.31 (160.27)
1N-ASA-11-600	11.00 (279.40)	6 (152.40)	5.38 (136.65)
1N-ASA-11-600V	11.00 (279.40)	6 (152.40)	6.44 (163.58)
1N-ASA-11-800	11.00 (279.40)	8 (203.20)	7.38 (187.45)
1N-ASA-13.5-800	13.50 (342.90)	8 (203.20)	7.75 (196.85)
1N-ASA-13.5-1000	13.50 (342.90)	10 (254.00)	9.88 (250.95)
1N-ASA-16-1000	16.00 (406.40)	10 (254.00)	9.88 (250.95)
1N-ASA-16-1200	16.00 (406.40)	12 (304.80)	9.88 (250.95)



### ASA Full Nipples

One of each pair of mating ASA flanges requires an O-ring groove. To specify grooved flanges refer to the instructions below.

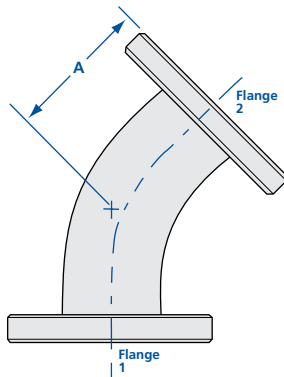
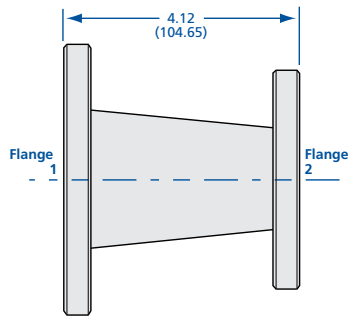
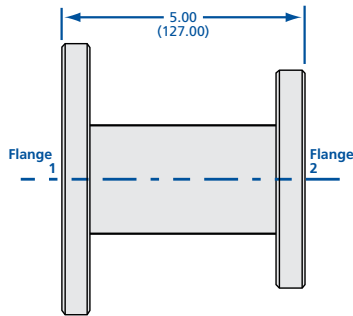
MODEL NUMBER	FLANGE OD	TUBE OD	A
2N-ASA-5-200N	5.00 (127.00)	2 (50.80)	6.50 (165.10)
2N-ASA-5-250N	5.00 (127.00)	2½ (63.50)	6.50 (165.10)
2N-ASA-5-250NV	5.00 (127.00)	2½ (63.50)	8.00 (203.20)
2N-ASA-6-300N	6.00 (152.40)	3 (76.20)	7.00 (177.80)
2N-ASA-7.5-400N	7.50 (190.50)	4 (101.60)	8.26 (209.80)
2N-ASA-7.5-400NV	7.50 (190.50)	4 (101.60)	10.24 (260.10)
2N-ASA-9-400N	9.00 (228.60)	4 (101.60)	8.26 (209.80)
2N-ASA-9-400NV	9.00 (228.60)	4 (101.60)	10.24 (260.10)
2N-ASA-9-600N	9.00 (228.60)	6 (152.40)	10.50 (266.70)
2N-ASA-9-600NV	9.00 (228.60)	6 (152.40)	12.62 (320.55)
2N-ASA-11-600N	11.00 (279.40)	6 (152.40)	10.76 (273.30)
2N-ASA-11-600NV	11.00 (279.40)	6 (152.40)	12.88 (327.15)
2N-ASA-11-800N	11.00 (279.40)	8 (203.20)	14.76 (374.90)
2N-ASA-13.5-800N	13.50 (342.90)	8 (203.20)	15.50 (393.70)
2N-ASA-13.5-1000N	13.50 (342.90)	10 (254.00)	19.76 (501.90)
2N-ASA-16-1000N	16.00 (406.40)	10 (254.00)	19.76 (501.90)
2N-ASA-16-1200N	16.00 (406.40)	12 (304.80)	19.76 (501.90)



### O-ring Groove Option

Indicate grooved flanges by adding "-G + Flange number from drawing" to the end of main part number. Add the appropriate cost for each grooved flange.

**Example:** 4C-ASA-9-600-G1-G3



### ASA Reducer Nipples

One of each pair of mating ASA flanges requires an O-ring groove. To specify grooved flanges refer to the instructions below.

MODEL NUMBER	FLANGE 1	FLANGE 2	TUBE OD
2NR-ASA-9-5-N	ASA-9	ASA-5	2 (50.80)
2NR-ASA-9-6-N	ASA-9	ASA-6	3 (76.20)
2NR-ASA-9-7.5-N	ASA-9	ASA-7.5	4 (101.60)
2NR-ASA-11-5-N	ASA-11	ASA-5	2 (50.80)
2NR-ASA-11-6-N	ASA-11	ASA-6	3 (76.20)
2NR-ASA-11-7.5-N	ASA-11	ASA-7.5	4 (101.60)
2NR-ASA-11-9-N	ASA-11	ASA-9	6 (152.40)
2NR-ASA-13.5-5-N	ASA-13.5	ASA-5	2 (50.80)
2NR-ASA-13.5-6-N	ASA-13.5	ASA-6	3 (76.20)
2NR-ASA-13.5-7.5-N	ASA-13.5	ASA-7.5	4 (101.60)
2NR-ASA-13.5-9-N	ASA-13.5	ASA-9	6 (152.40)
2NR-ASA-13.5-11-N	ASA-13.5	ASA-11	8 (203.20)
2NR-ASA-16-5-N	ASA-16	ASA-5	2 (50.80)
2NR-ASA-16-6-N	ASA-16	ASA-6	3 (76.20)
2NR-ASA-16-7.5-N	ASA-16	ASA-7.5	4 (101.60)
2NR-ASA-16-9-N	ASA-16	ASA-9	6 (152.40)
2NR-ASA-16-11-N	ASA-16	ASA-11	8 (203.20)
2NR-ASA-16-13.5-N	ASA-16	ASA-13.5	10 (254.00)

### Conical Reducer Nipples

One of each pair of mating ASA flanges requires an O-ring groove. To specify grooved flanges refer to the instructions below.

MODEL NUMBER	FLANGE 1 SIZE	FLANGE 1 TUBE OD	FLANGE 2 SIZE	FLANGE 2 TUBE OD
2NRC-ASA-6-5-N	ASA-6	3 (76.20)	ASA-5	2 (50.80)
2NRC-ASA-7.5-5-N	ASA-7.5	4 (101.60)	ASA-5	2 (50.80)
2NRC-ASA-7.5-6-N	ASA-7.5	4 (101.60)	ASA-6	3 (76.20)

### ASA 45° Radius Elbows with Tangents

One of each pair of mating ASA flanges requires an O-ring groove. To specify grooved flanges refer to the instructions below.

MODEL NUMBER	FLANGE OD	TUBE OD	A
2KL-ASA-5-N	5.00 (127.00)	2 (50.80)	2.09 (53.09)
2KL-ASA-6-N	6.00 (152.40)	3 (76.20)	3.93 (99.82)
2KL-ASA-7.5-N	7.50 (190.50)	4 (101.60)	5.02 (127.51)
2KL-ASA-9-N	9.00 (228.60)	4 (101.60)	5.02 (127.51)

### O-ring Groove Option

Indicate grooved flanges by adding "-G + Flange number from drawing" to the end of main part number. Add the appropriate cost for each grooved flange.  
**Example: 4C-ASA-9-600-G1-G3**

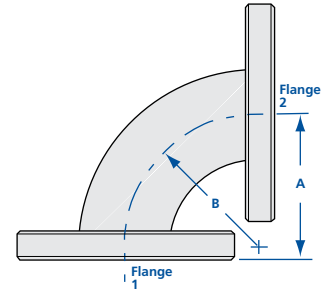
All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.



### ASA 90° Radius Elbows

One of each pair of mating ASA flanges requires an O-ring groove. To specify grooved flanges refer to the instructions below.

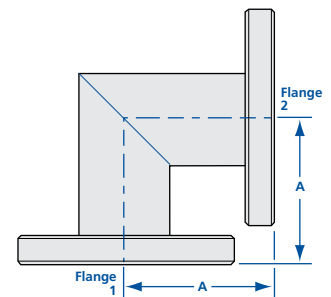
MODEL NUMBER	FLANGE OD	TUBE OD	A	B
2E-ASA-5-N	5.00 (127.0)	2 (50.80)	3.25 (82.55)	3 (76.20)
2E-ASA-6-N	6.00 (152.4)	3 (76.20)	4.75 (120.65)	4½ (114.30)
2E-ASA-9-N	9.00 (228.6)	4 (101.60)	6.25 (158.75)	6 (152.40)
2E-ASA-11-N	11.00 (279.4)	6 (152.40)	9.38 (238.25)	9 (228.60)
2E-ASA-13.5-N	13.50 (342.9)	8 (203.20)	12.38 (314.45)	12 (304.80)
2E-ASA-16-N	16.00 (406.4)	10 (254.00)	15.38 (390.65)	15 (381.00)



### ASA 90° Mitered Elbows

One of each pair of mating ASA flanges requires an O-ring groove. To specify grooved flanges refer to the instructions below.

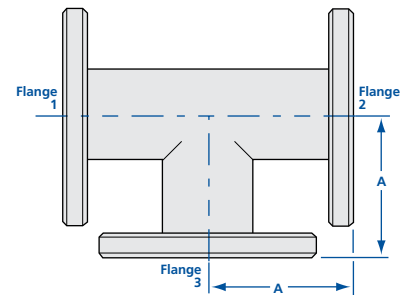
MODEL NUMBER	FLANGE OD	TUBE OD	A
2E-ASA-5-200NM	5.00 (127.00)	2 (50.80)	3.25 (82.55)
2E-ASA-5-250NM	5.00 (127.00)	2½ (63.50)	3.25 (82.55)
2E-ASA-5-250NMV	5.00 (127.00)	2½ (63.50)	4.00 (101.60)
2E-ASA-7.5-400NMV	7.50 (190.50)	4 (101.60)	5.12 (130.05)
2E-ASA-9-400NMV	9.00 (228.60)	4 (101.60)	5.12 (130.05)
2E-ASA-9-600NM	9.00 (228.60)	6 (152.40)	5.25 (133.35)
2E-ASA-9-600NMV	9.00 (228.60)	6 (152.40)	6.31 (160.27)
2E-ASA-11-600NMV	11.00 (279.40)	6 (152.40)	6.44 (163.58)
2E-ASA-11-800NM	11.00 (279.40)	8 (203.20)	7.38 (187.45)
2E-ASA-13.5-800NM	13.50 (342.90)	8 (203.20)	7.75 (196.85)
2E-ASA-13.5-1000NM	13.50 (342.90)	10 (254.00)	9.88 (250.95)
2E-ASA-16-1000NM	16.00 (406.40)	10 (254.00)	9.88 (250.95)



### ASA Tees

One of each pair of mating ASA flanges requires an O-ring groove. To specify grooved flanges refer to the instructions below.

MODEL NUMBER	FLANGE OD	TUBE OD	A
3T-ASA-5-200N	5.00 (127.00)	2 (50.80)	3.25 (82.55)
3T-ASA-5-250N	5.00 (127.00)	2½ (63.50)	3.25 (82.55)
3T-ASA-5-250NV	5.00 (127.00)	2½ (63.50)	4.00 (101.60)
3T-ASA-7.5-400NV	7.50 (190.50)	4 (101.60)	5.12 (130.05)
3T-ASA-9-400NV	9.00 (228.60)	4 (101.60)	5.12 (130.05)
3T-ASA-9-600N	9.00 (228.60)	6 (152.40)	5.25 (133.35)
3T-ASA-9-600NV	9.00 (228.60)	6 (152.40)	6.31 (160.27)
3T-ASA-11-600NV	11.00 (279.40)	6 (152.40)	6.44 (163.58)
3T-ASA-11-800N	11.00 (279.40)	8 (203.20)	7.38 (187.45)
3T-ASA-13.5-800N	13.50 (342.90)	8 (203.20)	7.75 (196.85)
3T-ASA-13.5-1000N	13.50 (342.90)	10 (254.00)	9.88 (250.95)
3T-ASA-16-1000N	16.00 (406.40)	10 (254.00)	9.88 (250.95)

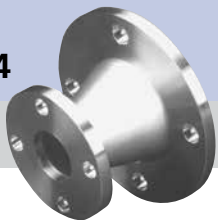


### O-ring Groove Option

Indicate grooved flanges by adding "-G + Flange number from drawing" to the end of main part number. Add the appropriate cost for each grooved flange.

**Example: 4C-ASA-9-600-G1-G3**



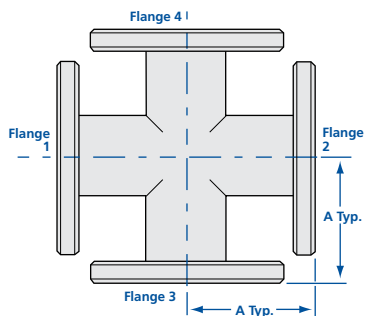


# Flanges & Fittings

## ASA Fittings

### ASA 4-Way Crosses

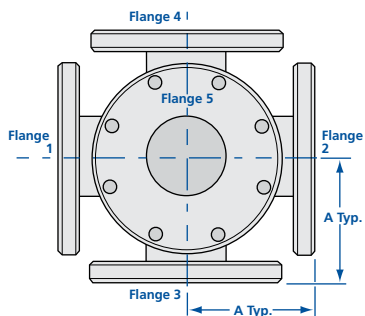
One of each pair of mating ASA flanges requires an O-ring groove. To specify grooved flanges refer to the instructions below.



MODEL NUMBER	FLANGE OD	TUBE OD	A
4C-ASA-5-200N	5.00 (127.00)	2 (50.80)	3.25 (82.55)
4C-ASA-5-250N	5.00 (127.00)	2 1/2 (63.50)	3.25 (82.55)
4C-ASA-5-250NV	5.00 (127.00)	2 1/2 (63.50)	4.00 (101.60)
4C-ASA-7.5-400NV	7.50 (190.50)	4 (101.60)	5.12 (130.05)
4C-ASA-9-400NV	9.00 (228.60)	4 (101.60)	5.12 (130.05)
4C-ASA-9-600N	9.00 (228.60)	6 (152.40)	5.25 (133.35)
4C-ASA-9-600NV	9.00 (228.60)	6 (152.40)	6.31 (160.27)
4C-ASA-11-600NV	11.00 (279.40)	6 (152.40)	6.44 (163.58)
4C-ASA-11-800N	11.00 (279.40)	8 (203.20)	7.38 (187.45)
4C-ASA-13.5-800N	13.50 (342.90)	8 (203.20)	7.75 (196.85)
4C-ASA-13.5-1000N	13.50 (342.90)	10 (254.00)	9.88 (250.95)
4C-ASA-16-1000N	16.00 (406.40)	10 (254.00)	9.88 (250.95)

### ASA 5-Way Crosses

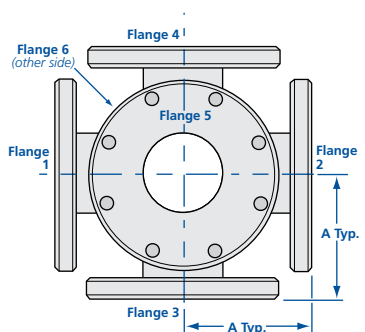
One of each pair of mating ASA flanges requires an O-ring groove. To specify grooved flanges refer to the instructions below.



MODEL NUMBER	FLANGE OD	TUBE OD	A
5C-ASA-5-200N	5.00 (127.00)	2 (50.80)	3.25 (82.55)
5C-ASA-5-250N	5.00 (127.00)	2 1/2 (63.50)	3.25 (82.55)
5C-ASA-5-250NV	5.00 (127.00)	2 1/2 (63.50)	4.00 (101.60)
5C-ASA-7.5-400NV	7.50 (190.50)	4 (101.60)	5.12 (130.05)
5C-ASA-9-400NV	9.00 (228.60)	4 (101.60)	5.12 (130.05)
5C-ASA-9-600N	9.00 (228.60)	6 (152.40)	5.25 (133.35)
5C-ASA-9-600NV	9.00 (228.60)	6 (152.40)	6.31 (160.27)
5C-ASA-11-600NV	11.00 (279.40)	6 (152.40)	6.44 (163.58)
5C-ASA-11-800N	11.00 (279.40)	8 (203.20)	7.38 (187.45)
5C-ASA-13.5-800N	13.50 (342.90)	8 (203.20)	7.75 (196.85)
5C-ASA-13.5-1000N	13.50 (342.90)	10 (254.00)	9.88 (250.95)
5C-ASA-16-1000N	16.00 (406.40)	10 (254.00)	9.88 (250.95)

### ASA 6-Way Crosses

One of each pair of mating ASA flanges requires an O-ring groove. To specify grooved flanges refer to the instructions below.



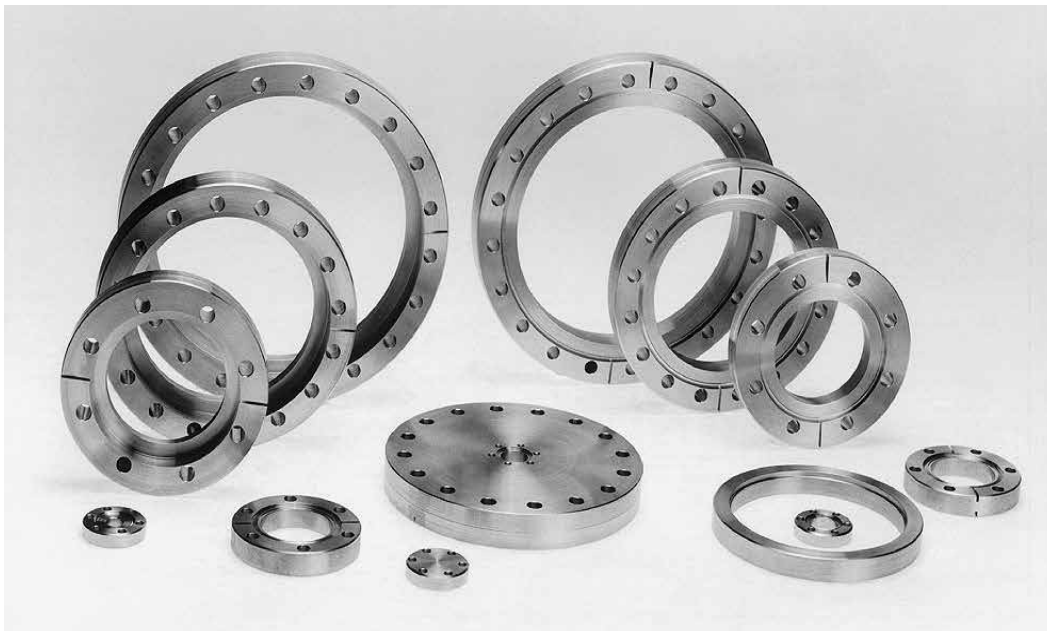
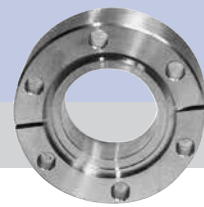
MODEL NUMBER	FLANGE OD	TUBE OD	A
6C-ASA-5-200N	5.00 (127.00)	2 (50.80)	3.25 (82.55)
6C-ASA-5-250N	5.00 (127.00)	2 1/2 (63.50)	3.25 (82.55)
6C-ASA-5-250NV	5.00 (127.00)	2 1/2 (63.50)	4.00 (101.60)
6C-ASA-7.5-400NV	7.50 (190.50)	4 (101.60)	5.12 (130.05)
6C-ASA-9-400NV	9.00 (228.60)	4 (101.60)	5.12 (130.05)
6C-ASA-9-600N	9.00 (228.60)	6 (152.40)	5.25 (133.35)
6C-ASA-9-600NV	9.00 (228.60)	6 (152.40)	6.31 (160.27)
6C-ASA-11-600NV	11.00 (279.40)	6 (152.40)	6.44 (163.58)
6C-ASA-11-800N	11.00 (279.40)	8 (203.20)	7.38 (187.45)
6C-ASA-13.5-800N	13.50 (342.90)	8 (203.20)	7.75 (196.85)
6C-ASA-13.5-1000N	13.50 (342.90)	10 (254.00)	9.88 (250.95)
6C-ASA-16-1000N	16.00 (406.40)	10 (254.00)	9.88 (250.95)

All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.

### O-ring Groove Option

Indicate grooved flanges by adding "-G + Flange number from drawing" to the end of main part number. Add the appropriate cost for each grooved flange.

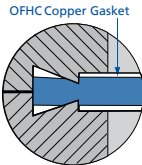
**Example: 4C-ASA-9-600-G1-G3**



Nor-Cal CF flanges are compatible with other Conflat style flanges and are available in sizes from 1<sup>1</sup>/<sub>3</sub> to 16<sup>1</sup>/<sub>2</sub> inch (33.96-419.1mm) OD for 1/4 to 14 inch (6.35-355.6mm) tube diameters. Normally our standard material is in the low carbon range for 304. Flanges are made from 304 that has been specially treated to remove impurities inherent in 300 series steels. Special UHV-flanges 4 1/2 inches (114.3mm) OD and smaller can be made from 304 electroslog remelt (ESR) bar stock. ESR is a refining process that produces stainless steel with higher purity, fewer inclusions and more uniform grain structure to eliminate microscopic leak paths. Our standard flange material is certified to meet ASTM A-240 and has less than 0.01% sulfur to prevent sulfur stringers. Grain size is 3 to 6 per ASTM E-112. Maximum inclusion size is 2.5 per ASTM E-45. As specials, 304L and 316L mate-

rial can be supplied in roll-forged rings. Machining is consistent with good UHV practice. Machine coolant is sulfur free to reduce outgassing. State-of-the-art CNC machine centers are used to produce flanges with consistent high quality. Flanges are machine washed in approved aqueous detergent after machining. Chem-cleaning and clean room packaging are available.

CF flanges utilize an OFHC copper gasket to produce a vacuum tight seal up to 10<sup>-13</sup> mbar, even when baked repeatedly to 450°C. When the copper gasket is compressed between the knife edges of CF flanges, its material flows laterally to fill surface imperfections.



Nor-Cal offers CF flanges in rotatable as well as nonrotatable versions. (Refer to diagram on page 48.) When components of several systems are used interchangeably, the use of rotatable flanges is recommended. Assembly is facilitated by rotating the receiver portion of the flange to align its bolt holes with those of the mating flange. The insert is welded to the tube or component and contains the knife edge portion of the CF flange.

Nonrotatable CF flanges, unlike rotatable, contain both sealing surface and bolt holes in one unit. This makes the nonrotatable flange less expensive, and therefore the preferred choice when mating component orientation is not a concern. All fittings are priced with a rotatable flange opposing a nonrotatable. For fittings with all nonrotatable flanges subtract the difference in price between a rotatable and nonrotatable flange of the desired size multiplied by the number of additional nonrotatable flanges.



### SPECIFICATIONS

**General:** Rotatable or nonrotatable with tapped or clearance bolt holes

**Nominal OD sizes:** 1<sup>1</sup>/<sub>3</sub> to 16<sup>1</sup>/<sub>2</sub> inches (34-419mm)

**Tube OD sizes:** 1/4 to 14 inches (6-350mm)

#### Materials

**Flange:** 304 stainless steel (316L available on request)

**Gaskets:** Viton, copper or silver plated

**Bolts:** 18-8 stainless steel or silver plated

#### Vacuum range

**Metal seal:** ≥1 x 10<sup>-13</sup> mbar - UHV

**Elastomer seal:** ≥1 x 10<sup>-8</sup> mbar - High vacuum

#### Temperature range

**Metal seal:** -200°C to 450°C

**Elastomer seal:** -20°C to 150°C

### New Products



#### Metric Flanges and Hardware

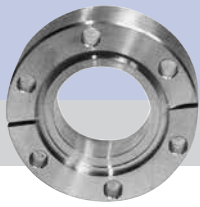
Nor-Cal now stocks bored metric tapped CF flanges in 2<sup>3</sup>/<sub>4</sub>, 4<sup>1</sup>/<sub>2</sub>, 6, 8 and 10 inch (69.85, 114.3, 152.5, 203.2 and 254mm) ODs. Other sizes are available upon request. Fasteners for metric flanges are stocked for each flange size.



#### Silver plated Gaskets and Bolts

We are now offering silver plated copper gaskets and bolt kits in a variety of sizes. Silver plated copper gaskets are recommended when the use of pure copper is unacceptable. Silver plated bolt kits offer an alternative to using anti-seize thread lubricant.

*All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.*



# Flanges & Fittings

## CF Flange Assembly Instructions

### SPECIFICATIONS

**General:** Rotatable or nonrotatable flanges with tapped or clearance bolt holes

**Nominal OD sizes:** 1<sup>1</sup>/<sub>3</sub> to 16<sup>1</sup>/<sub>2</sub> inches (34-419mm)

**Tube sizes:** 1/4 to 14 inches (6.35-355.6mm)

#### Materials

Flange: 304 stainless steel  
(316L available on request)

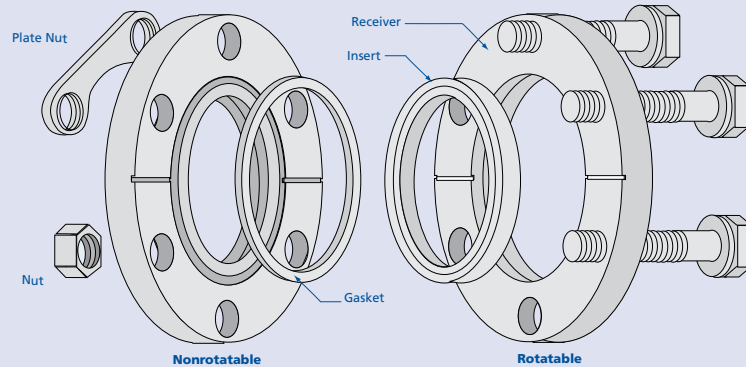
Gaskets: Viton, copper or silver plated  
Bolts: 18-8 stainless steel or silver plated

#### Vacuum range

Metal seal:  $\geq 1 \times 10^{-13}$  mbar - UHV  
Elastomer seal:  $\geq 1 \times 10^{-8}$  mbar - High vacuum

#### Temperature Range

Metal seal: -200°C to 450°C  
Elastomer seal: -20°C to 150°C



### Fastening Hardware

CF flanges are available with tapped or untapped holes. Tapped flanges are available in UNC/UNF or metric threads. Tapped flanges have through holes, so bolts may protrude slightly from the back of the flange when fastened to an untapped flange. Untapped CF flanges can be fastened to each other with stainless steel bolts and hex nuts or plate nuts. Plate nuts center themselves over two adjacent holes and can be held in place with one finger while the bolts are tightened. They are available for most flange sizes from 1<sup>1</sup>/<sub>3</sub> to 10 inch (33.96-254mm) ODs. As an alternative to hex head bolts, 12-point bolts are available for CF flanges from 2<sup>3</sup>/<sub>4</sub> to 10 inch (33.96 to 354mm) ODs. Silver plated bolts eliminate the need for anti-seize compound in clean room environments.

### Assembly Instructions for Nor-Cal CF (Conflat) Flanges

1. Apply a small amount of high temperature anti-seize compound to the bolt threads.
2. Check that both flange surfaces are clean and sealing edges are free from nicks and scratches.
3. Using clean, lint free gloves, unpack gasket.
4. Place gasket in the knife edge counterbore of nonrotatable flange.
5. Align the mating hole pattern and leak test grooves.
6. Install the proper bolts and tighten hand tight. Check to see that the flange faces are parallel.
7. Tighten the bolts 1/4 to 1/2 turns using a star pattern until the flange faces are metal to metal.
8. Torque the fasteners to the listed value using the same pattern.

#### Torque Specifications\*

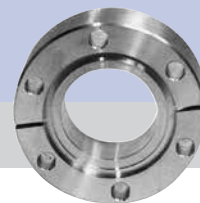
NOMINAL OD	BOLT SIZE	TORQUE IN Nm
1 <sup>1</sup> / <sub>3</sub> (34)	8-32 (M4)	3.2
2 <sup>1</sup> / <sub>8</sub> (54)	1/4 - 28 (M6)	12.4
2 <sup>3</sup> / <sub>4</sub> (70)	1/4 - 28 (M6)	12.4
3 <sup>3</sup> / <sub>8</sub> (86)	5/16 - 24 (M8)	21.5
4 <sup>1</sup> / <sub>2</sub> (114)	5/16 - 24 (M8)	21.5
4 <sup>5</sup> / <sub>8</sub> (117)	5/16 - 24 (M8)	21.5
6 (152)	5/16 - 24 (M8)	21.5
6 <sup>3</sup> / <sub>4</sub> (171)	5/16 - 24 (M8)	21.5
8 (203)	5/16 - 24 (M8)	21.5
10 (254)	5/16 - 24 (M8)	21.5
12 (305)	5/16 - 24 (M8)	21.5
13 <sup>1</sup> / <sub>4</sub> (337)	3/8 - 24 (M8)	39.0
14 (356)	3/8 - 24 (M8)	39.0
14 <sup>1</sup> / <sub>2</sub> (368)	3/8 - 24 (M8)	39.0
16 <sup>1</sup> / <sub>2</sub> (419)	3/8 - 24 (M8)	39.0

\* Specifications for Nor-Cal supplied fasteners only

All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.







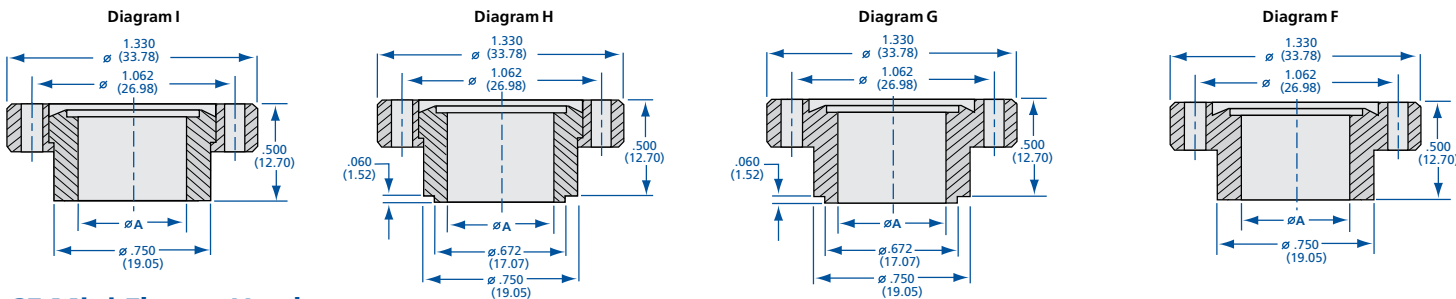
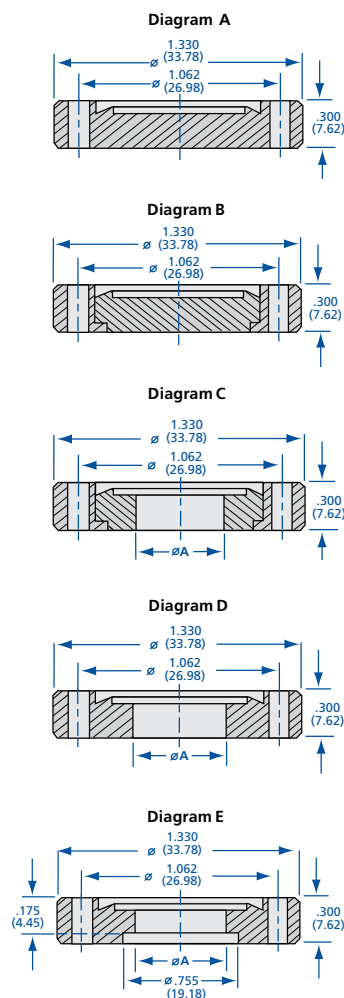
CF mini flanges are manufactured to the same high standard as our other CF flanges for 1/4, 3/8, 1/2, and 3/4 inch (6.35, 9.53, 12.7 and 19.05mm) OD tube sizes. Nor-Cal offers special purpose, double-sided and zero-length reducer mini flanges along with fittings, viewports and feedthroughs in this size, so we can supply all the components necessary to build a complete table-top, small laboratory or gas handling system from stock.

### CF Mini Flanges

MODEL NUMBER	TYPE	DIAGRAM	A	BOLT HOLES	DIAMETER OR THREAD
133-000N	Blank	A	-	6	.172
133-000NK	Blank weld neck with weld prep	G	-	6	.172
133-025N	Bored	D	.255 (6.48)	6	.172
133-038N	Bored	D	.0380 (9.65)	6	.172
133-050N	Bored	D	0.505 (12.83)	6	.172
133-075N	Counterbored for tube OD	E	0.625 (15.88)	6	.172
133-075NK	Bored weld neck with weld prep	G	0.625 (15.88)	6	.172
133-075NBK	Bored weld neck without weld prep	F	0.625 (15.88)	6	.172
133-000NT	Blank	A	-	6	8-32
133-000NKT	Blank weld neck with weld prep	G	-	6	8-32
133-025NT	Bored	D	.255 (6.48)	6	8-32
133-038NT	Bored	D	.0380 (9.65)	6	8-32
133-050NT	Bored	D	0.505 (12.83)	6	8-32
133-075NT	Counterbored for tube OD	E	0.625 (15.88)	6	8-32
133-075NKT	Bored weld neck with weld prep	G	0.625 (15.88)	6	8-32
133-075NBKT	Bored weld neck without weld prep	F	0.625 (15.88)	6	8-32
133-000R	Blank	B	-	6	.172
133-000RK	Blank weld neck with weld prep	H	-	6	.172
133-025R	Bored	C	.255 (6.48)	6	.172
133-038R	Bored	C	.0380 (9.65)	6	.172
133-050R	Bored	C	0.505 (12.83)	6	.172
133-075R	Bored	C	0.625 (15.88)	6	.172
133-075RK	Bored weld neck with weld prep	H	0.625 (15.88)	6	.172
133-075RBK	Bored weld neck without weld prep	I	0.625 (15.88)	6	.172
133-000RT	Blank	B	-	6	8-32
133-000RKT	Blank weld neck with weld prep	H	-	6	8-32
133-025RT	Bored	C	.255 (6.48)	6	8-32
133-038RT	Bored	C	.0380 (9.65)	6	8-32
133-050RT	Bored	C	0.505 (12.83)	6	8-32
133-075RT	Bored	C	0.625 (15.88)	6	8-32
133-075RKT	Bored weld neck with weld prep	H	0.625 (15.88)	6	8-32
133-075RBKT	Bored weld neck without weld prep	I	0.625 (15.88)	6	8-32

#### Model Number Definitions

**N** = Nonrotatable, clearance bolt holes    **NT** = Nonrotatable, tapped bolt holes    **R** = Rotatable, clearance bolt holes  
**RT** = Rotatable, tapped bolt holes    **K** = Weld neck with weld prep    **BK** = Weld neck without weld prep    **Add -M4** = Metric Thread



### CF Mini Flange Hardware

MODEL NUMBER	DESCRIPTION
G-133	(10) OFHC copper gaskets
G-133-SP	(10) Silver plated copper gaskets
G-133V	(5) Viton gaskets
B-133	(25) SS 8-32 x .75 inch bolts, nuts & washers
B-133T	(25) SS 8-32 x .56 inch bolts & washers
B-133-SP	(25) Silver plated SS 8-32 x .75 inch bolts, nuts & washers
B-133T-SP	(25) Silver plated SS 8-32 x .56 inch bolts & washers
NP-075	(24) 8-32 plate nuts. See page 63.
KNP-075	(12) Plate nuts and (24) 8-32 x .75 inch bolts



#### SPECIFICATIONS

**General:** Rotatable and nonrotatable with tapped or clearance bolt holes

#### Materials

Flanges: 304 stainless steel  
 (316L available upon request)  
 Gaskets: Copper, Viton or silver plated  
 Bolts: 18-8 stainless steel or silver plated

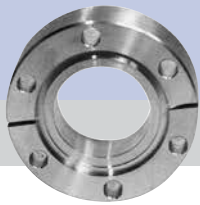
**Torque:** 3.2 Nm

#### Vacuum range

Metal seal:  $\geq 1 \times 10^{-13}$  mbar - UHV  
 Elastomer seal:  $\geq 1 \times 10^{-8}$  mbar - High vacuum

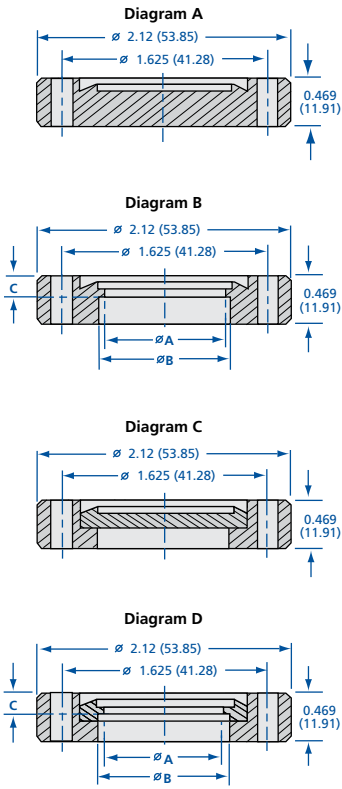
#### Temperature Range

Metal seal: -200°C to 450°C  
 Elastomer seal: -20°C to 150°C



# Flanges & Fittings

## CF Flanges and Hardware



### CF Flanges - 2 1/8 Inch (54mm) Nominal OD

MODEL NUMBER	TYPE	DIAGRAM	ID A	B	C	BOLT HOLES	DIAMETER OR THREAD
<b>212-000N</b>	Blank	A	-	-	-	4	.265
<b>212-025N</b>	Bored	B	0.255 (6.48)	-	-	4	.265
<b>212-050N</b>	Bored	B	0.505 (12.83)	-	-	4	.265
<b>212-075N</b>	Bored	B	0.688 (17.48)	0.760 (19.30)	0.167 (4.24)	4	.265
<b>212-100N</b>	Bored	B	0.938 (23.83)	1.010 (25.65)	0.167 (4.24)	4	.265
<b>212-000NT</b>	Blank	A	-	-	-	4	1/4-28
<b>212-025NT</b>	Bored	B	0.255 (6.48)	-	-	4	1/4-28
<b>212-050NT</b>	Bored	B	0.505 (12.83)	-	-	4	1/4-28
<b>212-075NT</b>	Bored	B	0.688 (17.48)	0.760 (19.30)	0.167 (4.24)	4	1/4-28
<b>212-100NT</b>	Bored	B	0.938 (23.83)	1.010 (25.65)	0.167 (4.24)	4	1/4-28
<b>212-000R</b>	Blank	C	-	-	-	4	.265
<b>212-025R</b>	Bored	D	0.255 (6.48)	-	-	4	.265
<b>212-050R</b>	Bored	D	0.505 (12.83)	-	-	4	.265
<b>212-075R</b>	Bored	D	0.688 (17.48)	0.760 (19.30)	0.167 (4.24)	4	.265
<b>212-100R</b>	Bored	D	0.938 (23.83)	1.010 (25.65)	0.167 (4.24)	4	.265
<b>212-000RT</b>	Blank	C	-	-	-	4	1/4-28
<b>212-025RT</b>	Bored	D	0.255 (6.48)	-	-	4	1/4-28
<b>212-050RT</b>	Bored	D	0.505 (12.83)	-	-	4	1/4-28
<b>212-075RT</b>	Bored	D	0.688 (17.48)	0.760 (19.30)	0.167 (4.24)	4	1/4-28
<b>212-100RT</b>	Bored	D	0.938 (23.83)	1.010 (25.65)	0.167 (4.24)	4	1/4-28

#### Model Number Definitions

**N** = Nonrotatable, clearance bolt holes **NT** = Nonrotatable, tapped bolt holes **R** = Rotatable, clearance bolt holes  
**RT** = Rotatable, tapped bolt holes **Add -M6** = Metric tapped bolt holes

### CF Flange Hardware - 2 1/8 (54mm) Inch Nominal OD



MODEL NUMBER	DESCRIPTION
<b>G-212</b>	(10) OFHC copper gaskets
<b>G-212V</b>	(5) Viton gaskets
<b>B-212</b>	(25) SS 1/4-28 x 1 1/4 inch bolts, nuts & washers
<b>B-212T</b>	(25) SS 1/4-28 x 7/8 inch bolts & washers
<b>B-212-12</b>	(25) SS 12-pt. 1/4-28 x 1 1/4 inch bolts, nuts & washers
<b>B-212T-12</b>	(25) SS 12-pt. 1/4-28 x 7/8 inch bolts & washers

#### SPECIFICATIONS

**General:** Rotatable and nonrotatable with tapped or clearance bolt holes

#### Materials

Flanges: 304 stainless steel  
 (316L available upon request)  
 Gaskets: Copper, Viton  
 Bolts: 18-8 stainless steel

**Torque:** 12.4 Nm

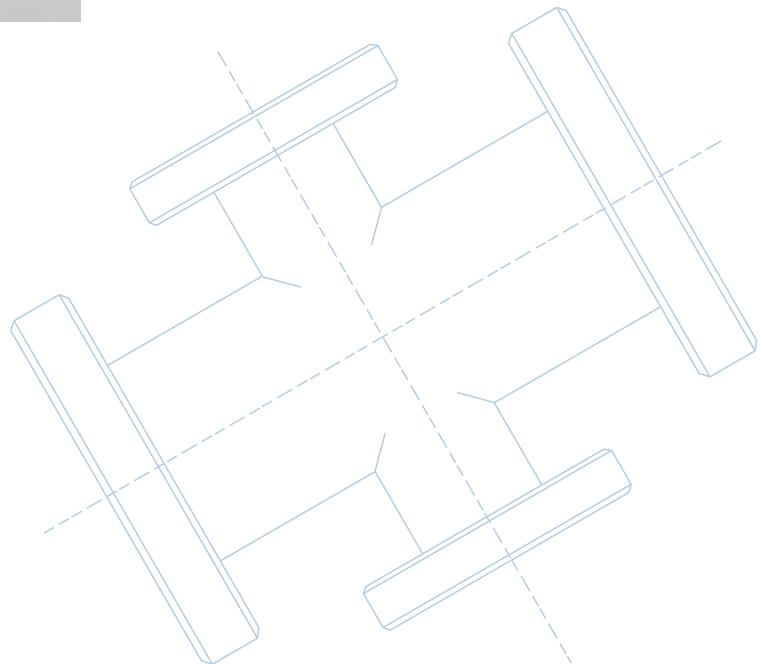
#### Vacuum range

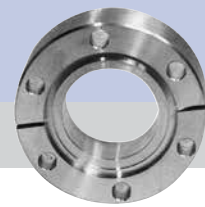
Metal seal:  $\geq 1 \times 10^{-13}$  mbar - UHV  
 Elastomer seal:  $\geq 1 \times 10^{-8}$  mbar - High vacuum

#### Temperature range

Metal seal: -200°C to 450°C  
 Elastomer seal: -20°C to 150°C

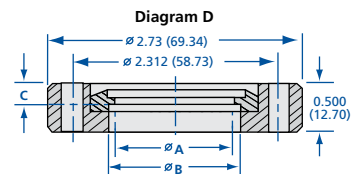
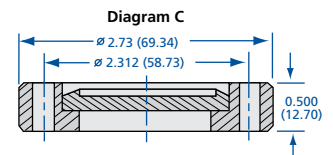
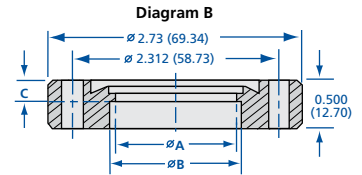
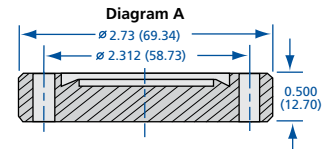
All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.





### CF Flanges - 2 3/4 Inch (70mm) Nominal OD

MODEL NUMBER	TYPE	DIAGRAM	ID A	B	C	BOLT HOLES	DIAMETER OR THREAD
275-000N	Blank	A	-	-	-	6	.265
275-025N	Bored	B	0.255 (6.48)	-	-	6	.265
275-050N	Bored	B	0.505 (12.83)	-	-	6	.265
275-075N	Bored	B	0.688 (17.48)	0.760 (19.30)	0.209 (5.31)	6	.265
275-100N	Bored	B	0.938 (23.83)	1.010 (25.65)	0.209 (5.31)	6	.265
275-125N	Bored	B	1.188 (30.18)	1.260 (32.00)	0.209 (5.31)	6	.265
275-150N	Bored	B	1.438 (36.53)	1.510 (38.35)	0.209 (5.31)	6	.265
275-162N	Bored	B	1.560 (39.62)	1.635 (41.53)	0.209 (5.31)	6	.265
275-175N	Bored	B	1.620 (41.15)	1.760 (44.70)	0.209 (5.31)	6	.265
275-000NT	Blank	A	-	-	-	6	1/4-28
275-025NT	Bored	B	0.255 (6.48)	-	-	6	1/4-28
275-050NT	Bored	B	0.505 (12.83)	-	-	6	1/4-28
275-075NT	Bored	B	0.688 (17.48)	0.760 (19.30)	0.209 (5.31)	6	1/4-28
275-100NT	Bored	B	0.938 (23.83)	1.010 (25.65)	0.209 (5.31)	6	1/4-28
275-125NT	Bored	B	1.188 (30.18)	1.260 (32.00)	0.209 (5.31)	6	1/4-28
275-150NT	Bored	B	1.438 (36.53)	1.510 (38.35)	0.209 (5.31)	6	1/4-28
275-162NT	Bored	B	1.560 (39.62)	1.635 (41.53)	0.209 (5.31)	6	1/4-28
275-175NT	Bored	B	1.620 (41.15)	1.760 (44.70)	0.209 (5.31)	6	1/4-28
275-000R	Blank	C	-	-	-	6	.265
275-025R	Bored	D	0.255 (6.48)	-	-	6	.265
275-050R	Bored	D	0.505 (12.83)	-	-	6	.265
275-075R	Bored	D	0.688 (30.18)	0.760 (19.30)	0.209 (5.31)	6	.265
275-100R	Bored	D	0.938 (23.83)	1.010 (25.65)	0.209 (5.31)	6	.265
275-125R	Bored	D	1.188 (30.18)	1.260 (32.00)	0.209 (5.31)	6	.265
275-150R	Bored	D	1.438 (36.53)	1.510 (38.35)	0.209 (5.31)	6	.265
275-000RT	Blank	C	-	-	-	6	1/4-28
275-025RT	Bored	D	0.255 (6.48)	-	-	6	1/4-28
275-050RT	Bored	D	0.505 (12.83)	-	-	6	1/4-28
275-075RT	Bored	D	0.688 (30.18)	0.760 (19.30)	0.209 (5.31)	6	1/4-28
275-100RT	Bored	D	0.938 (23.83)	1.010 (25.65)	0.209 (5.31)	6	1/4-28
275-125RT	Bored	D	1.188 (30.18)	1.260 (32.00)	0.209 (5.31)	6	1/4-28
275-150RT	Bored	D	1.438 (36.53)	1.510 (38.35)	0.209 (5.31)	6	1/4-28



#### Model Number Definitions

**N** = Nonrotatable, clearance bolt holes **NT** = Nonrotatable, tapped bolt holes **R** = Rotatable, clearance bolt holes  
**RT** = Rotatable, tapped bolt holes **Add -M6** = Metric tapped bolt holes

### CF Flange Hardware - 2 3/4 (70mm) Inch Nominal OD

MODEL NUMBER	DESCRIPTION
G-275	(10) OFHC copper gaskets
G-275V	(5) Viton gaskets
G-275-SP	(10) Silver plated copper gaskets
B-275	(25) SS 1/4-28 x 1 1/4 inch bolts, nuts & washers
B-275T	(25) SS 1/4-28 x 1 inch bolts & washers
B-275-12	(25) SS 12-pt. 1/4-28 x 1 1/4 inch bolts, nuts & washers
B-275-12-SP	(25) Silver plated SS 12-pt. 1/4-28 x 1 1/4 inch bolts, nuts & washers
B-275T-12	(25) SS 12-pt. 1/4-28 x 1 inch bolts & washers
B-275T-12-SP	(25) Silver plated SS 12-pt. 1/4-28 x 7/8 inch bolts & washers
B-275T-M	(25) SS (metric) M6 x 1.00 x 25mm bolts & washers
NP-150	(24) 1/4-28 plate nuts. See page 63
KNP-150	(12) Plate nuts, (24) 1/4-28 x 1 1/4 inch bolts & washers
KNP-150-12	(12) Plate nuts, (24) 12-pt. 1/4-28 x 1 1/4 inch bolts & washers



#### SPECIFICATIONS

**General:** Rotatable and nonrotatable with tapped or clearance holes

#### Materials

Flanges: 304 stainless steel  
 (316L available upon request)  
 Gaskets: Copper, Viton or silver plated  
 Bolts: 18-8 stainless steel or silver plated

**Torque:** 12.4 Nm

#### Vacuum range

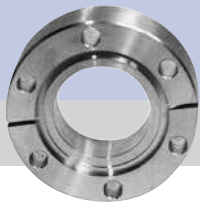
Metal seal:  $\geq 1 \times 10^{-13}$  mbar - UHV  
 Elastomer seal:  $\geq 1 \times 10^{-8}$  mbar - High vacuum

#### Temperature Range

Metal seal: -200°C to 450°C  
 Elastomer seal: -20°C to 150°C

All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.





# Flanges & Fittings

## CF Flanges and Hardware

### CF Flanges - 3<sup>3</sup>/<sub>8</sub> Inch (86mm) Nominal OD

MODEL NUMBER	TYPE	DIAGRAM	OD A	ID B	C	D	E	F	BOLT HOLES	DIAMETER OR THREAD
338-000N	Blank	A	3.36 (85.34)	-	-	-	2.850 (72.39)	0.687 (17.45)	8	.332
338-150N	Bored	B	3.36 (85.34)	1.438 (36.53)	1.510 (38.35)	0.225 (5.72)	2.850 (72.39)	0.687 (17.45)	8	.332
338-200N	Bored	B	3.36 (85.34)	1.938 (49.23)	2.010 (51.05)	0.225 (5.72)	2.850 (72.39)	0.687 (17.45)	8	.332
338-000NT	Blank	A	3.36 (85.34)	-	-	-	2.850 (72.39)	0.687 (17.45)	8	5/16-24
338-150NT	Bored	B	3.36 (85.34)	1.438 (36.53)	1.510 (38.35)	0.225 (5.72)	2.850 (72.39)	0.687 (17.45)	8	5/16-24
338-200NT	Bored	B	3.36 (85.34)	1.938 (49.23)	2.010 (51.05)	0.225 (5.72)	2.850 (72.39)	0.687 (17.45)	8	5/16-24
338-000R	Blank	C	3.36 (85.34)	-	-	-	2.850 (72.39)	0.687 (17.45)	8	.332
338-150R	Bored	D	3.36 (85.34)	1.438 (36.53)	1.510 (38.35)	0.225 (5.72)	2.850 (72.39)	0.687 (17.45)	8	.332
338-200R	Bored	D	3.36 (85.34)	1.938 (49.23)	2.010 (51.05)	0.225 (5.72)	2.850 (72.39)	0.687 (17.45)	8	.332
338-000RT	Blank	C	3.36 (85.34)	-	-	-	2.850 (72.39)	0.687 (17.45)	8	5/16-24
338-150RT	Bored	D	3.36 (85.34)	1.438 (36.53)	1.510 (38.35)	0.225 (5.72)	2.850 (72.39)	0.687 (17.45)	8	5/16-24
338-200RT	Bored	D	3.36 (85.34)	1.938 (49.23)	2.010 (51.05)	0.225 (5.72)	2.850 (72.39)	0.687 (17.45)	8	5/16-24

### CF Flanges - 4<sup>1</sup>/<sub>2</sub> Inch (114mm) Nominal OD

MODEL NUMBER	TYPE	DIAGRAM	OD A	ID B	C	D	E	F	BOLT HOLES	DIAMETER OR THREAD
450-000N	Blank	A	4.47 (113.54)	-	-	-	3.628 (92.15)	0.687 (17.45)	8	.332
450-150N	Bored	B	4.47 (113.54)	1.438 (36.53)	1.510 (38.35)	0.375 (9.53)	3.628 (92.15)	0.687 (17.45)	8	.332
450-200N	Bored	B	4.47 (113.54)	1.938 (49.23)	2.010 (51.05)	0.375 (9.53)	3.628 (92.15)	0.687 (17.45)	8	.332
450-250N	Bored	B	4.47 (113.54)	2.438 (61.93)	2.510 (63.75)	0.375 (9.53)	3.628 (92.15)	0.687 (17.45)	8	.332
450-000NT	Blank	A	4.47 (113.54)	-	-	-	3.628 (92.15)	0.687 (17.45)	8	5/16-24
450-150NT	Bored	B	4.47 (113.54)	1.438 (36.53)	1.510 (38.35)	0.375 (9.53)	3.628 (92.15)	0.687 (17.45)	8	5/16-24
450-200NT	Bored	B	4.47 (113.54)	1.938 (49.23)	2.010 (51.05)	0.375 (9.53)	3.628 (92.15)	0.687 (17.45)	8	5/16-24
450-250NT	Bored	B	4.47 (113.54)	2.438 (61.93)	2.510 (63.75)	0.375 (9.53)	3.628 (92.15)	0.687 (17.45)	8	5/16-24
450-000R	Blank	C	4.47 (113.54)	-	-	-	3.628 (92.15)	0.750 (19.05)	8	.332
450-150R	Bored	D	4.47 (113.54)	1.438 (36.53)	1.510 (38.35)	0.375 (9.53)	3.628 (92.15)	0.750 (19.05)	8	.332
450-200R	Bored	D	4.47 (113.54)	1.938 (49.23)	2.010 (51.05)	0.375 (9.53)	3.628 (92.15)	0.750 (19.05)	8	.332
450-250R	Bored	D	4.47 (113.54)	2.438 (61.93)	2.510 (63.75)	0.375 (9.53)	3.628 (92.15)	0.750 (19.05)	8	.332
450-000RT	Blank	C	4.47 (113.54)	-	-	-	3.628 (92.15)	0.750 (19.05)	8	5/16-24
450-150RT	Bored	D	4.47 (113.54)	1.438 (36.53)	1.510 (38.35)	0.375 (9.53)	3.628 (92.15)	0.750 (19.05)	8	5/16-24
450-200RT	Bored	D	4.47 (113.54)	1.938 (49.23)	2.010 (51.05)	0.375 (9.53)	3.628 (92.15)	0.750 (19.05)	8	5/16-24
450-250RT	Bored	D	4.47 (113.54)	2.438 (61.93)	2.510 (63.75)	0.375 (9.53)	3.628 (92.15)	0.750 (19.05)	8	5/16-24

#### Model Number Definitions

N = Nonrotatable, clearance bolt holes  
 NT = Nonrotatable, tapped bolt holes  
 R = Rotatable, clearance bolt holes  
 RT = Rotatable, tapped bolt holes  
 Add -M8 = Metric tapped bolt holes

### CF Flange Hardware - 3<sup>3</sup>/<sub>8</sub> Inch (86mm) Nominal OD

MODEL NUMBER	DESCRIPTION
G-338	(10) OFHC copper gaskets
G-338-SP	(10) Silver plated copper gaskets
G-338V	(1) Viton gasket
B-338	(25) SS 5/16-24 x 1 3/4 inch bolts, nuts & washers
B-338T	(25) SS 5/16-24 x 1 1/4 inch bolts & washers
B-338-12	(25) SS 12-pt. 5/16-24 x 1 3/4 inch bolts, nuts & washers
B-338T-12	(25) SS 12-pt. 5/16-24 x 1 1/4 inch bolts & washers
B-338-12-SP	(25) Silver plated SS 12-pt. 5/16-24 x 1 3/4 inch bolts, nuts & washers
B-338T-12-SP	(25) Silver plated SS 12-pt. 5/16-24 x 1 1/4 inch bolts, washers
NP-200	(24) 5/16-24 plate nuts. See page 63
KNP-200	(16) Plate nuts, (32) 5/16-24 x 1 3/4 inch bolts & washers
KNP-200-12	(16) Plate nuts, (32) 12-pt. 5/16-24 x 1 3/4 inch bolts & washers

### CF Flange Hardware - 4<sup>1</sup>/<sub>2</sub> Inch (114mm) Nominal OD

MODEL NUMBER	DESCRIPTION
G-450	(10) OFHC copper gaskets
G-450-SP	(10) Silver plated copper gaskets
G-450V	(1) Viton gasket
B-450	(25) SS 5/16-24 x 2 inch bolts, nuts & washers
B-450T	(25) SS 5/16-24 x 1 1/4 inch bolts & washers
B-450-12	(25) SS 12-pt. 5/16-24 x 2 inch bolts, nuts & washers
B-450T-12	(25) SS 12-pt. 5/16-24 x 1 1/4 inch bolts & washers
B-450-12-SP	(25) Silver plated SS 12-pt. 5/16-24 x 2 inch bolts, nuts & washers
B-450T-12-SP	(25) Silver plated SS 12-pt. 5/16-24 x 1 1/4 inch bolts & washers
B-450-M	(25) SS (metric) M8 x 1.25 x 35mm bolts & washers
NP-250	(24) 5/16-24 plate nuts. See page 63
KNP-250	(16) Plate nuts, (32) 5/16-24 x 2 inch bolts & washers
KNP-250-12	(16) Plate nuts, (32) 12-pt. 5/16-24 x 2 inch bolts & washers

#### SPECIFICATIONS

**General:** Rotatable and nonrotatable with tapped or clearance bolt holes

#### Materials

Flanges: 304 stainless steel  
 (316L available upon request)  
 Gaskets: Copper, Viton or silver plated  
 Bolts: 18-8 stainless steel or silver plated

**Torque:** 21.5 Nm

#### Vacuum range

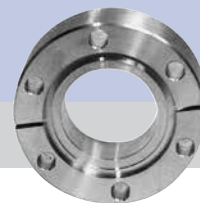
Metal seal:  $\geq 1 \times 10^{-13}$  mbar - UHV  
 Elastomer seal:  $\geq 1 \times 10^{-8}$  mbar - High vacuum

#### Temperature range

Metal seal: -200°C to 450°C  
 Elastomer seal: -20°C to 150°C

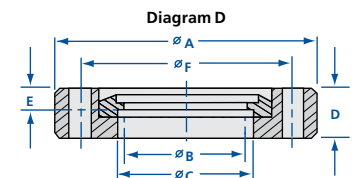
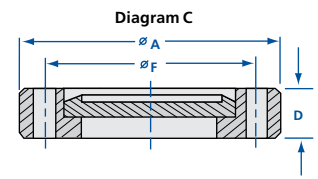
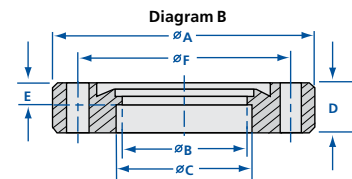
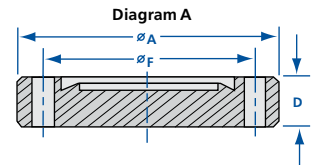
All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.





### CF Flanges - 4 5/8 Inch (117mm) Nominal OD

MODEL NUMBER	TYPE	DIAGRAM	OD A	ID B	C	D	E	F	BOLT HOLES	DIAMETER OR THREAD
462-000N	Blank	A	4.61 (117.09)	-	-	0.812 (20.62)	-	4.030 (102.36)	10	.332
462-300N	Bored	B	4.61 (117.09)	2.938 (74.63)	3.010 (76.45)	0.812 (20.62)	0.281 (7.14)	4.030 (102.36)	10	.332
462-000NT	Blank	A	4.61 (117.09)	-	-	0.812 (20.62)	-	4.030 (102.36)	10	5/16-24
462-300NT	Bored	B	4.61 (117.09)	2.938 (74.63)	3.010 (76.45)	0.812 (20.62)	0.281 (7.14)	4.030 (102.36)	10	5/16-24
462-000R	Blank	C	4.61 (117.09)	-	-	0.812 (20.62)	-	4.030 (102.36)	10	.332
462-300R	Bored	D	4.61 (117.09)	2.938 (74.63)	3.010 (76.45)	0.812 (20.62)	0.281 (7.14)	4.030 (102.36)	10	.332
462-000RT	Blank	C	4.61 (117.09)	-	-	0.812 (20.62)	-	4.030 (102.36)	10	5/16-24
462-300RT	Bored	D	4.61 (117.09)	2.938 (74.63)	3.010 (76.45)	0.812 (20.62)	0.281 (7.14)	4.030 (102.36)	10	5/16-24



### CF Flanges - 6 Inch (152mm) Nominal OD

MODEL NUMBER	TYPE	DIAGRAM	OD A	ID B	C	D	E	F	BOLT HOLES	DIAMETER OR THREAD
600-000N	Blank	A	5.97 (151.64)	-	-	0.781 (19.84)	-	5.128 (130.25)	16	.332
600-400N	Bored	B	5.97 (151.64)	3.910 (99.31)	4.010 (101.85)	0.781 (19.84)	0.438 (11.13)	5.128 (130.25)	16	.332
600-000NT	Blank	A	5.97 (151.64)	-	-	0.781 (19.84)	-	5.128 (130.25)	16	5/16-24
600-400NT	Bored	B	5.97 (151.64)	3.910 (99.31)	4.010 (101.85)	0.781 (19.84)	0.438 (11.13)	5.128 (130.25)	16	5/16-24
600-000R	Blank	C	5.97 (151.64)	-	-	0.844 (21.44)	-	5.128 (130.25)	16	.332
600-400R	Bored	D	5.97 (151.64)	3.910 (99.31)	4.010 (101.85)	0.844 (21.44)	0.438 (11.13)	5.128 (130.25)	16	.332
600-000RT	Blank	C	5.97 (151.64)	-	-	0.844 (21.44)	-	5.128 (130.25)	16	5/16-24
600-400RT	Bored	D	5.97 (151.64)	3.910 (99.31)	4.010 (101.85)	0.844 (21.44)	0.438 (11.13)	5.128 (130.25)	16	5/16-24

#### Model Number Definitions

**N** = Nonrotatable, clearance bolt holes    **NT** = Nonrotatable, tapped bolt holes    **R** = Rotatable, clearance bolt holes  
**RT** = Rotatable, tapped bolt holes    **Add-M8** = Metric tapped bolt holes

### CF Flange Hardware - 4 5/8 Inch (117mm) Nominal OD

MODEL NUMBER	DESCRIPTION
G-462	(10) OFHC copper gaskets
G-462V	(1) Viton gasket
B-462	(25) SS 5/16-24 x 2 1/4 inch bolts, nuts & washers
B-462T	(25) SS 5/16-24 x 1 1/4 inch bolts & washers
B-462-12	(25) SS 12-pt. 5/16-24 x 2 1/4 inch bolts, nuts & washers
B-462T-12	(25) SS 12-pt. 5/16-24 x 1 1/4 inch bolts & washers
NP-300	(24) 5/16-24 plate nuts. See page 63
KNP-300	(20) Plate nuts, (40) 5/16-24 x 2 1/4 inch bolts & washers
KNP-300-12	(20) Plate nuts, (40) 12-pt. 5/16-24 x 2 1/4 inch bolts & washers



#### SPECIFICATIONS

**General:** Rotatable and nonrotatable with tapped or clearance bolt holes

#### Materials

**Flanges:** 304 stainless steel  
*(316L available upon request)*  
**Gaskets:** Copper, Viton and silver plated  
**Bolts:** 18-8 stainless steel and silver plated

**Torque:** 21.5 Nm

#### Vacuum range

**Metal seal:**  $\geq 1 \times 10^{-13}$  mbar - UHV  
**Elastomer seal:**  $\geq 1 \times 10^{-8}$  mbar - High vacuum

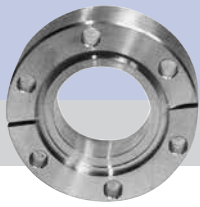
#### Temperature Range

**Metal seal:** -200°C to 450°C  
**Elastomer seal:** -20°C to 150°C

### CF Flange Hardware - 6 Inch (152mm) Nominal OD

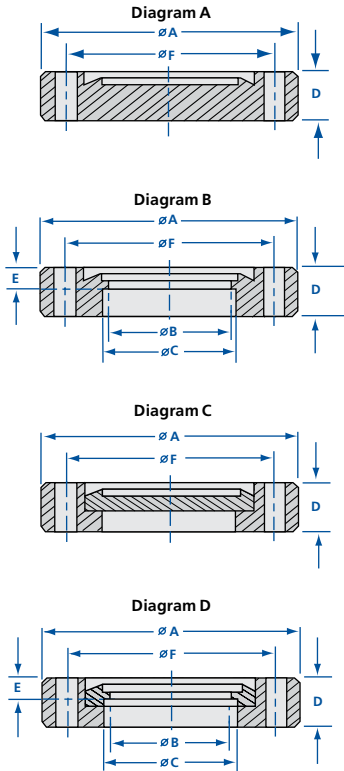
MODEL NUMBER	DESCRIPTION
G-600	(10) OFHC copper gaskets
G-600V	(1) Viton gasket
G-600-SP	(10) Silver plated copper gaskets
B-600	(25) SS 5/16-24 x 2 1/4 inch bolts, nuts & washers
B-600T	(25) SS 5/16-24 x 1 1/4 inch bolts & washers
B-600-12	(25) SS 12-pt. 5/16-24 x 2 1/4 inch bolts, nuts & washers
B-600T-12	(25) SS 12-pt. 5/16-24 x 1 1/4 inch bolts & washers
B-600-12-SP	(25) Silver plated SS 12-pt. 5/16-24 x 2 1/4 inch bolts, nuts & washers
B-600T-12-SP	(25) Silver plated SS 12-pt. 5/16-24 x 1 1/4 inch bolts & washers
B-600T-M	(25) SS (metric) M8 x 1 1/4 x 35mm bolts & washers
NP-400	(24) 5/16-24 plate nuts. See page 63
KNP-400	(16) Plate nuts (32) 5/16-24 x 2 1/4 inch bolts & washers
KNP-400-12	(16) Plate nuts (32) 12-pt. 5/16-24 x 2 1/4 inch bolts & washers





# Flanges & Fittings

## CF Flanges and Hardware



### CF Flanges - 6<sup>3</sup>/<sub>4</sub> Inch (171mm) Nominal OD

MODEL NUMBER	TYPE	DIAGRAM	OD A	ID B	C	D	E	F	BOLT HOLES	DIAMETER OR THREAD
675-000N	Blank	A	6.73 (170.94)	-	-	0.844 (21.44)	-	5.969 (151.61)	18	.332
675-500N	Bored	B	6.73 (170.94)	4.875 (123.83)	5.010 (127.25)	0.844 (21.44)	0.460 (11.68)	5.969 (151.61)	18	.332
675-000RT	Blank	A	6.73 (170.94)	-	-	0.844 (21.44)	-	5.969 (151.61)	18	5/16-24
675-500RT	Bored	B	6.73 (170.94)	4.875 (123.83)	5.010 (127.25)	0.844 (21.44)	0.460 (11.68)	5.969 (151.61)	18	5/16-24
675-000R	Blank	C	6.73 (170.94)	-	-	0.844 (21.44)	-	5.969 (151.61)	18	.332
675-500R	Bored	D	6.73 (170.94)	4.875 (123.83)	5.010 (127.25)	0.844 (21.44)	0.460 (11.68)	5.969 (151.61)	18	.332
675-000RT	Blank	C	6.73 (170.94)	-	-	0.844 (21.44)	-	5.969 (151.61)	18	5/16-24
675-500RT	Bored	D	6.73 (170.94)	4.875 (123.83)	5.010 (127.25)	0.844 (21.44)	0.460 (11.68)	5.969 (151.61)	18	5/16-24

### CF Flanges - 8 Inch (203mm) Nominal OD

MODEL NUMBER	TYPE	DIAGRAM	OD A	ID B	C	D	E	F	BOLT HOLES	DIAMETER OR THREAD
800-000N	Blank	A	7.97 (202.44)	-	-	0.875 (22.23)	-	7.128 (181.05)	20	.332
800-600N	Bored	B	7.97 (202.44)	5.875 (149.23)	6.020 (152.91)	0.875 (22.23)	0.500 (12.7)	7.128 (181.05)	20	.332
800-000RT	Blank	A	7.97 (202.44)	-	-	0.875 (22.23)	-	7.128 (181.05)	20	5/16-24
800-600RT	Bored	B	7.97 (202.44)	5.875 (149.23)	6.020 (152.91)	0.875 (22.23)	0.500 (12.7)	7.128 (181.05)	20	5/16-24
800-000R	Blank	C	7.97 (202.44)	-	-	0.875 (22.23)	-	7.128 (181.05)	20	.332
800-600R	Bored	D	7.97 (202.44)	5.875 (149.23)	6.020 (152.91)	0.875 (22.23)	0.500 (12.7)	7.128 (181.05)	20	.332
800-000RT	Blank	C	7.97 (202.44)	-	-	0.875 (22.23)	-	7.128 (181.05)	20	5/16-24
800-600RT	Bored	D	7.97 (202.44)	5.875 (149.23)	6.020 (152.91)	0.875 (22.23)	0.500 (12.7)	7.128 (181.05)	20	5/16-24

#### Model Number Definitions

**N** = Nonrotatable, clearance bolt holes    **NT** = Nonrotatable, tapped bolt holes    **R** = Rotatable, clearance bolt holes  
**RT** = Rotatable, tapped bolt holes    **Add-M8** = Metric tapped bolt holes

#### SPECIFICATIONS

**General:** Rotatable and nonrotatable with tapped or clearance bolt holes

**Material**  
 Flanges: 304 stainless steel  
 (316L available upon request)  
 Gaskets: Copper, Viton or silver plated  
 Bolts: 18-8 stainless steel or silver plated

**Torque:** 21.5 Nm

**Vacuum range**  
 Metal seal:  $\geq 1 \times 10^{-13}$  mbar - UHV  
 Elastomer seal:  $\geq 1 \times 10^{-8}$  mbar - High vacuum

**Temperature range**  
 Metal seal: -200°C to 450°C  
 Elastomer seal: -20°C to 150°C



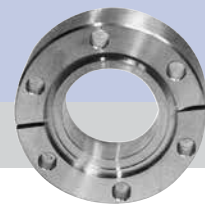
### CF Flange Hardware - 6<sup>3</sup>/<sub>4</sub> Inch (171mm) Nominal OD

MODEL NUMBER	DESCRIPTION
G-675	(10) OFHC copper gaskets
G-675V	(1) Viton gasket
B-675	(25) SS 5/16-24 x 2 1/4 inch bolts, nuts & washers
B-675T	(25) SS 5/16-24 x 1 1/2 inch bolts & washers
B-675-12	(25) SS 12-pt. 5/16-24 x 2 1/4 inch bolts, nuts & washers
B-675T-12	(25) SS 12-pt. 5/16-24 x 1 3/4 inch bolts & washers

### CF Flange Hardware - 8 Inch (203mm) Nominal OD

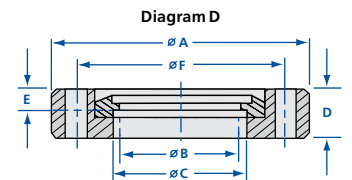
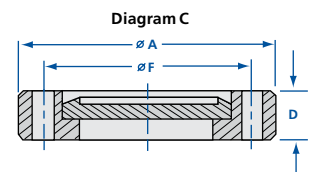
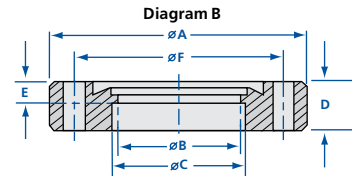
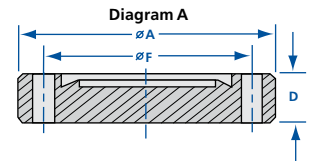
MODEL NUMBER	DESCRIPTION
G-800	(10) OFHC copper gaskets
G-800V	(1) Viton gasket
G-800-SP	(10) Silver plated copper gaskets
B-800	(25) SS 5/16-24 x 2 1/4 inch bolts, nuts & washers
B-800T	(25) SS 5/16-24 x 1 3/4 inch bolts & washers
B-800-12	(25) SS 12-pt. 5/16-24 x 2 1/4 inch bolts, nuts & washers
B-800T-12	(25) SS 12-pt. 5/16-24 x 1 3/4 inch bolts & washers
B-800-12-SP	(25) Silver plated SS 12-pt. 5/16-24 x 2 1/4 inch bolts, nuts & washers
B-800T-12-SP	(25) Silver plated SS 12-pt. 5/16-24 x 1 3/4 inch bolts & washers
B-800T-M	(25) SS (metric) M8 x 1 1/4 x 45mm bolts & washers
NP-600	(24) 5/16-24 plate nuts. See page 63
KNP-600	(20) Plate nuts, (40) 5/16-24 x 2 1/4 inch bolts & washers
KNP-600-12	(20) Plate nuts, (40) 5/16-24 x 2 1/4 inch 12-pt. bolts & washers

All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.



### CF Flanges - 10 Inch (254mm) Nominal OD

MODEL NUMBER	TYPE	DIAGRAM	OD A	ID B	C	D	E	F	BOLT HOLES	DIAMETER OR THREAD
1000-000N	Blank	A	9.97 (253.24)	-	-	0.968 (24.59)	-	9.128 (231.85)	24	.332
1000-800N	Bored	B	9.97 (253.24)	7.875 (200.03)	8.020 (203.71)	0.968 (24.59)	0.500 (12.70)	9.128 (231.85)	24	.332
1000-000NT	Blank	A	9.97 (253.24)	-	-	0.968 (24.59)	-	9.128 (231.85)	24	5/16-24
1000-800NT	Bored	B	9.97 (253.24)	7.875 (200.03)	8.020 (203.71)	0.968 (24.59)	0.500 (12.70)	9.128 (231.85)	24	5/16-24
1000-000R	Blank	C	9.97 (253.24)	-	-	0.968 (24.59)	-	9.128 (231.85)	24	.332
1000-800R	Bored	D	9.97 (253.24)	7.875 (200.03)	8.020 (203.71)	0.968 (24.59)	0.500 (12.70)	9.128 (231.85)	24	.332
1000-000RT	Blank	C	9.97 (253.24)	-	-	0.968 (24.59)	-	9.128 (231.85)	24	5/16-24
1000-800RT	Bored	D	9.97 (253.24)	7.875 (200.03)	8.020 (203.71)	0.968 (24.59)	0.500 (12.70)	9.128 (231.85)	24	5/16-24



### CF Flanges - 12 Inch (305mm) Nominal OD

MODEL NUMBER	TYPE	DIAGRAM	OD A	ID B	C	D	E	F	BOLT HOLES	DIAMETER OR THREAD
1200-000N	Blank	A	12.00 (304.80)	-	-	1.125 (28.58)	-	11.181 (284)	32	.332
1200-1000N	Bored	B	12.00 (304.80)	9.875 (250.83)	10.020 (254.51)	1.125 (28.58)	0.500 (12.70)	11.181 (284)	32	.332
1200-000NT	Blank	A	12.00 (304.80)	-	-	1.125 (28.58)	-	11.181 (284)	32	5/16-24
1200-1000NT	Bored	B	12.00 (304.80)	9.875 (250.83)	10.020 (254.51)	1.125 (28.58)	0.500 (12.70)	11.181 (284)	32	5/16-24
1200-000R	Blank	C	12.00 (304.80)	-	-	1.125 (28.58)	-	11.181 (284)	32	.332
1200-1000R	Bored	D	12.00 (304.80)	9.875 (250.83)	10.020 (254.51)	1.125 (28.58)	0.500 (12.70)	11.181 (284)	32	.332
1200-000RT	Blank	C	12.00 (304.80)	-	-	1.125 (28.58)	-	11.181 (284)	32	5/16-24
1200-1000RT	Bored	D	12.00 (304.80)	9.875 (250.83)	10.020 (254.51)	1.125 (28.58)	0.500 (12.70)	11.181 (284)	32	5/16-24

#### Model Number Definitions

**N** = Nonrotatable, clearance bolt holes    **NT** = Nonrotatable, tapped bolt holes    **R** = Rotatable, clearance bolt holes  
**RT** = Rotatable, tapped bolt holes    **Add -M8** = Metric tapped bolt holes

### CF Flange Hardware - 10 Inch (254mm) Nominal OD

MODEL NUMBER	DESCRIPTION
G-1000	(10) OFHC copper gaskets
G-1000V	(1) Viton gasket
G-1000-SP	(10) Silver plated copper gaskets
B-1000	(25) SS 5/16-24 x 2 1/2 inch bolts, nuts & washers
B-1000T	(25) SS 5/16-24 x 1 3/4 inch bolts & washers
B-1000-12	(25) SS 12-pt. 5/16-24 x 2 1/2 inch bolts, nuts & washers
B-1000T-12	(25) SS 12-pt. 5/16-24 x 1 3/4 inch bolts & washers
B-1000-12-SP	(25) Silver plated SS 12-pt. 5/16-24 x 2 1/2 inch bolts, nuts & washers
B-1000T-12-SP	(25) Silver plated SS 12-pt. 5/16-24 x 1 3/4 inch bolts & washers
B-1000T-M	(25) SS (metric) M8 x 1 1/4 x 45mm bolts & washers
NP-800	(24) 5/16-24 plate nuts. See page 63
KNP-800	(24) Plate nuts, (48) 5/16-24 x 2 1/4 inch bolts & washers
KNP-800-12	(24) Plate nuts, (48) 12-pt. 5/16-24 x 2 1/4 inch bolts & washers



#### SPECIFICATIONS

**General:** Rotatable and nonrotatable with tapped or clearance bolt holes

#### Material

Flanges: 304 stainless steel (316L available upon request)  
 Gaskets: Copper, Viton or silver plated  
 Bolts: 18-8 stainless steel or silver plated

**Torque:** 21.5 Nm

#### Vacuum range

Metal seal:  $\geq 1 \times 10^{-13}$  mbar - UHV  
 Elastomer seal:  $\geq 1 \times 10^{-8}$  mbar - High vacuum

#### Temperature Range

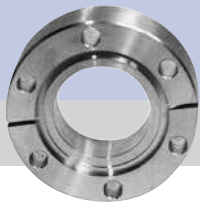
Metal seal: -200°C to 450°C  
 Elastomer seal: -20°C to 150°C

### CF Flange Hardware - 12 Inch (305mm) Nominal OD

MODEL NUMBER	DESCRIPTION
G-1200	(1) OFHC copper gasket
B-1200	(32) SS 5/16-24 x 3 inch bolts, nuts & washers
B-1200T	(32) SS 5/16-24 x 1 3/4 inch bolts & washers







# Flanges & Fittings

## CF Flanges and Hardware

Diagram A

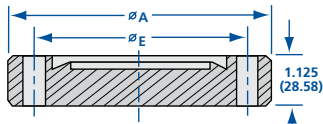


Diagram B

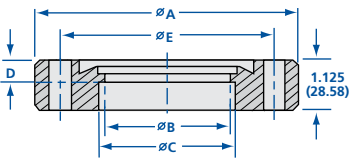


Diagram C

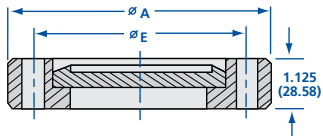
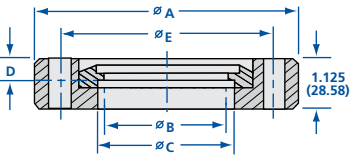


Diagram D



### CF Flanges - 13 1/4 Inch (337mm) Nominal OD

MODEL NUMBER	TYPE	DIAGRAM	OD A	ID B	C	D	E	BOLT HOLES	DIAMETER OR THREAD
1325-000N	Blank	A	13.25 (336.55)	-	-	-	12.055 (306.20)	30	.390
1325-1000N	Bored	B	13.25 (336.55)	9.875 (250.83)	10.020 (254.51)	0.500 (12.70)	12.055 (306.20)	30	.390
1325-000NT	Blank	A	13.25 (336.55)	-	-	-	12.055 (306.20)	30	3/8-24
1325-1000NT	Bored	B	13.25 (336.55)	9.875 (250.83)	10.020 (254.51)	0.500 (12.70)	12.055 (306.20)	30	3/8-24
1325-000R	Blank	C	13.25 (336.55)	-	-	-	12.055 (306.20)	30	.390
1325-1000R	Bored	D	13.25 (336.55)	9.875 (250.83)	10.020 (254.51)	0.500 (12.70)	12.055 (306.20)	30	.390
1325-000RT	Blank	C	13.25 (336.55)	-	-	-	12.055 (306.20)	30	3/8-24
1325-1000RT	Bored	D	13.25 (336.55)	9.875 (250.83)	10.020 (254.51)	0.500 (12.70)	12.055 (306.20)	30	3/8-24

### CF Flanges - 14 Inch (356mm) Nominal OD

MODEL NUMBER	TYPE	DIAGRAM	OD A	ID B	C	D	E	BOLT HOLES	DIAMETER OR THREAD
1400-000N	Blank	A	14.00 (355.60)	-	-	-	12.810 (325.37)	30	.390
1400-1200N	Bored	B	14.00 (355.60)	11.875 (301.63)	12.030 (305.56)	0.500 (12.70)	12.810 (325.37)	30	.390
1400-000NT	Blank	A	14.00 (355.60)	-	-	-	12.810 (325.37)	30	3/8-24
1400-1200NT	Bored	B	14.00 (355.60)	11.875 (301.63)	12.030 (305.56)	0.500 (12.70)	12.810 (325.37)	30	3/8-24
1400-000R	Blank	C	14.00 (355.60)	-	-	-	12.810 (325.37)	30	.390
1400-1200R	Bored	D	14.00 (355.60)	11.875 (301.63)	12.030 (305.56)	0.500 (12.70)	12.810 (325.37)	30	.390
1400-000RT	Blank	C	14.00 (355.60)	-	-	-	12.810 (325.37)	30	3/8-24
1400-1200RT	Bored	D	14.00 (355.60)	11.875 (301.63)	12.030 (305.56)	0.500 (12.70)	12.810 (325.37)	30	3/8-24

#### Model Number Definitions

**N** = Nonrotatable, clearance bolt holes    **NT** = Nonrotatable, tapped bolt holes    **R** = Rotatable, clearance bolt holes  
**RT** = Rotatable, tapped bolt holes    **Add-M8** = Metric tapped bolt holes

### CF Flange Hardware-13 1/4 Inch (337mm) Nominal OD

MODEL NUMBER	DESCRIPTION
G-1325	(1) OFHC copper gasket
G-1325V	(1) Viton gasket
B-1325	(30) SS 3/8-24 x 3 inch bolts, nuts & washers
B-1325T	(30) SS 3/8-24 x 2 inch bolts & washers

### CF Flange Hardware - 14 Inch (356mm) Nominal OD

MODEL NUMBER	DESCRIPTION
G-1400	(1) OFHC copper gasket
G-1400V	(1) Viton gasket
B-1400	(30) SS 3/8-24 x 3 inch bolts, nuts & washers
B-1400T	(30) SS 3/8-24 x 2 inch bolts & washers



#### SPECIFICATIONS

**General:** Rotatable and nonrotatable with tapped or clearance bolt holes

**Material**  
 Flanges: 304 stainless steel  
 (316L available upon request)  
 Gaskets: Copper, Viton  
 Bolts: 18-8 stainless steel

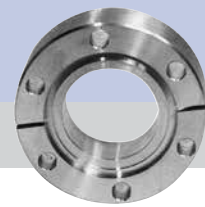
**Torque:** 39.0 Nm

**Vacuum range**  
 Metal seal:  $\geq 1 \times 10^{-13}$  mbar - UHV  
 Elastomer seal:  $\geq 1 \times 10^{-8}$  mbar - High vacuum

**Temperature range**  
 Metal seal: -200°C to 450°C  
 Elastomer seal: -20°C to 150°C

All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.





### CF Flanges - 14½ Inch (368mm) Nominal OD

MODEL NUMBER	TYPE	DIAGRAM	OD A	ID B	C	D	E	BOLT HOLES	DIAMETER OR THREAD
1450-000N	Blank	A	14.50 (368.30)	Blank	-	-	13.310 (338.07)	32	0.390
1450-1200N	Bored	B	14.50 (368.30)	11.875 (301.63)	12.020 (305.31)	0.500 (12.70)	13.310 (338.07)	32	0.390
1450-000NT	Blank	A	14.50 (368.30)	Blank	-	-	13.310 (338.07)	32	¾-24
1450-1200NT	Bored	B	14.50 (368.30)	11.875 (301.63)	12.020 (305.31)	0.500 (12.70)	13.310 (338.07)	32	¾-24
1450-000R	Blank	C	14.50 (368.30)	Blank	-	-	13.310 (338.07)	32	0.390
1450-1200R	Bored	D	14.50 (368.30)	11.875 (301.63)	12.020 (305.31)	0.500 (12.70)	13.310 (338.07)	32	0.390
1450-000RT	Blank	C	14.50 (368.30)	Blank	-	-	13.310 (338.07)	32	¾-24
1450-1200RT	Bored	D	14.50 (368.30)	11.875 (301.63)	12.020 (305.31)	0.500 (12.70)	13.310 (338.07)	32	¾-24

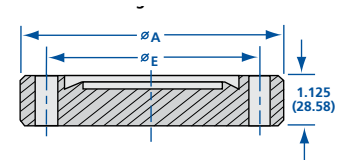


Diagram B

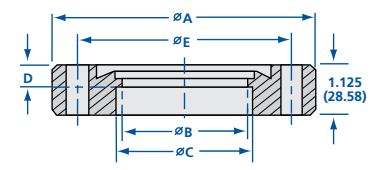


Diagram C

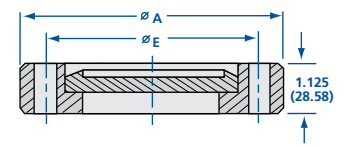
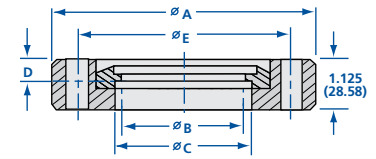


Diagram D



### CF Flanges - 16½ Inch (419mm) Nominal OD

MODEL NUMBER	TYPE	DIAGRAM	OD A	ID B	C	D	E	BOLT HOLES	DIAMETER OR THREAD
1650-000N	Blank	A	16.50 (419.10)	Blank	-	-	15.310 (388.87)	36	0.390
1650-1400N	Bored	B	16.50 (419.10)	13.750 (349.25)	14.020 (356.11)	0.500 (12.70)	15.310 (388.87)	36	0.390
1650-000NT	Blank	A	16.50 (419.10)	Blank	-	-	15.310 (388.87)	36	¾-24
1650-1400NT	Bored	B	16.50 (419.10)	13.750 (349.25)	14.020 (356.11)	0.500 (12.70)	15.310 (388.87)	36	¾-24
1650-000R	Blank	C	16.50 (419.10)	Blank	-	-	15.310 (388.87)	36	0.390
1650-1400R	Bored	D	16.50 (419.10)	13.750 (349.25)	14.020 (356.11)	0.500 (12.70)	15.310 (388.87)	36	0.390
1650-000RT	Blank	C	16.50 (419.10)	Blank	-	-	15.310 (388.87)	36	¾-24
1650-1400RT	Bored	D	16.50 (419.10)	13.750 (349.25)	14.020 (356.11)	0.500 (12.70)	15.310 (388.87)	36	¾-24

#### Model Number Definitions

**N** = Nonrotatable, clearance bolt holes    **NT** = Nonrotatable, tapped bolt holes    **R** = Rotatable, clearance bolt holes  
**RT** = Rotatable, tapped bolt holes    **Add-M8** = Metric tapped bolt holes

### CF Flange Hardware - 14½ Inch (368mm) Nominal OD

MODEL NUMBER	DESCRIPTION
G-1450	(1) OFHC copper gasket
B-1450	(32) SS ¾-24 x 3 inch bolts, nuts & washers
B-1450T	(32) SS ¾-24 x 2 inch bolts & washers



### CF Flange Hardware - 16½ Inch (419mm) Nominal OD

MODEL NUMBER	DESCRIPTION
G-1650	(1) OFHC copper gasket
G-1650V	(1) Viton gasket
B-1650	(36) SS ¾-24 x 3 inch bolts, nuts & washers
B-1650T	(36) SS ¾-24 x 2 inch bolts & washers

#### SPECIFICATIONS

**General:** Rotatable and nonrotatable with tapped or clearance bolt holes

#### Material

Flanges: 304 stainless steel  
 (316L available upon request)  
 Gaskets: Copper, Viton  
 Bolts: 18-8 stainless steel

**Torque:** 39 Nm.

#### Vacuum range

Metal seal: ≥1 x 10<sup>-13</sup> mbar - UHV  
 Elastomer seal: ≥1 x 10<sup>-8</sup> mbar - High vacuum

#### Temperature range

Metal seal: -200°C to 450°C  
 Elastomer seal: -20°C to 150°C

All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.

# Flanges & Fittings

## CF Special Purpose Flanges



### SPECIFICATIONS

**General:** Nonrotatable with clearance bolt holes

#### Material

Flanges: 304 stainless steel  
(316L available on request)  
Gaskets: Copper, Viton  
Bolts: 18-8 stainless steel

**Torque:** See page 48

#### Vacuum range

Metal seal:  $\geq 1 \times 10^{-13}$  mbar - UHV  
Elastomer seal:  $\geq 1 \times 10^{-8}$  mbar - High vacuum

#### Temperature range

Metal seal: -200°C to 450°C  
Elastomer seal: -20°C to 150°C

Nor-Cal's special purpose CF flanges are used as roughing accessories, accommodating thermocouple gauge tubes, up-to-air valves and/or NPT threaded fittings. Double-sided flanges are provided with one or more radially tapped holes. Blank flanges are provided with a single concentric  $1/8$  NPT tapped hole. Hardware for special purpose flanges is located on the appropriate flange size pages.



### CF Double-Sided Special Purpose Flanges

MODEL NUMBER	FLANGE OD	FEATURE	DIAGRAM	A	B
<b>133-D1</b>	1.33 (33.78)	(1) $1/16$ inch (1.59) NPT hole	A	0.25 (6.35)	0.50 (12.70)
<b>275-D1</b>	2.75 (69.85)	(1) $1/8$ inch (3.18) NPT hole	A	0.38 (9.65)	0.75 (19.05)
<b>133-D2</b>	1.33 (33.78)	(2) $1/16$ inch (1.59) NPT holes	B	0.25 (6.35)	0.50 (12.70)
<b>275-D2</b>	2.75 (69.85)	(2) $1/8$ inch (3.18) NPT holes	B	0.38 (9.65)	0.75 (19.05)
<b>133-DT</b>	1.33 (33.78)	Thermocouple gauge tube	C	0.25 (6.35)	0.50 (12.70)
<b>275-DT</b>	2.75 (69.85)	Thermocouple gauge tube	C	0.38 (9.65)	0.75 (19.05)
<b>133-DV</b>	1.33 (33.78)	Up-to-air valve	D	0.25 (6.35)	0.50 (12.70)
<b>275-DV</b>	2.75 (69.85)	Up-to-air valve	D	0.38 (9.65)	0.75 (19.05)
<b>133-DV-1/4 MVCR</b>	1.33 (33.78)	Up-to-air valve & $1/4$ inch (6.35) Cajon male VCR fitting on valve	D	0.25 (6.35)	0.50 (12.70)
<b>275-DV-1/4 MVCR</b>	2.75 (69.85)	Up-to-air valve & $1/4$ inch (6.35) Cajon male VCR fitting on valve	D	0.38 (9.65)	0.75 (19.05)
<b>133-DV-1/4 FVCR</b>	1.33 (33.78)	Up-to-air valve & $1/4$ inch (6.35) Cajon female VCR fitting on valve	D	0.25 (6.35)	0.50 (12.70)
<b>275-DV-1/4 FVCR</b>	2.75 (69.85)	Up-to-air valve & $1/4$ inch (6.35) Cajon female VCR fitting on valve	D	0.38 (9.65)	0.75 (19.05)
<b>133-DV-1/4 SWAG</b>	1.33 (33.78)	Up-to-air valve & $1/4$ inch (6.35) Swagelok fitting on valve	D	0.25 (6.35)	0.50 (12.70)
<b>275-DV-1/4 SWAG</b>	2.75 (69.85)	Up-to-air valve & $1/4$ inch (6.35) Swagelok fitting on valve	D	0.38 (9.65)	0.75 (19.05)
<b>133-D1V</b>	1.33 (33.78)	(1) $1/16$ inch (1.59) NPT hole & up-to-air valve	F	0.25 (6.35)	0.50 (12.70)
<b>275-D1V</b>	2.75 (69.85)	(1) $1/8$ inch (3.18) NPT hole & up-to-air valve	F	0.38 (9.65)	0.75 (19.05)
<b>133-DTV</b>	1.33 (33.78)	Thermocouple gauge tube & up-to-air valve	E	0.25 (6.35)	0.50 (12.70)
<b>275-DTV</b>	2.75 (69.85)	Thermocouple gauge tube & up-to-air valve	E	0.38 (9.65)	0.75 (19.05)
<b>133-DTV-1/4 MVCR</b>	1.33 (33.78)	Thermocouple gauge tube & up-to-air valve with $1/4$ inch (6.35) Cajon male VCR fitting on valve	E	0.25 (6.35)	0.50 (12.70)
<b>275-DTV-1/4 MVCR</b>	2.75 (69.85)	Thermocouple gauge tube & up-to-air valve with $1/4$ inch (6.35) Cajon male VCR fitting on valve	E	0.38 (9.65)	0.75 (19.05)
<b>133-DTV-1/4 FVCR</b>	1.33 (33.78)	Thermocouple gauge tube & up-to-air valve with $1/4$ inch (6.35) Cajon female VCR fitting on valve	E	0.25 (6.35)	0.50 (12.70)
<b>275-DTV-1/4 FVCR</b>	2.75 (69.85)	Thermocouple gauge tube & up-to-air valve with $1/4$ inch (6.35) Cajon female VCR fitting on valve	E	0.38 (9.65)	0.75 (19.05)
<b>133-DTV-1/4 SWAG</b>	1.33 (33.78)	Thermocouple gauge tube & up-to-air valve with $1/4$ inch (6.35) Swagelok fitting on valve	E	0.25 (6.35)	0.50 (12.70)
<b>275-DTV-1/4 SWAG</b>	2.75 (69.85)	Thermocouple gauge tube & up-to-air valve with $1/4$ inch (6.35) Swagelok fitting on valve	E	0.38 (9.65)	0.75 (19.05)
<b>275-DS-MINI</b>	2.75 (69.85)	(1) 1.33 inch (33.78) OD side port	G	0.38 (9.65)	0.75 (19.05)

Diagram A

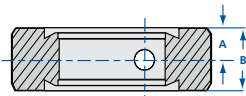


Diagram B

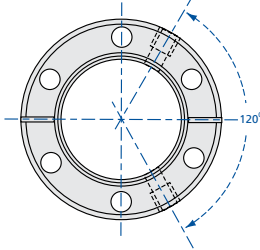


Diagram C

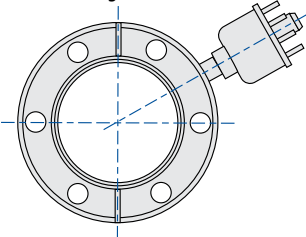


Diagram D

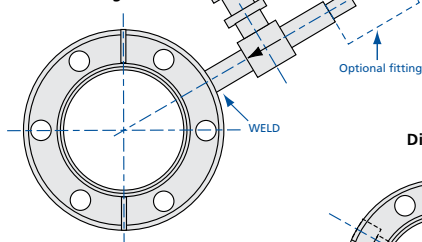


Diagram E

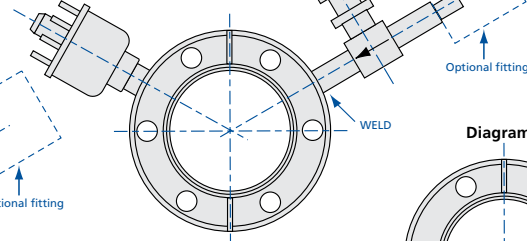


Diagram F

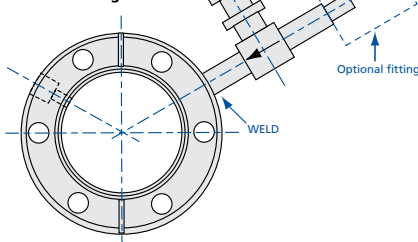
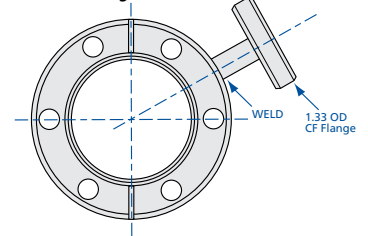
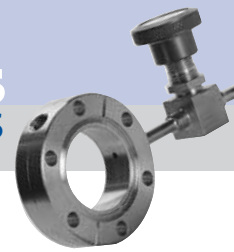


Diagram G



# Flanges & Fittings

## CF Special Purpose Flanges



### CF Straight-Through Special Purpose Flanges

MODEL NUMBER	FLANGE OD	FEATURE	DIAGRAM
133-ST	1.33 (33.78)	(1) 1/8 inch (3.18) NPT hole	A
275-ST	2.75 (69.85)	(1) 1/8 inch (3.18) NPT hole	A
133-STT	1.33 (33.78)	Thermocouple gauge tube	B
275-STT	2.75 (69.85)	Thermocouple gauge tube	B
133-STV	1.33 (33.78)	Up-to-air valve	C
275-STV	2.75 (69.85)	Up-to-air valve	C
133-STV-1/4 MVCR	1.33 (33.78)	Up-to-air valve and 1/4 inch (6.35) Cajon male VCR fitting on valve	C
275-STV-1/4 MVCR	2.75 (69.85)	Up-to-air valve and 1/4 inch (6.35) Cajon male VCR fitting on valve	C
133-STV-1/4 FVCR	1.33 (33.78)	Up-to-air valve and 1/4 inch (6.35) Cajon female VCR fitting on valve	C
275-STV-1/4 FVCR	2.75 (69.85)	Up-to-air valve and 1/4 inch (6.35) Cajon female VCR fitting on valve	C
133-STV-1/4 SWAG	1.33 (33.78)	Up-to-air valve and 1/4 inch (6.35) Swagelok fitting on valve	C
275-STV-1/4 SWAG	2.75 (69.85)	Up-to-air valve and 1/4 inch (6.35) Swagelok fitting on valve	C

### SPECIFICATIONS

**General:** Nonrotatable with clearance bolt holes

**Material**

Flanges: 304 stainless steel  
(316L available upon request)  
Gaskets: Copper, Viton  
Bolts: 18-8 stainless steel

**Torque:** See page 48

**Vacuum range**

Metal seal:  $\geq 1 \times 10^{-13}$  mbar - UHV  
Elastomer seal:  $\geq 1 \times 10^{-8}$  mbar - High vacuum

**Temperature Range**

Metal seal: -200°C to 450°C  
Elastomer seal: -20°C to 150°C

Diagram A

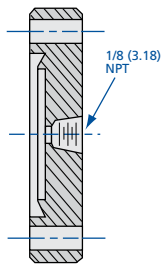


Diagram B

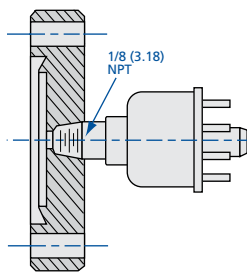
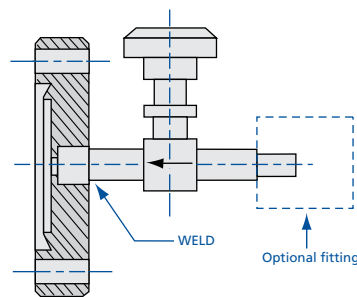
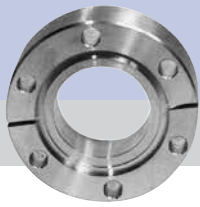


Diagram C



All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.





# Flanges & Fittings

## CF Double-Sided Flanges

Nor-Cal's double-sided flanges are identical to standard CF flanges except the same gasket-sealing detail is machined into both faces of the flange. These flanges can be inserted between like-sized flanges as spacers, orifice plates, or when radially drilled, as custom penetrations into vacuum systems.

### CF Double-Sided Flanges - 1 1/3 thru 14 Inch (34-356mm) Nominal OD

MODEL NUMBER	NOMINAL OD	MADE FROM	A	B
133-000D	1 1/3 (34)	133-000N	-	0.300 (7.62)
133-025D	1 1/3 (34)	133-000N	0.255 (6.48)	0.300 (7.62)
133-038D	1 1/3 (34)	133-000N	0.380 (9.65)	0.300 (7.62)
133-050D	1 1/3 (34)	133-000N	0.505 (12.83)	0.300 (7.62)
133-075D	1 1/3 (34)	133-000N	0.630 (16.00)	0.300 (7.62)
133-000DS	1 1/3 (34)	133-000NS	-	0.500 (12.7)
133-075DS	1 1/3 (34)	133-000NS	0.630 (16.00)	0.500 (12.7)
212-000D	2 1/8 (54)	212-000N	-	0.470 (11.94)
212-100D	2 1/8 (54)	212-000N	1.010 (25.65)	0.470 (11.94)
275-000D	2 1/8 (54)	275-000N	-	0.500 (12.7)
275-025D	2 3/4 (70)	275-000N	0.255 (6.48)	0.500 (12.7)
275-050D	2 3/4 (70)	275-000N	0.505 (12.83)	0.500 (12.7)
275-075D	2 3/4 (70)	275-000N	0.760 (19.30)	0.500 (12.7)
275-100D	2 3/4 (70)	275-000N	1.010 (25.65)	0.500 (12.7)
275-125D	2 3/4 (70)	275-000N	1.260 (32.00)	0.500 (12.7)
275-150D	2 3/4 (70)	275-000N	1.510 (38.35)	0.500 (12.7)
275-000DS	2 3/4 (70)	275-000NS	-	0.750 (19.05)
275-150DS	2 3/4 (70)	275-000NS	1.510 (38.35)	0.750 (19.05)
338-000D	3 3/8 (86)	338-000N	-	0.687 (17.45)
338-150D	3 3/8 (86)	338-000N	1.510 (38.35)	0.687 (17.45)
338-200D	3 3/8 (86)	338-000N	2.010 (51.05)	0.687 (17.45)
450-000D	4 1/2 (114)	450-000N	-	0.687 (17.45)
450-150D	4 1/2 (114)	450-000N	1.510 (38.35)	0.687 (17.45)
450-200D	4 1/2 (114)	450-000N	2.010 (51.05)	0.687 (17.45)
450-250D	4 1/2 (114)	450-000N	2.510 (63.75)	0.687 (17.45)
462-000D	4 5/8 (117)	462-000N	-	0.812 (20.62)
462-300D	4 5/8 (117)	462-000N	3.010 (76.45)	0.812 (20.62)
600-000D	6 (152)	600-000N	-	0.781 (19.84)
600-400D	6 (152)	600-000N	4.010 (101.85)	0.781 (19.84)
675-000D	6 3/4 (171)	675-000N	-	0.844 (21.44)
675-500D	6 3/4 (171)	675-000N	5.010 (127.25)	0.844 (21.44)
800-000D	8 (203)	800-000N	-	0.875 (22.23)
800-600D	8 (203)	800-000N	6.020 (152.91)	0.875 (22.23)
1000-000D	10 (254)	1000-000N	-	0.968 (24.59)
1000-800D	10 (254)	1000-000N	8.020 (203.71)	0.968 (24.59)
1325-000D	13 1/4 (337)	1325-000N	-	1.125 (28.58)
1325-1000D	13 1/4 (337)	1325-000N	10.020 (254.51)	1.125 (28.58)
1400-000D	14 (356)	1400-000N	-	1.125 (28.58)
1400-1200D	14 (356)	1400-000N	12.020 (305.31)	1.125 (28.58)

DS = Thicker than standard flange D = Double-sided flange, nonrotatable

### CF Double-Sided Flange Hardware

MODEL NUMBER	NOMINAL OD	DESCRIPTION
G-133	1 1/3 (34)	(10) OFHC copper gaskets
G-133V	1 1/3 (34)	(5) Viton gaskets
B-133D	1 1/3 (34)	(5) SS 8-32 x 1 1/4 inch bolts, nuts and washers
G-212	2 1/8 (54)	(10) OFHC copper gaskets
G-212V	2 1/8 (54)	(5) Viton gaskets
B-212D	2 1/8 (54)	(25) SS 1/4-28 x 1 1/4 inch bolts, nuts and washers
G-275	2 3/4 (70)	(10) OFHC copper gaskets
G-275V	2 3/4 (70)	(5) Viton gaskets
B-275DS	2 3/4 (70)	(25) SS 1/4-28 x 2 inch bolts, nuts and washers
B-275D	2 3/4 (70)	(25) SS 1/4-28 x 1 3/4 inch bolts, nuts and washers
KNP-150D	2 3/4 (70)	(6) Plate nuts, 1/4-28 x 2 inch (12) bolts and washers
G-338	3 3/8 (86)	(10) OFHC copper gaskets
G-338V	3 3/8 (86)	(1) Viton gaskets
B-338D	3 3/8 (86)	(25) SS 5/16-24 x 2 1/2 inch bolts, nuts and washers
G-450	4 1/2 (114)	(10) OFHC copper gaskets
G-450V	4 1/2 (114)	(1) Viton gaskets
B-450D	4 1/2 (114)	(25) SS 5/16-24 x 3 3/4 inch bolts, nuts and washers
G-462	4 5/8 (117)	(10) OFHC copper gaskets
G-462V	4 5/8 (117)	(1) Viton gaskets
B-462D	4 5/8 (117)	(25) SS 5/16-24 x 3 inch bolts, nuts and washers
G-600	6 (152)	(10) OFHC copper gaskets
G-600V	6 (152)	(1) Viton gaskets
B-600D	6 (152)	(25) SS 5/16-24 x 3 inch bolts, nuts and washers
G-675	6 3/4 (171)	(10) OFHC copper gaskets
G-675V	6 3/4 (171)	(1) Viton gaskets
B-675D	6 3/4 (171)	(25) SS 5/16-24 x 3 inch bolts, nuts and washers
G-800	8 (203)	(10) OFHC copper gaskets
G-800V	8 (203)	(1) Viton gaskets
B-800D	8 (203)	(25) SS 5/16-24 x 3 inch bolts, nuts & washers
G-1000	10 (254)	(10) OFHC copper gaskets
G-1000V	10 (254)	(1) Viton gaskets
B-1000D	10 (254)	(25) SS 5/16-24 x 3 1/2 inch bolts, nuts and washers
G-1325	13 1/4 (337)	(1) OFHC copper gaskets
G-1325V	13 1/4 (337)	(1) Viton gaskets

#### SPECIFICATIONS

**General:** Nonrotatable with clearance bolt holes

#### Material

Flanges: 304 stainless steel  
(316L available upon request)  
Gaskets: Copper, Viton  
Bolts: 18-8 stainless steel

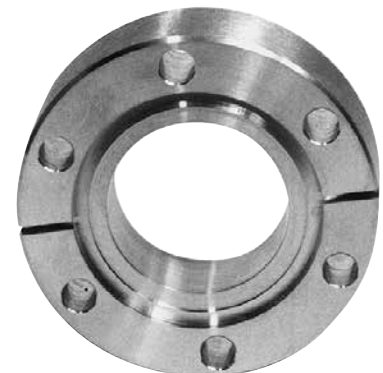
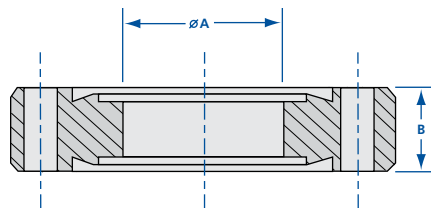
**Torque:** See page 48

#### Vacuum range

Metal seal:  $\geq 1 \times 10^{-13}$  mbar - UHV  
Elastomer seal:  $\geq 1 \times 10^{-8}$  mbar - High vacuum

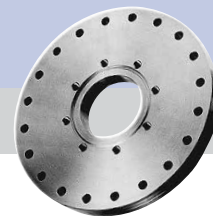
#### Temperature range

Metal seal: -200°C to 450°C  
Elastomer seal: -20°C to 150°C



# Flanges & Fittings

## CF Zero Length Reducer Flanges



Nor-Cal's zero length reducer flanges are a convenient and inexpensive way to reduce a large flange for smaller vacuum plumbing and/or component connection. To list all possible reducer combinations would require excessive space, therefore only the most commonly used reducers are listed. If your requirement is not listed, please inquire.

### CF Zero Length Reducer Flanges

MODEL NUMBER	SMALL FLANGE DETAIL	LARGE FLANGE DETAIL	A	B
212-133-075Z	133-000NT	212-000NT	0.625 (15.88)	0.470 (11.94)
275-133-075Z	133-000NT	275-000N	0.625 (15.88)	0.500 (12.70)
275-212-100Z	212-000NT	275-000NT	1.000 (25.40)	0.500 (12.70)
338-133-075Z	133-000NT	338-000N	0.625 (15.88)	0.687 (17.45)
338-212-100Z	212-000NT	338-000NT	1.000 (25.40)	0.687 (17.45)
338-275-150Z	275-000NT	338-000NT	1.500 (38.10)	0.687 (17.45)
450-133-075Z	133-000NT	450-000N	0.625 (15.88)	0.687 (17.45)
450-212-100Z	212-000NT	450-000N	1.000 (25.40)	0.687 (17.45)
450-275-150Z	275-000NT	450-000N	1.500 (38.10)	0.687 (17.45)
450-338-200Z	338-000NT	450-000NT	2.000 (50.80)	0.687 (17.45)
462-133-075Z	133-000NT	462-000N	0.625 (15.88)	0.812 (20.62)
462-212-100Z	212-000NT	462-000N	1.000 (25.40)	0.812 (20.62)
462-275-150Z	275-000NT	462-000N	1.500 (38.10)	0.812 (20.62)
462-338-200Z	338-000NT	462-000N	2.000 (50.80)	0.812 (20.62)
600-133-075Z	133-000NT	600-000N	0.625 (15.88)	0.781 (19.84)
600-212-100Z	212-000NT	600-000N	1.000 (25.40)	0.781 (19.84)
600-275-150Z	275-000NT	600-000N	1.500 (38.10)	0.781 (19.84)
600-338-200Z	338-000NT	600-000N	2.000 (50.80)	0.781 (19.84)
600-450-250Z	450-000NT	600-000N	2.500 (63.50)	0.781 (19.84)
600-462-300Z	462-000NT	600-000NT	3.000 (76.20)	0.781 (19.84)
675-133-075Z	133-000NT	675-000N	0.625 (15.88)	0.844 (21.44)
675-212-100Z	212-000NT	675-000N	1.000 (25.40)	0.844 (21.44)
675-275-150Z	275-000NT	675-000N	1.500 (38.10)	0.844 (21.44)
675-338-200Z	338-000NT	675-000N	2.000 (50.80)	0.844 (21.44)
675-450-250Z	450-000NT	675-000N	2.500 (63.50)	0.844 (21.44)
675-462-300Z	462-000NT	675-000N	3.000 (76.20)	0.844 (21.44)
675-600-400Z	600-000NT	675-000NT	4.000 (101.60)	0.844 (21.44)
800-133-075Z	133-000NT	800-000N	0.625 (15.88)	0.875 (22.23)
800-212-100Z	212-000NT	800-000N	1.000 (25.40)	0.875 (22.23)
800-275-150Z	275-000NT	800-000N	1.500 (38.10)	0.875 (22.23)
800-338-200Z	338-000NT	800-000N	2.000 (50.80)	0.875 (22.23)
800-450-250Z	450-000NT	800-000N	2.500 (63.50)	0.875 (22.23)
800-462-300Z	462-000NT	800-000N	3.000 (76.20)	0.875 (22.23)
800-600-400Z	600-000NT	800-000N	4.000 (101.60)	0.875 (22.23)
800-675-500Z	675-000NT	800-000NT	5.000 (127.00)	0.875 (22.23)
1000-133-075Z	133-000NT	1000-000N	0.625 (15.88)	0.968 (24.59)
1000-212-100Z	212-000NT	1000-000N	1.000 (25.40)	0.968 (24.59)
1000-275-150Z	275-000NT	1000-000N	1.500 (38.10)	0.968 (24.59)
1000-338-200Z	338-000NT	1000-000N	2.000 (50.80)	0.968 (24.59)
1000-450-250Z	450-000NT	1000-000N	2.500 (63.50)	0.968 (24.59)
1000-462-300Z	462-000NT	1000-000N	3.000 (76.20)	0.968 (24.59)
1000-600-400Z	600-000NT	1000-000N	4.000 (101.60)	0.968 (24.59)
1000-675-500Z	675-000NT	1000-000N	5.000 (127.00)	0.968 (24.59)
1000-800-600Z	800-000NT	1000-000N	6.000 (152.40)	0.968 (24.59)
1325-133-075Z	133-000NT	1325-000N	0.625 (15.88)	1.125 (28.58)
1325-212-100Z	212-000NT	1325-000N	1.000 (25.40)	1.125 (28.58)
1325-275-150Z	275-100NT	1325-000N	1.500 (38.10)	1.125 (28.58)
1325-338-200Z	338-000NT	1325-000N	2.000 (50.80)	1.125 (28.58)
1325-450-250Z	450-000NT	1325-000N	2.500 (63.50)	1.125 (28.58)
1325-462-300Z	462-000NT	1325-000N	3.000 (76.20)	1.125 (28.58)
1325-600-400Z	600-000NT	1325-000N	4.000 (101.60)	1.125 (28.58)
1325-675-500Z	675-000NT	1325-000N	5.000 (127.00)	1.125 (28.58)
1325-800-600Z	800-000NT	1325-000N	6.000 (152.40)	1.125 (28.58)
1325-1000-800Z	1000-000NT	1325-000N	8.000 (203.20)	1.125 (28.58)

### SPECIFICATIONS

**General:** Nonrotatable with tapped or clearance bolt holes

**Material**

Flanges: 304 stainless steel  
(316L available upon request)  
Gaskets: Copper, Viton or silver plated  
Bolts: 18-8 stainless steel or silver plated

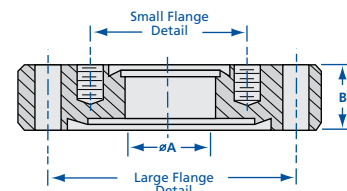
**Torque:** See page 48

**Vacuum range**

Metal seal:  $\geq 1 \times 10^{-13}$  mbar - UHV  
Elastomer seal:  $\geq 1 \times 10^{-8}$  mbar - High vacuum

**Temperature range**

Metal seal: -200°C to 450°C  
Elastomer seal: -20°C to 150°C

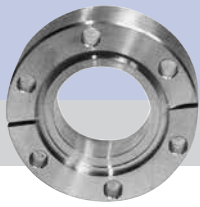


For gasket and hardware options please refer to appropriate flange page

### Flange Detail Definitions

N = Nonrotatable, clearance bolt holes NT = Nonrotatable, tapped bolt holes

All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.



# Flanges & Fittings

## Aluminum to Stainless Steel Transitions

### SPECIFICATIONS

**General:** Nonrotatable with clearance bolt holes

**Material**

Flanges: 304 stainless steel  
(316L available upon request)  
Gaskets: Copper, Viton or silver plated  
Bolts: 18-8 stainless steel or silver plated

**Torque:** 21.5 Nm.

**Vacuum range**

Metal seal:  $\geq 1 \times 10^{-13}$  mbar - UHV  
Elastomer seal:  $\geq 1 \times 10^{-8}$  mbar - High vacuum

**Temperature range**

Metal seal: -200°C to 450°C  
Elastomer seal: -20°C to 150°C

Nor-Cal's new Aluminum to Stainless Steel Transitions provide a reliable UHV seal for aluminum vacuum systems. An explosion bonded composite of aluminum, stainless steel and two other UHV materials make these transitions leak tight at UHV pressures. Transitions are welded to a stainless steel CF flange as a complete unit ready to weld to your aluminum chamber or beamline, or the transition can be purchased separately for welding to your own CF flange.

The explosion bonds have been tested for tensile, shear and thermal stress. Testing included thermal quenching from 773°K to 77°K. This process has shown vacuum integrity to better than  $5 \times 10^{-10}$  standard cc per second with wall thickness as thin as 0.025 inch (6.35mm). Each unit is thermally cycled to 300°C. Helium leak testing is done before and after thermal cycling.

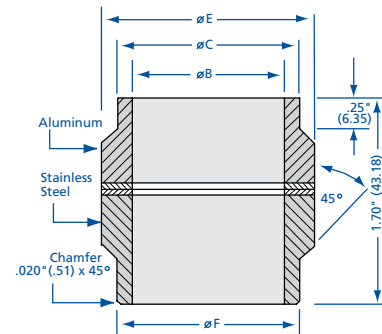
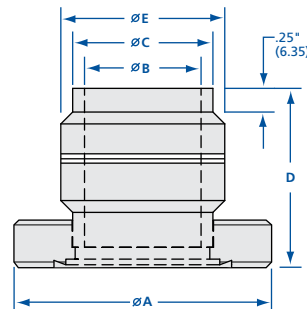


### Applications

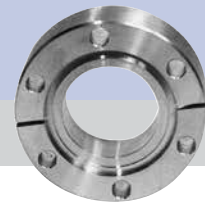
- Accelerators
- Synchrotrons
- Semiconductor processing

### Aluminum to Stainless Steel Transitions

MODEL NUMBER	DESCRIPTION	A	B	C	D	E
<b>ALST-075-CF</b>	Nonrotatable CF	1.33 (33.78)	0.50 (12.70)	0.750 (19.05)	2.20 (55.88)	1.00 (25.40)
<b>ALST-075</b>	Transition only	-	0.50 (12.70)	0.750 (19.05)	-	1.00 (25.40)
<b>ALST-150-CF</b>	Nonrotatable CF	2.73 (69.34)	1.25 (31.75)	1.500 (38.10)	1.91 (48.51)	1.75 (44.45)
<b>ALST-150</b>	Transition only	-	1.25 (31.75)	1.500 (38.10)	-	1.75 (44.45)
<b>ALST-250-CF</b>	Nonrotatable CF	4.47 (113.54)	2.25 (57.15)	2.500 (63.50)	2.08 (52.83)	2.75 (69.85)
<b>ALST-250</b>	Transition only	-	2.25 (57.15)	2.500 (63.50)	-	2.75 (69.85)
<b>ALST-400-CF</b>	Nonrotatable CF	5.97 (151.64)	3.75 (95.25)	4.000 (101.60)	2.14 (54.36)	4.25 (107.95)
<b>ALST-400</b>	Transition only	-	3.75 (95.25)	4.000 (101.60)	-	4.25 (107.95)
<b>ALST-600-CF</b>	Nonrotatable CF	7.97 (202.44)	5.75 (146.05)	6.000 (152.40)	2.20 (55.88)	6.25 (158.75)
<b>ALST-600</b>	Transition only	-	5.75 (146.05)	6.000 (152.40)	-	6.25 (158.75)
<b>ALST-800-CF</b>	Nonrotatable CF	9.97 (253.24)	7.75 (196.85)	8.000 (203.20)	2.20 (55.88)	8.25 (209.55)
<b>ALST-800</b>	Transition only	-	7.75 (196.85)	8.000 (203.20)	-	8.25 (209.55)



All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.



Nor-Cal manufactures plate nuts for most sizes of CF flanges from 1 1/3 to 10 inches (33.96 TO 254mm) OD. These handy backing nuts center themselves over two adjacent bolt holes on the back side of a flange and can be held in place with one finger while bolts are tightened with a single wrench. Plate nuts are perfect for those hard to reach (and see) spaces that are encountered during system assembly and service.

### Plate Nuts

MODEL NUMBER	FLANGE OD	THREAD SIZE	A	B	C	D
NP-075	1 1/3 (40)	8-32	0.80 (20.32)	0.3 (7.62)	0.53 (13.46)	0.15 (3.81)
NP-150	2 3/4 (70)	1/4-28	1.59 (40.39)	0.5 (12.70)	1.15 (29.21)	0.18 (4.57)
NP-150M	2 3/4 (70)	M6	1.59 (40.39)	0.5 (12.70)	1.15 (29.21)	0.18 (4.57)
NP-200	3 3/8 (86)	5/16-24	1.75 (44.45)	0.5 (12.70)	1.09 (27.69)	0.22 (5.59)
NP-250	4 1/2 (114)	5/16-24	2.03 (51.56)	0.5 (12.70)	1.39 (35.31)	0.22 (5.59)
NP-250M	4 1/2 (114)	M8	2.03 (51.56)	0.5 (12.70)	1.39 (35.31)	0.22 (5.59)
NP-300	4 5/8 (117)	5/16-24	1.75 (44.45)	0.5 (12.70)	1.25 (31.75)	0.22 (5.59)
NP-400	6 (152)	5/16-24	1.75 (44.45)	0.5 (12.70)	1.00 (25.40)	0.22 (5.59)
NP-400M	6 (152)	M8	1.75 (44.45)	0.5 (12.70)	1.00 (25.40)	0.22 (5.59)
NP-600	8 (200)	5/16-24	1.75 (44.45)	0.5 (12.70)	1.12 (28.45)	0.22 (5.59)
NP-600M	8 (200)	M8	1.75 (44.45)	0.5 (12.70)	1.12 (28.45)	0.22 (5.59)
NP-800	10 (254)	5/16-24	1.75 (44.45)	0.5 (12.70)	1.19 (30.23)	0.22 (5.59)

All plate nuts – 24 per package

### Plate Nut Assembly Kits with Hex Head Bolts

MODEL NUMBER	FLANGE OD	DESCRIPTION
KNP-075	1 1/3 (34)	(12) Plate nuts (24) SS 8-32 x 3/4 inch bolts and washers
KNP-150	2 3/4 (70)	(12) Plate nuts (24) SS 1/4-28 x 1 1/4 inch bolts and washers
KNP-200	3 3/8 (86)	(16) Plate nuts (32) SS 5/16-24 x 1 3/4 inch bolts and washers
KNP-250	4 1/2 (114)	(16) Plate nuts (32) SS 5/16-24 x 2 inch bolts and washers
KNP-300	4 5/8 (117)	(20) Plate nuts (40) SS 5/16-24 x 2 1/4 inch bolts and washers
KNP-400	6 (152)	(16) Plate nuts (32) SS 5/16-24 x 2 1/4 inch bolts and washers
KNP-600	8 (200)	(16) Plate nuts (32) SS 5/16-24 x 2 1/4 inch bolts and washers
KNP-800	10 (254)	(24) Plate nuts (48) SS 5/16-24 x 2 1/2 inch bolts and washers

### Plate Nut Assembly Kits with 12-pt. Bolts

MODEL NUMBER	FLANGE OD	DESCRIPTION
KNP-150-12	2 3/4 (70)	(12) Plate nuts (24) SS 12-pt. 1/4-28 x 1 1/4 inch bolts and washers
KNP-200-12	3 3/8 (86)	(16) Plate nuts (32) SS 12-pt. 5/16-24 x 1 3/4 inch bolts and washers
KNP-250-12	4 1/2 (114)	(16) Plate nuts (32) SS 12-pt. 5/16-24 x 2 inch bolts and washers
KNP-300-12	4 5/8 (117)	(20) Plate nuts (40) SS 12-pt. 5/16-24 x 2 1/4 inch bolts and washers
KNP-400-12	6 (152)	(16) Plate nuts (32) SS 12-pt. 5/16-24 x 2 1/4 inch bolts and washers
KNP-600-12	8 (200)	(20) Plate nuts (49) SS 12-pt. 5/16-24 x 2 1/4 inch bolts and washers
KNP-800-12	10 (254)	(24) Plate nuts (48) SS 12-pt. 5/16-24 x 2 1/2 inch bolts and washers

Plate Nut for 1 1/3 (33.78) and 2 3/4 (69.85) Flanges

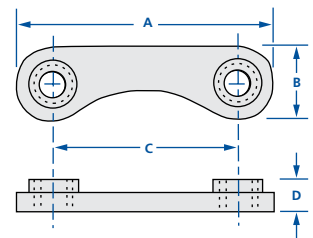
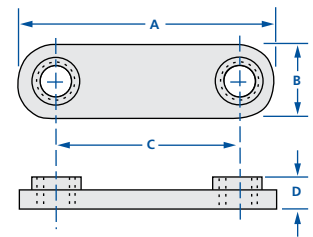
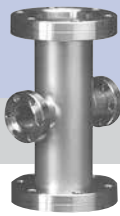


Plate Nut for Flanges larger than 2 3/4 (69.85)



All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.





### SPECIFICATIONS

**General:** Rotatable or nonrotatable with clearance bolt holes

#### Materials

**Tube/Flanges:** 304 stainless steel  
(316L available on request)

**Gaskets:** Viton, copper or silver plated

**Bolts:** 18-8 stainless steel or silver plated

**Torque:** Refer to specific flange specs

#### Vacuum range

**Metal seal:**  $\geq 1 \times 10^{-13}$  mbar - UHV

**Elastomer seal:**  $\geq 1 \times 10^{-8}$  mbar - High vacuum

#### Temperature range

**Metal seal:** -200°C to 450°C

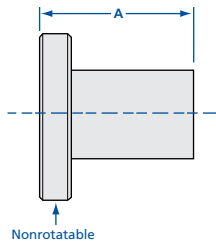
**Elastomer:** -20°C to 150°C



Nor-Cal manufactures a complete line of vacuum fittings with CF flanges. The tube portions are fabricated from 304 stainless steel. On request 316L stainless steel can be supplied. Nor-Cal makes its own elbows, and all tees and crosses are made with the pulled port technique. This allows smooth, crevice-free butt welds to provide the maximum in cleanliness for UHV applications. Bakeout range is up to 450°C.

Standard finish is bead blasted. Electropolish can also be provided as an option. Call for pricing.

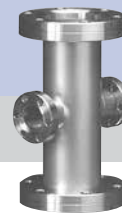
### CF Half Nipples



MODEL NUMBER	FLANGE OD	TUBE OD	A
<b>1N-075</b>	1.33 (33.78)	3/4 (19.05)	1.50 (38.10)
<b>1N-100</b>	2.12 (53.85)	1 (25.40)	2.05 (52.07)
<b>1N-150</b>	2.75 (69.85)	1 1/2 (38.10)	2.46 (62.48)
<b>1N-200</b>	3.38 (85.85)	2 (50.80)	3.22 (81.79)
<b>1N-250</b>	4.50 (114.30)	2 1/2 (63.50)	3.38 (85.85)
<b>1N-250V</b>	4.50 (114.30)	2 1/2 (63.50)	4.12 (104.65)
<b>1N-300</b>	4.62 (117.35)	3 (76.20)	3.53 (89.66)
<b>1N-400</b>	6.00 (152.40)	4 (101.60)	4.32 (109.73)
<b>1N-400V</b>	6.00 (152.40)	4 (101.60)	5.31 (134.87)
<b>1N-600</b>	8.00 (203.20)	6 (152.40)	5.50 (139.70)
<b>1N-600V</b>	8.00 (203.20)	6 (152.40)	6.56 (166.62)
<b>1N-800</b>	10.00 (254.00)	8 (203.20)	7.50 (190.50)
<b>1N-1000</b>	13.25 (336.55)	10 (254.00)	10.00 (254.00)
<b>1N-1200</b>	14.00 (355.60)	12 (304.80)	10.00 (254.00)



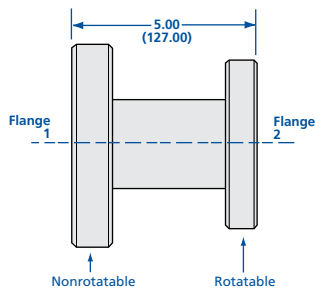
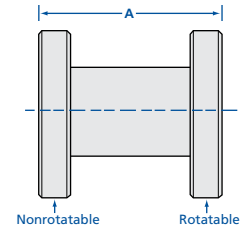
All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.



### CF Full Nipples



MODEL NUMBER	FLANGE OD	TUBE OD	A
2N-075	1.33 (33.78)	3/4 (19.05)	3.00 (76.20)
2N-100	2.12 (53.85)	1 (25.40)	4.10 (104.14)
2N-150	2.75 (69.85)	1 1/2 (38.10)	4.92 (124.97)
2N-200	3.38 (85.85)	2 (50.80)	6.44 (163.58)
2N-250	4.50 (114.30)	2 1/2 (63.50)	6.76 (171.70)
2N-250V	4.50 (114.30)	2 1/2 (63.50)	8.24 (209.3)
2N-300	4.62 (117.35)	3 (76.20)	7.06 (179.32)
2N-400	6.00 (152.40)	4 (101.60)	8.64 (219.46)
2N-400V	6.00 (152.40)	4 (101.60)	10.62 (269.75)
2N-600	8.00 (203.20)	6 (152.40)	11.00 (279.40)
2N-600V	8.00 (203.20)	6 (152.40)	13.12 (333.25)
2N-800	10.00 (254.00)	8 (203.20)	15.00 (381.00)
2N-1000	13.25 (336.55)	10 (254.00)	20.00 (508.00)
2N-1200	14.00 (355.60)	12 (304.80)	20.00 (508.00)



### CF Reducer Nipples

MODEL NUMBER	FLANGE 1 OD	FLANGE 2 OD	TUBE OD
2NR-600-275	6.00 (152.40)	2 3/4 (69.85)	1.50 (38.10)
2NR-800-275	8.00 (203.20)	2 3/4 (69.85)	1.50 (38.10)
2NR-800-450	8.00 (203.20)	4 1/2 (114.30)	2.50 (63.50)
2NR-800-600	8.00 (203.20)	6 (152.40)	4.00 (101.60)
2NR-1000-275	10.00 (254.00)	2 3/4 (69.85)	1.50 (38.10)
2NR-1000-450	10.00 (254.00)	4 1/2 (114.30)	2.50 (63.50)
2NR-1000-600	10.00 (254.00)	6 (152.40)	4.00 (101.60)
2NR-1000-800	10.00 (254.00)	8 (203.20)	6.00 (152.40)
2NR-1325-1000	13.25 (336.55)	10 (254.00)	8.00 (203.20)
2NR-1400-1200	14.00 (355.60)	12 (304.80)	10.00 (254.00)

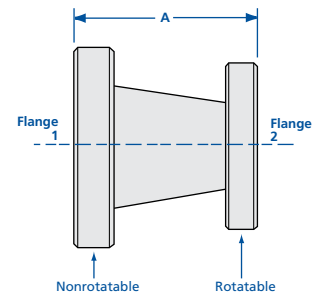


Note: Reducer nipples with other CF flanges and different lengths are available upon request.

### CF Conical Reducer Nipples



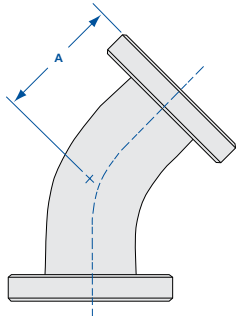
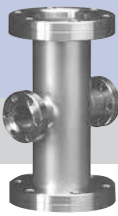
MODEL NUMBER	FLANGE 1 OD	FLANGE 1 TUBE OD	FLANGE 2 OD	FLANGE 2 TUBE OD	A
2NRC-212-133	2.12 (53.85)	1 (25.40)	1.33 (33.78)	3/4 (19.05)	2.04 (51.82)
2NRC-275-133	2.75 (69.85)	1 1/2 (38.10)	1.33 (33.78)	3/4 (19.05)	3.08 (78.23)
2NRC-275-212	2.75 (69.85)	1 1/2 (38.10)	2.12 (53.85)	1 (25.40)	2.75 (69.85)
2NRC-338-212	3.38 (85.85)	2 (50.80)	2.12 (53.85)	1 (25.40)	2.77 (70.36)
2NRC-338-275	3.38 (85.85)	2 (50.80)	2.75 (69.85)	1 1/2 (38.10)	2.81 (71.37)
2NRC-450-275	4.50 (114.3)	2 1/2 (63.50)	2.75 (69.85)	1 1/2 (38.10)	2.96 (75.18)
2NRC-450-338	4.50 (114.3)	2 1/2 (63.50)	3.38 (85.85)	2 (50.80)	2.98 (75.69)
2NRC-462-275	4.62 (117.35)	3 (76.20)	2.75 (69.85)	1 1/2 (38.10)	4.12 (104.65)
2NRC-462-338	4.62 (117.35)	3 (76.20)	3.38 (85.85)	2 (50.80)	4.13 (104.90)
2NRC-462-450	4.62 (117.35)	3 (76.20)	4.50 (114.30)	2 1/2 (63.50)	4.28 (108.71)
2NRC-600-338	6.00 (152.40)	4 (101.60)	3.38 (85.85)	2 (50.80)	4.29 (108.97)
2NRC-600-450	6.00 (152.40)	4 (101.60)	4.50 (114.30)	2 1/2 (63.50)	4.44 (112.78)
2NRC-600-462	6.00 (152.40)	4 (101.60)	4.62 (117.35)	3 (76.20)	4.34 (110.24)



All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.

# Flanges & Fittings

## CF Fittings



Both Flanges Rotatable

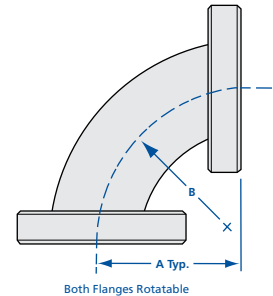
### CF 45° Radius Elbow with Tangents

MODEL NUMBER	FLANGE OD	TUBE OD	A
<b>2KL-075</b>	1.33 (33.78)	3/4 (19.05)	0.94 (23.88)
<b>2KL-100</b>	2.12 (53.85)	1 (25.40)	1.14 (28.96)
<b>2KL-150</b>	2.75 (69.85)	1 1/2 (38.10)	1.74 (44.20)
<b>2KL-200</b>	3.38 (85.85)	2 (50.80)	2.07 (52.58)
<b>2KL-250</b>	4.50 (114.30)	2 1/2 (63.50)	3.37 (85.60)
<b>2KL-300</b>	4.62 (117.35)	3 (76.20)	3.96 (100.58)
<b>2KL-400</b>	6.00 (152.40)	4 (101.60)	5.22 (132.59)



### CF 90° Radius Elbows

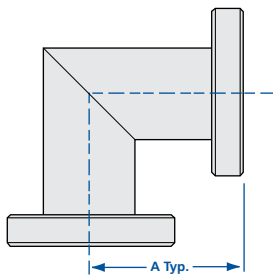
MODEL NUMBER	FLANGE OD	TUBE OD	A	B
<b>2E-075</b>	1.33 (33.78)	3/4 (19.05)	1.50 (38.10)	1.00 (25.40)
<b>2E-100</b>	2.12 (53.85)	1 (25.40)	1.67 (42.42)	1.50 (38.10)
<b>2E-150</b>	2.75 (69.85)	1 1/2 (38.10)	2.46 (62.48)	2.25 (57.15)
<b>2E-200</b>	3.38 (85.85)	2 (50.80)	3.22 (81.79)	3.00 (76.20)
<b>2E-250</b>	4.50 (114.30)	2 1/2 (63.50)	4.12 (104.65)	3.75 (95.25)
<b>2E-300</b>	4.62 (117.35)	3 (76.20)	4.78 (121.41)	4.50 (114.30)
<b>2E-400</b>	6.00 (152.40)	4 (101.60)	6.44 (163.58)	6.00 (152.40)
<b>2E-600</b>	8.00 (203.20)	6 (152.40)	9.50 (241.30)	9.00 (228.60)
<b>2E-800</b>	10.00 (254.00)	8 (203.20)	12.50 (317.50)	12.00 (304.80)
<b>2E-1000</b>	13.25 (336.55)	10 (254.00)	15.50 (393.70)	15.00 (381.00)



Both Flanges Rotatable

### CF 90° Mitered Elbows

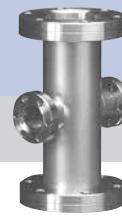
MODEL NUMBER	FLANGE OD	TUBE OD	A
<b>2E-075M</b>	1.33 (33.78)	3/4 (19.05)	1.50 (38.10)
<b>2E-100M</b>	2.12 (53.85)	1 (25.40)	2.05 (52.07)
<b>2E-150M</b>	2.75 (69.85)	1 1/2 (38.10)	2.46 (62.48)
<b>2E-200M</b>	3.38 (85.85)	2 (50.80)	3.22 (81.79)
<b>2E-250M</b>	4.50 (114.30)	2 1/2 (63.50)	3.38 (85.85)
<b>2E-250MV</b>	4.50 (114.30)	2 1/2 (63.50)	4.12 (104.65)
<b>2E-300M</b>	4.62 (117.35)	3 (76.20)	3.53 (89.66)
<b>2E-400M</b>	6.00 (152.40)	4 (101.60)	4.32 (109.73)
<b>2E-400MV</b>	6.00 (152.40)	4 (101.60)	5.31 (134.87)
<b>2E-500M</b>	6.75 (171.45)	5 (127.00)	4.71 (119.63)
<b>2E-600M</b>	8.00 (203.20)	6 (152.40)	5.50 (139.70)
<b>2E-600MV</b>	8.00 (203.20)	6 (152.40)	6.56 (166.62)
<b>2E-800M</b>	10.00 (254.00)	8 (203.20)	7.50 (190.50)
<b>2E-1000M</b>	13.25 (336.55)	10 (254.00)	10.00 (254.00)



Both Flanges Rotatable



All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.



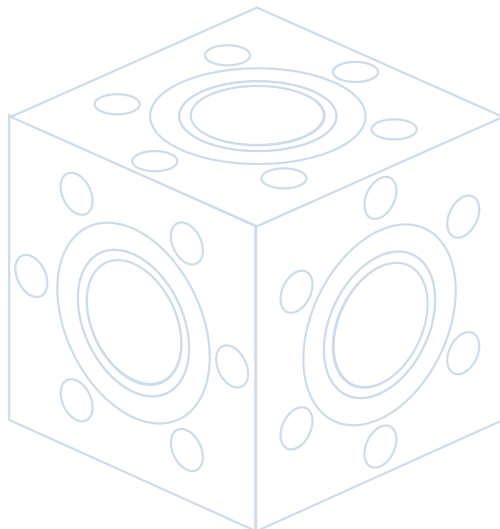
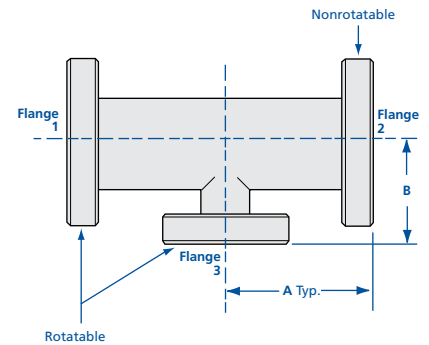
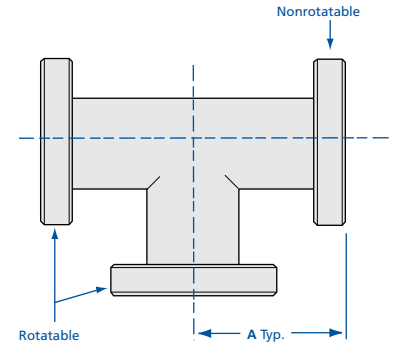
### CF Tees

MODEL NUMBER	FLANGE OD	TUBE OD	A
3T-075	1.33 (33.78)	3/4 (19.05)	1.50 (38.10)
3T-100	2.12 (53.85)	1 (25.40)	2.05 (52.07)
3T-150	2.75 (69.85)	1 1/2 (38.10)	2.46 (62.48)
3T-200	3.38 (85.85)	2 (50.80)	3.22 (81.79)
3T-250	4.50 (114.30)	2 1/2 (63.50)	3.38 (85.85)
3T-250V	4.50 (114.30)	2 1/2 (63.50)	4.12 (104.65)
3T-300	4.62 (117.35)	3 (76.20)	3.53 (89.66)
3T-400	6.00 (152.40)	4 (101.60)	4.32 (109.73)
3T-400V	6.00 (152.40)	4 (101.60)	5.31 (134.87)
3T-500	6.75 (171.45)	5 (127.00)	4.71 (119.63)
3T-600	8.00 (203.20)	6 (152.40)	5.50 (139.70)
3T-600V	8.00 (203.20)	6 (152.40)	6.56 (166.62)
3T-800	10.00 (254.00)	8 (203.20)	7.50 (190.50)
3T-1000	13.25 (336.55)	10 (254.00)	10.00 (254.00)

Note: Reducer tees in other tube sizes are available upon request.

### CF Reducer Tees

MODEL NUMBER	FLANGE 1 & 2 FLANGE OD	FLANGE 1 & 2 TUBE OD	FLANGE 3 FLANGE OD	FLANGE 3 TUBE OD	A	B
3TR-150-075	2.75 (69.85)	1 1/2 (38.10)	1.33 (33.78)	3/4 (19.05)	2.46 (62.48)	1.87 (47.50)
3TR-150-100	2.75 (69.85)	1 1/2 (38.10)	2.12 (53.85)	1 (25.40)	2.46 (62.48)	2.29 (58.17)
3TR-200-075	3.38 (85.85)	2 (50.80)	1.33 (33.78)	3/4 (19.05)	3.22 (81.79)	2.13 (54.10)
3TR-200-150	3.38 (85.85)	2 (50.80)	2.75 (69.85)	1 1/2 (38.10)	3.22 (81.79)	2.71 (68.83)
3TR-250-150	4.50 (114.30)	2 1/2 (63.50)	2.75 (69.85)	1 1/2 (38.10)	3.38 (85.85)	2.96 (75.18)
3TR-250-200	4.50 (114.30)	2 1/2 (63.50)	3.38 (85.85)	2 (50.80)	3.38 (85.85)	3.48 (88.39)
3TR-300-200	4.62 (117.35)	3 (76.20)	3.38 (85.85)	2 (50.80)	3.53 (89.66)	3.73 (94.74)
3TR-300-250	4.62 (117.35)	3 (76.20)	4.50 (114.30)	2 1/2 (63.50)	3.53 (89.66)	3.63 (92.20)
3TR-400-150	6.00 (152.40)	4 (101.60)	2.75 (69.85)	1 1/2 (38.10)	4.32 (109.73)	3.71 (94.23)
3TR-400-200	6.00 (152.40)	4 (101.60)	3.38 (85.85)	2 (50.80)	4.32 (109.73)	4.23 (107.44)
3TR-400-250	6.00 (152.40)	4 (101.60)	4.50 (114.30)	2 1/2 (63.50)	4.32 (109.73)	4.13 (104.90)
3TR-400-300	6.00 (152.40)	4 (101.60)	4.62 (117.35)	3 (76.20)	4.32 (109.73)	4.03 (102.36)
3TR-500-400	6.75 (171.45)	5 (127.00)	6.00 (152.40)	4 (101.60)	4.71 (119.63)	4.82 (122.43)
3TR-600-150	8.00 (203.20)	6 (152.40)	2.75 (69.85)	1 1/2 (38.10)	5.50 (139.70)	4.71 (119.63)
3TR-600-200	8.00 (203.20)	6 (152.40)	3.38 (85.85)	2 (50.80)	5.50 (139.70)	5.23 (132.84)
3TR-600-250	8.00 (203.20)	6 (152.40)	4.50 (114.30)	2 1/2 (63.50)	5.50 (139.70)	5.13 (130.30)
3TR-600-400	8.00 (203.20)	6 (152.40)	6.00 (152.40)	4 (101.60)	5.50 (139.70)	5.32 (135.13)
3TR-800-600	10.00 (254.00)	8 (203.20)	8.00 (203.20)	6 (152.40)	7.50 (190.50)	6.50 (165.10)

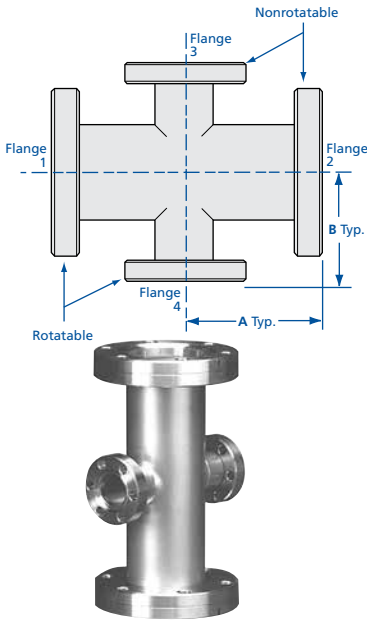
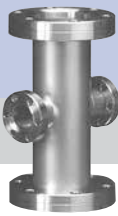


All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.



# Flanges & Fittings

## CF Fittings



### CF Reducer Crosses

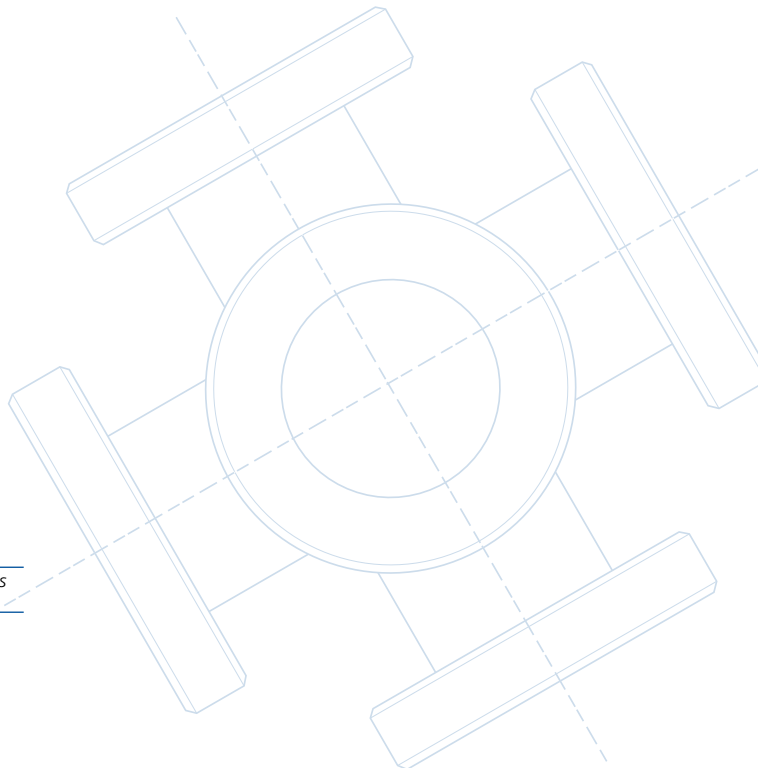
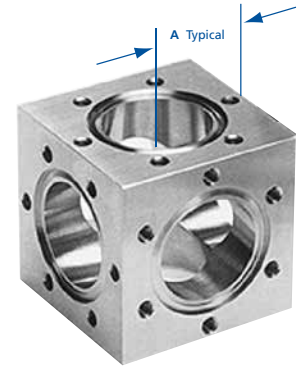
MODEL NUMBER	FLANGE 1 & 2 FLANGE OD	FLANGE 1 & 2 TUBE OD	FLANGE 3 & 4 FLANGE OD	FLANGE 3 & 4 TUBE OD	A	B
4CR-150-075	2.75 (69.85)	1½ (38.10)	1.33 (33.78)	¾ (19.05)	2.46 (62.48)	1.87 (47.50)
4CR-150-100	2.75 (69.85)	1½ (38.10)	2.12 (53.85)	1 (25.40)	2.46 (62.48)	2.29 (58.17)
4CR-200-075	3.38 (85.85)	2 (50.80)	1.33 (33.78)	¾ (19.05)	3.22 (81.79)	2.13 (54.10)
4CR-200-150	3.38 (85.85)	2 (50.80)	2.75 (69.85)	1½ (38.10)	3.22 (81.79)	2.71 (68.83)
4CR-250-150	4.50 (114.30)	2½ (63.50)	2.75 (69.85)	1½ (38.10)	3.38 (85.85)	2.96 (75.18)
4CR-250-200	4.50 (114.30)	2½ (63.50)	3.38 (85.85)	2 (50.80)	3.38 (85.85)	3.48 (88.39)
4CR-300-200	4.62 (117.35)	3 (76.20)	3.38 (85.85)	2 (50.80)	3.53 (89.66)	3.73 (94.74)
4CR-300-250	4.62 (117.35)	3 (76.20)	4.50 (114.30)	2½ (63.50)	3.53 (89.66)	3.63 (92.2)
4CR-400-150	6.00 (152.40)	4 (101.60)	2.75 (69.85)	1½ (38.10)	4.32 (109.73)	3.71 (94.23)
4CR-400-200	6.00 (152.40)	4 (101.60)	3.38 (85.85)	2 (50.80)	4.32 (109.73)	4.23 (107.44)
4CR-400-250	6.00 (152.40)	4 (101.60)	4.50 (114.30)	2½ (63.50)	4.32 (109.73)	4.13 (104.90)
4CR-400-300	6.00 (152.40)	4 (101.60)	4.62 (117.35)	3 (76.20)	4.32 (109.73)	4.03 (102.36)
4CR-500-400	6.75 (171.45)	5 (127.00)	6.00 (152.40)	4 (101.60)	4.71 (119.63)	4.82 (122.43)
4CR-600-150	8.00 (203.20)	6 (152.40)	2.75 (69.85)	1½ (38.10)	5.50 (139.70)	4.71 (119.63)
4CR-600-200	8.00 (203.20)	6 (152.40)	3.38 (85.85)	2 (50.80)	5.50 (139.70)	5.23 (132.84)
4CR-600-250	8.00 (203.20)	6 (152.40)	4.50 (114.30)	2½ (63.50)	5.50 (139.70)	5.13 (130.30)
4CR-600-400	8.00 (203.20)	6 (152.40)	6.00 (152.40)	4 (101.60)	5.50 (139.70)	5.32 (135.13)
4CR-800-600	10.00 (254.00)	6 (152.40)	8.00 (203.20)	6 (152.40)	7.50 (190.50)	6.50 (165.10)

Note: Other reducer combinations can be supplied upon request.

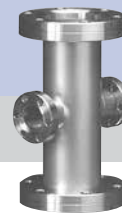
### CF 6-Way Cube Crosses

MODEL NUMBER	NOMINAL FLANGE SIZE	A
6C-075-CU	1.33 (33.78)	0.67 (17.02)
6C-150-CU	2.75 (69.85)	1.37 (34.80)
6C-250-CU	4.50 (114.30)	2.24 (56.90)
6C-400-CU	6 (152.40)	2.98 (75.69)
6C-600-CU	8.00 (203.20)	3.98 (101.09)

Note: Cube crosses are available in other sizes upon request



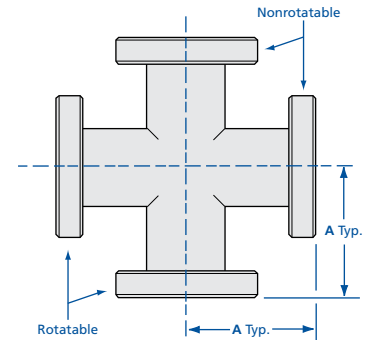
All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.



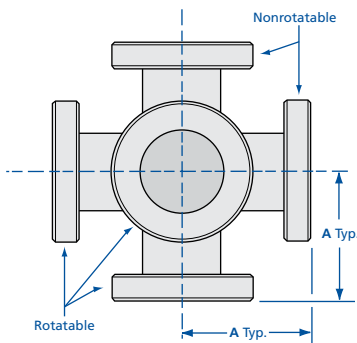
### CF 4-Way Crosses



MODEL NUMBER	FLANGE OD	TUBE OD	A
4C-075	1.33 (33.78)	3/4 (19.05)	1.50 (38.10)
4C-100	2.12 (53.85)	1 (25.40)	2.05 (52.07)
4C-150	2.75 (69.85)	1 1/2 (38.10)	2.46 (62.48)
4C-200	3.38 (85.85)	2 (50.80)	3.22 (81.79)
4C-250	4.50 (114.30)	2 1/2 (63.50)	3.38 (85.85)
4C-250V	4.50 (114.30)	2 1/2 (63.50)	4.12 (104.65)
4C-300	4.62 (117.35)	3 (76.20)	3.53 (89.66)
4C-400	6.00 (152.40)	4 (101.60)	4.32 (109.73)
4C-400V	6.00 (152.40)	4 (101.60)	5.31 (134.87)
4C-500	6.75 (171.45)	5 (127.00)	4.71 (119.63)
4C-600	8.00 (203.20)	6 (152.40)	5.50 (139.70)
4C-600V	8.00 (203.20)	6 (152.40)	6.56 (166.62)
4C-800	10.00 (254.00)	8 (203.20)	7.50 (190.50)
4C-1000	13.25 (336.55)	10 (254.00)	10.00 (254.00)



### CF 5-Way Crosses



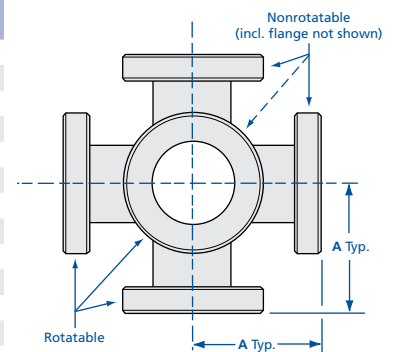
MODEL NUMBER	FLANGE OD	TUBE OD	A
5C-075	1.33 (33.78)	3/4 (19.05)	1.50 (38.10)
5C-100	2.12 (53.85)	1 (25.40)	2.05 (52.07)
5C-150	2.75 (69.85)	1 1/2 (38.10)	2.46 (62.48)
5C-200	3.38 (85.85)	2 (50.80)	3.22 (81.79)
5C-250	4.50 (114.30)	2 1/2 (63.50)	3.38 (85.85)
5C-250V	4.50 (114.30)	2 1/2 (63.50)	4.12 (104.65)
5C-300	4.62 (117.35)	3 (76.20)	3.53 (89.66)
5C-400	6.00 (152.40)	4 (101.60)	4.32 (109.73)
5C-400V	6.00 (152.40)	4 (101.60)	5.31 (134.87)
5C-500	6.75 (171.45)	5 (127.00)	4.71 (119.63)
5C-600	8.00 (203.20)	6 (152.40)	5.50 (139.70)
5C-600V	8.00 (203.20)	6 (152.40)	6.56 (166.62)
5C-800	10.00 (254.00)	8 (203.20)	7.50 (190.50)
5C-1000	13.25 (336.55)	10 (254.00)	10.00 (254.00)



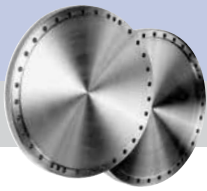
### CF 6-Way Crosses



MODEL NUMBER	FLANGE OD	TUBE OD	A
6C-075	1.33 (33.78)	3/4 (19.05)	1.50 (38.10)
6C-100	2.12 (53.85)	1 (25.40)	2.05 (52.07)
6C-150	2.75 (69.85)	1 1/2 (38.10)	2.46 (62.48)
6C-200	3.38 (85.85)	2 (50.80)	3.22 (81.79)
6C-250	4.50 (114.30)	2 1/2 (63.50)	3.38 (85.85)
6C-250V	4.50 (114.30)	2 1/2 (63.50)	4.12 (104.65)
6C-300	4.62 (117.35)	3 (76.20)	3.53 (89.66)
6C-400	6.00 (152.40)	4 (101.60)	4.32 (109.73)
6C-400V	6.00 (152.40)	4 (101.60)	5.31 (134.87)
6C-500	6.75 (171.45)	5 (127.00)	4.71 (119.63)
6C-600	8.00 (203.20)	6 (152.40)	5.50 (139.70)
6C-600V	8.00 (203.20)	6 (152.40)	6.56 (166.62)
6C-800	10.00 (254.00)	8 (203.20)	7.50 (190.50)
6C-1000	13.25 (336.55)	10 (254.00)	10.00 (254.00)



All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.



# Flanges & Fittings

## Wire Seal Flanges

### SPECIFICATIONS

**General:** Nonrotatable flanges with clearance bolt holes

**Nominal OD sizes:** 12<sup>3</sup>/<sub>8</sub> to 27<sup>1</sup>/<sub>8</sub> inches (314 to 689mm)

**Tube OD sizes:** 10 to 24 inches (254 to 609.6mm)

#### Materials

Flange: 304 stainless steel  
(316L available on request)

Gaskets: Copper

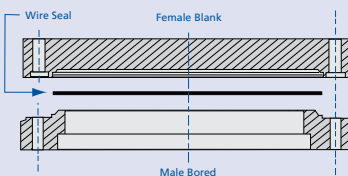
Bolts: 18-8 stainless steel

**Vacuum range:**  $\geq 1 \times 10^{-13}$  mbar - UHV

**Temperature range:** -200° to 450°C

### Wire Seal Flange Assembly Instructions

- Apply a small amount of high temperature anti-seize compound to the bolt threads.
- Check that both flange surfaces are clean and sealing edges are free from nicks and scratches.
- Using clean, lint free gloves, unpack gasket.
- Place seal over the sealing area on the male flange.
- Align the mating flange hole pattern and leak test grooves.
- Install the proper bolts and tighten hand tight. Check to see that the flange faces are parallel.
- Tighten the bolts 1/4 to 1/2 turns using a circular clockwise pattern until the flange faces are metal to metal.
- Torque the fasteners until leak tight using the same pattern. Never exceed maximum torque.

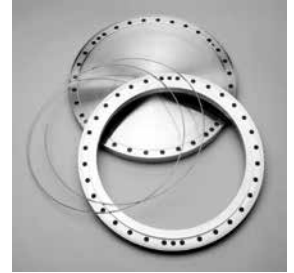


### Torque Specifications

NOMINAL OD	BOLT SIZE	MAX. TORQUE Nm
12 (305)	3/8 - 24	29.4
14 (356)	3/8 - 24	29.4
17 (432)	1/2 - 20	61.1
19 (483)	1/2 - 20	61.1
22 (559)	5/8 - 18	140.6
27 (686)	5/8 - 18	140.6

All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.

Nor-Cal's wire seal flanges are designed for use on bell jars, custom vacuum chambers and related systems. Standard sizes range from 12 to 27 inch (305 to 686mm) nominal OD for tube sizes from 10 to 24 inch (254 to 609.6mm) OD. A male and female flange compress a 0.080 inch (2.032mm) diameter OFHC copper wire to effect a seal. Gasket flow is confined by the geometry of the flange surfaces to the area of the seal. Minor nicks and scratches within this contact area are filled with crushed copper wire providing a seal that is leak tight at 10<sup>-13</sup> mbar after repeated bake out to 450°C. Solid blanks are standard. Dished head blanks are offered as a lower cost alternative.

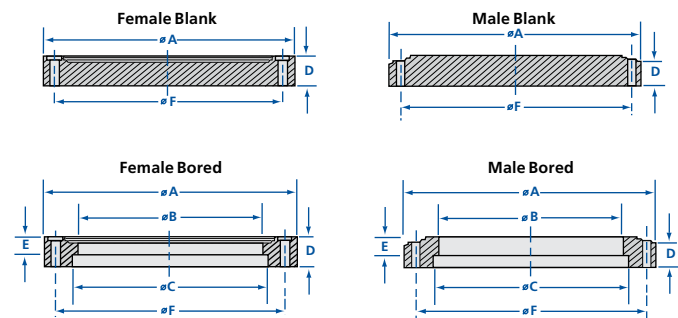


### Wire Seal Flanges

MODEL NUMBER	OD A	B	C	D	E	F	BOLT HOLES
WS-12-000M	12.375 (314.33)	-	-	1.13 (28.70)	-	11.343 (288.11)	24
WS-12-1000M	12.375 (314.33)	9.750 (247.65)	10.020 (254.51)	1.13 (28.70)	0.630 (16.00)	11.343 (288.11)	24
WS-12-000F	12.375 (314.33)	-	-	1.13 (28.70)	-	11.343 (288.11)	24
WS-12-1000F	12.375 (314.33)	9.750 (247.65)	10.020 (254.51)	1.13 (28.70)	0.630 (16.00)	11.343 (288.11)	24
WS-14-000M	14.625 (371.48)	-	-	1.13 (28.70)	-	13.593 (345.26)	32
WS-14-1200M	14.625 (371.48)	11.750 (298.45)	12.020 (305.31)	1.13 (28.70)	0.630 (16.00)	13.593 (345.26)	32
WS-14-000F	14.625 (371.48)	-	-	1.13 (28.70)	-	13.593 (345.26)	32
WS-14-1200F	14.625 (371.48)	11.750 (298.45)	12.020 (305.31)	1.13 (28.70)	0.630 (16.00)	13.593 (345.26)	32
WS-17-000M	17.250 (438.15)	-	-	1.13 (28.70)	-	15.718 (399.24)	36
WS-17-1400M	17.250 (438.15)	13.750 (349.25)	14.020 (356.11)	1.13 (28.70)	0.630 (16.00)	15.718 (399.24)	36
WS-17-000F	17.250 (438.15)	-	-	1.13 (28.70)	-	15.718 (399.24)	36
WS-17-1400F	17.250 (438.15)	13.750 (349.25)	14.020 (356.11)	1.13 (28.70)	0.630 (16.00)	15.718 (399.24)	36
WS-19-000M	19.562 (496.87)	-	-	1.31 (33.27)	-	17.875 (454.03)	36
WS-19-1600M	19.562 (496.87)	15.750 (400.05)	16.020 (406.91)	1.31 (33.27)	0.630 (16.00)	17.875 (454.03)	36
WS-19-000F	19.562 (496.87)	-	-	1.31 (33.27)	-	17.875 (454.03)	36
WS-19-1600F	19.562 (496.87)	15.750 (400.05)	16.020 (406.91)	1.31 (33.27)	0.630 (16.00)	17.875 (454.03)	36
WS-22-000M	22.125 (561.98)	-	-	1.50 (38.10)	-	20.187 (512.75)	36
WS-22-1800M	22.125 (561.98)	17.750 (450.85)	18.020 (457.71)	1.50 (38.10)	1.000 (25.40)	20.187 (512.75)	36
WS-22-000F	22.125 (561.98)	-	-	1.50 (38.10)	-	20.187 (512.75)	36
WS-22-1800F	22.125 (561.98)	17.750 (450.85)	18.020 (457.71)	1.50 (38.10)	1.000 (25.40)	20.187 (512.75)	36
WS-27-000M	27.125 (688.98)	-	-	1.75 (44.45)	-	25.843 (656.41)	40
WS-27-2400M	27.125 (688.98)	23.625 (600.08)	24.020 (610.11)	1.75 (44.45)	1.125 (28.58)	25.843 (656.41)	40
WS-27-000F	27.125 (688.98)	-	-	1.75 (44.45)	-	25.843 (656.41)	40
WS-27-2400F	27.125 (688.98)	23.625 (600.08)	24.020 (610.11)	1.75 (44.45)	1.125 (28.58)	25.843 (656.41)	40

### Model Number Definitions

M = Male flange F = Female flange



### Wire Seal Flange Gaskets and Bolt Sets

MODEL NUMBER	FLANGE OD	DESCRIPTION	QUANTITY
WG-12	12.375 (314.33)	Copper gasket	1
WB-12	12.375 (314.33)	SS 3/8-24 x 2 1/2 bolts and nuts	24
WG-14	14.625 (371.48)	Copper gasket	1
WB-14	14.625 (371.48)	SS 3/8-24 x 2 1/2 bolts and nuts	32
WG-17	17.250 (438.15)	Copper gasket	1
WB-17	17.250 (438.15)	SS 1/2-20 x 2 3/4 bolts and nuts	36
WG-19	19.562 (496.87)	Copper gasket	1
WB-19	19.562 (496.87)	SS 1/2-20 x 3 bolts and nuts	36
WG-22	22.125 (561.98)	Copper gasket	1
WB-22	22.125 (561.98)	SS 5/8-18 x 3 1/2 bolts and nuts	36
WG-27	27.125 (688.98)	Copper gasket	1
WB-27	27.125 (688.98)	SS 5/8-18 x 4 bolts and nuts	40



### Adapter Fittings

Nor-Cal Products provides a broad range of adapter fittings in order to connect two dissimilar types of components. They are made from 304 or 316L stainless steel and are TIG welded, cleaned and leak checked for vacuum service. Tube finishes are normally bead blasted. However, tumbled or electropolished finish can be provided upon request. Flanges and nipples used to adapt different sizes of the same flange type are called reducers. They are listed in the flanges and fittings section for the particular flange type. For example, CF zero length reducer flanges are listed in the CF section of Flanges and Fittings.

#### Flange-to-Flange Adapters

Flange-to-flange adapter fittings are used as a transition between two dissimilar flange types. We offer adapter fittings with flange combinations for CF (Conflat), NW (ISO-KF), ISO and ASA (ANSI) components as standards. We frequently provide other flange combinations as specials. These include wire seal, JIS, MESG, and other flanges. Flange-to-flange adapter nipples usually have a short length of straight tubing between the two flanges. Where possible, we offer conical adapters as an option to reduce conductance loss at the opening of the larger flange. Nor-Cal also offers adapter tees and crosses with ISO and NW flanges. ASA to CF adapter flanges are also found in this section.

#### Flange-to-Fitting Adapters

Flange-to-fitting adapters are commonly used on chamber ports to connect flanges to special fittings. Nor-Cal offers these with CF, NW, ISO and ASA flanges for Swagelok, male and female VCR, quick disconnect, male and female NPT, ball socket and Welch pump fittings as standards. Other combinations can be supplied quickly as specials.

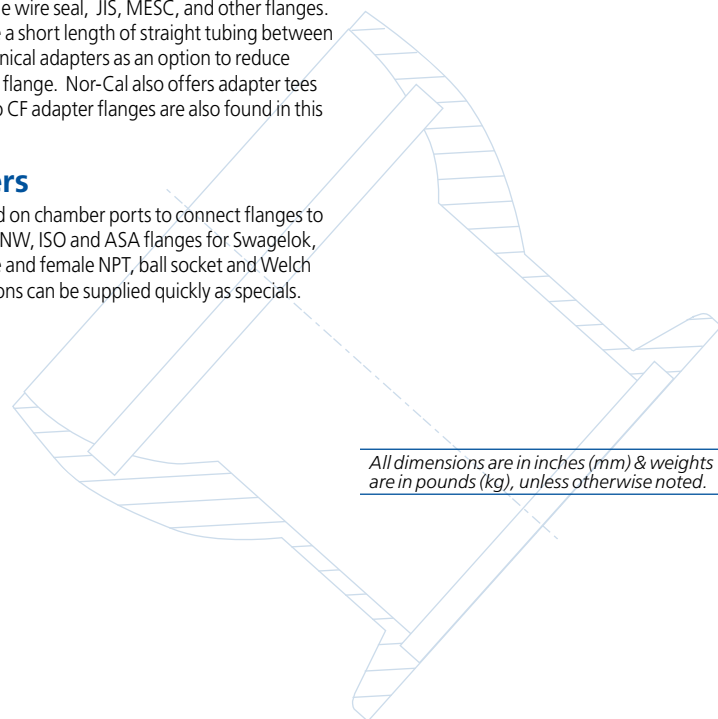


#### SPECIFICATIONS

**Materials:** 304 or 316L stainless steel

**Vacuum range**  
 Metal seal:  $\geq 1 \times 10^{-13}$  mbar - UHV  
 Elastomer seal:  $\geq 1 \times 10^{-8}$  mbar - High vacuum

**Temperature range**  
 Metal seal: -200°C to 450°C  
 Elastomer seal: -20°C to 150°C



All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.



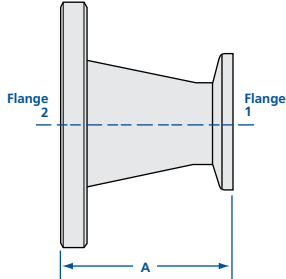
# Adapter Fittings

## Flange-to-Flange



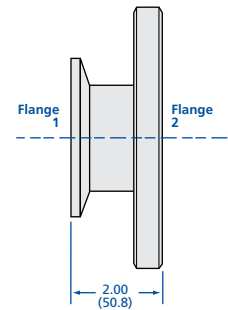
### NW to CF Conical Adapter Nipples

MODEL NUMBER	TYPE	FLANGE 1 NOM. TUBE OD	TYPE	FLANGE 2 NOM. TUBE OD	A
ANC-NW-16-212	NW-16	3/4 (19.05)	2.12 CF	1 (25.40)	1.69 (42.93)
ANC-NW-16-275	NW-16	3/4 (19.05)	2.75 CF	1 1/2 (38.10)	2.73 (69.34)
ANC-NW-25-133	NW-25	1 (25.40)	1.33 CF	3/4 (19.05)	2.03 (51.56)
ANC-NW-25-275	NW-25	1 (25.40)	2.75 CF	1 1/2 (38.10)	2.73 (69.34)
ANC-NW-25-338	NW-25	1 (25.40)	3.38 CF	2 (50.80)	2.75 (69.85)
ANC-NW-40-133	NW-40	1 1/2 (38.10)	1.33 CF	3/4 (19.05)	3.03 (76.96)
ANC-NW-40-212	NW-40	1 1/2 (38.10)	2.12 CF	1 (25.40)	2.69 (68.33)
ANC-NW-40-338	NW-40	1 1/2 (38.10)	3.38 CF	2 (50.80)	2.75 (69.85)
ANC-NW-40-450	NW-40	1 1/2 (38.10)	4.50 CF	2 1/2 (63.50)	2.90 (73.66)
ANC-NW-40-462	NW-40	1 1/2 (38.10)	4.62 CF	3 (76.20)	4.06 (103.12)
ANC-NW-50-212	NW-50	2 (50.80)	2.12 CF	1 (25.40)	2.69 (68.33)
ANC-NW-50-275	NW-50	2 (50.80)	2.75 CF	1 1/2 (38.10)	2.73 (69.34)
ANC-NW-50-450	NW-50	2 (50.80)	4.50 CF	2 1/2 (63.50)	2.90 (73.66)
ANC-NW-50-462	NW-50	2 (50.80)	4.62 CF	3 (76.50)	4.06 (103.12)
ANC-NW-50-600	NW-50	2 (50.80)	6.00 CF	4 (101.60)	4.21 (106.93)



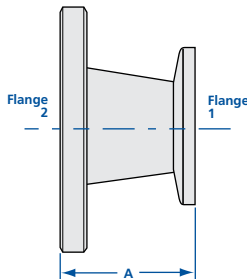
### NW to CF Adapter Nipples

MODEL NUMBER	FLANGE 1 TYPE	FLANGE 2 TYPE	NOM. TUBE OD
AN-NW-10-133	NW-10	1.33 CF	1/2 (12.70)
AN-NW-16-133	NW-16	1.33 CF	3/4 (19.05)
AN-NW-25-212	NW-25	2.12 CF	1 (25.40)
AN-NW-40-275	NW-40	2.75 CF	1 1/2 (38.10)
AN-NW-50-133	NW-50	1.33 CF	3/4 (19.05)
AN-NW-50-338	NW-50	3.38 CF	2 (50.80)



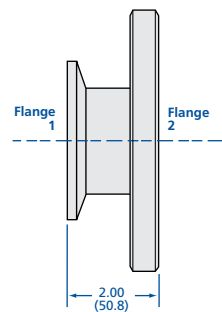
### NW to ASA Conical Adapter Nipples

MODEL NUMBER	TYPE	FLANGE 1 NOM. TUBE OD	FLANGE 2 TYPE NOM. TUBE OD	A
ANC-NW-25-ASA-5	NW-25	1 (25.40)	ASA-5 2 (50.80)	2.78 (70.61)
ANC-NW-40-ASA-5	NW-40	1 1/2 (38.10)	ASA-5 2 1/2 (63.50)	2.78 (70.61)
ANC-NW-40-ASA-6	NW-40	1 1/2 (38.10)	ASA-6 3 (76.20)	4.03 (102.36)
ANC-NW-50-ASA-5	NW-50	2 (50.80)	ASA-5 2 1/2 (63.50)	2.78 (70.61)
ANC-NW-50-ASA-6	NW-50	2 (50.80)	ASA-6 3 (76.20)	4.03 (102.36)
ANC-NW-50-ASA-7.5	NW-50	2 (50.80)	ASA-7.5 4 (101.60)	4.03 (102.36)



### NW to ASA Adapter Nipples

MODEL NUMBER	FLANGE 1 TYPE	FLANGE 2 TYPE	NOM. TUBE OD
AN-NW-16-ASA-5	NW-16	ASA-5	3/4 (19.05)
AN-NW-16-ASA-6	NW-16	ASA-6	3/4 (19.05)
AN-NW-16-ASA-7.5	NW-16	ASA-7.5	3/4 (19.05)
AN-NW-16-ASA-9	NW-16	ASA-9	3/4 (19.05)
AN-NW-16-ASA-11	NW-16	ASA-11	3/4 (19.05)
AN-NW-25-ASA-6	NW-25	ASA-6	1 (25.40)
AN-NW-25-ASA-7.5	NW-25	ASA-7.5	1 (25.40)
AN-NW-25-ASA-9	NW-25	ASA-9	1 (25.40)
AN-NW-25-ASA-11	NW-25	ASA-11	1 (25.40)
AN-NW-40-ASA-7.5	NW-40	ASA-7.5	1 1/2 (38.10)
AN-NW-40-ASA-9	NW-40	ASA-9	1 1/2 (38.10)
AN-NW-40-ASA-11	NW-40	ASA-11	1 1/2 (38.10)
AN-NW-50-ASA-9	NW-50	ASA-9	2 (50.80)
AN-NW-50-ASA-11	NW-50	ASA-11	2 (50.80)



#### SPECIFICATIONS

**Materials:** 304 stainless steel  
(316L available upon request)

**Vacuum range:**  $\geq 1 \times 10^{-8}$  mbar - High vacuum

**Temperature range:** -20°C to 150°C

**Note:** Add suffix "-G" to model number if O-Ring Groove is required on ASA flange.  
Call for ASA groove prices.

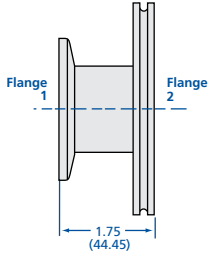
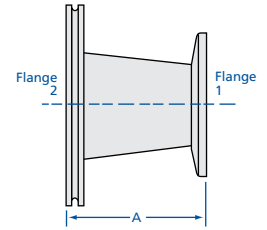
# Adapter Fittings

## Flange-to-Flange



### NW to ISO Conical Adapter Nipples

MODEL NUMBER	FLANGE 1 TYPE	FLANGE 1 NOM. TUBE OD	FLANGE 2 TYPE	FLANGE 2 NOM. TUBE OD	A
ANC-NW-40-ISO-63	NW-40	1½ (38.10)	ISO-63	2½ (63.50)	2.78 (70.61)
ANC-NW-40-ISO-80	NW-40	1½ (38.10)	ISO-80	3 (76.20)	4.03 (102.36)
ANC-NW-50-ISO-63	NW-50	2 (50.80)	ISO-63	2½ (63.50)	2.78 (70.61)
ANC-NW-50-ISO-80	NW-50	2 (50.80)	ISO-80	3 (76.20)	4.03 (102.36)
ANC-NW-50-ISO-100	NW-50	2 (50.80)	ISO-100	4 (101.60)	4.03 (102.36)



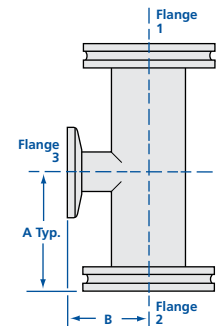
### NW to ISO Adapter Nipples

MODEL NUMBER	FLANGE 1 TYPE	FLANGE 2 TYPE	NOM. TUBE OD
AN-NW-16-ISO-63-OF	NW-16	ISO-63	¾ (19.05)
AN-NW-25-ISO-63-OF	NW-25	ISO-63	1 (25.40)
AN-NW-25-ISO-80-OF	NW-25	ISO-80	1 (25.40)
AN-NW-25-ISO-100-OF	NW-25	ISO-100	1 (25.40)
AN-NW-40-ISO-100-OF	NW-40	ISO-100	1½ (38.10)
AN-NW-50-ISO-160-OF	NW-50	ISO-160	2 (50.80)



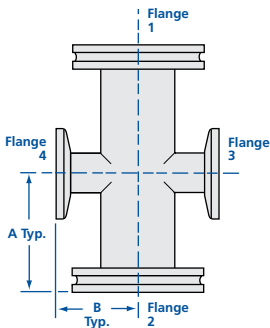
### NW to ISO Adapter Tees

MODEL NUMBER	FLANGE 1 TYPE	FLANGE 1 NOM. TUBE OD	FLANGE 2 TYPE	FLANGE 2 NOM. TUBE OD	A	B
3TA-NW-40-ISO-63-OF	ISO-63	2½ (63.50)	NW-40	1½ (38.10)	3.25 (82.55)	2.90 (73.66)
3TA-NW-40-ISO-80-OF	ISO-80	3 (76.20)	NW-40	1½ (38.10)	3.50 (88.90)	3.15 (80.01)
3TA-NW-40-ISO-100-OF	ISO-100	4 (101.60)	NW-40	1½ (38.10)	4.13 (104.90)	3.65 (92.71)
3TA-NW-40-ISO-160-OF	ISO-160	6 (152.40)	NW-40	1½ (38.10)	5.38 (136.65)	4.65 (118.11)
3TA-NW-50-ISO-63-OF	ISO-63	2½ (63.50)	NW-50	2 (50.80)	3.25 (82.55)	3.40 (86.36)
3TA-NW-50-ISO-80-OF	ISO-80	3 (76.20)	NW-50	2 (50.80)	3.50 (88.90)	3.65 (92.71)
3TA-NW-50-ISO-100-OF	ISO-100	4 (101.60)	NW-50	2 (50.80)	4.13 (104.90)	4.15 (105.41)
3TA-NW-50-ISO-160-OF	ISO-160	6 (152.40)	NW-50	2 (50.80)	5.38 (136.65)	5.15 (130.81)



### NW to ISO Adapter Crosses

MODEL NUMBER	FLANGE 1 TYPE	FLANGE 1 NOM. TUBE OD	FLANGE 2 TYPE	FLANGE 2 NOM. TUBE OD	A	B
4CA-NW-40-ISO-63-OF	ISO-63	2½ (63.50)	NW-40	1½ (38.10)	3.25 (82.55)	2.90 (73.66)
4CA-NW-40-ISO-80-OF	ISO-80	3 (76.20)	NW-40	1½ (38.10)	3.50 (88.90)	3.15 (80.01)
4CA-NW-40-ISO-100-OF	ISO-100	4 (101.60)	NW-40	1½ (38.10)	4.13 (104.90)	3.65 (92.71)
4CA-NW-40-ISO-160-OF	ISO-160	6 (152.40)	NW-40	1½ (38.10)	5.38 (136.65)	4.65 (118.11)
4CA-NW-50-ISO-63-OF	ISO-63	2½ (63.50)	NW-50	2 (50.80)	3.25 (82.55)	3.40 (86.36)
4CA-NW-50-ISO-80-OF	ISO-80	3 (76.20)	NW-50	2 (50.80)	3.50 (88.90)	3.65 (92.71)
4CA-NW-50-ISO-100-OF	ISO-100	4 (101.60)	NW-50	2 (50.80)	4.13 (104.90)	4.15 (105.41)
4CA-NW-50-ISO-160-OF	ISO-160	6 (152.40)	NW-50	2 (50.80)	5.38 (136.65)	5.15 (130.81)



### SPECIFICATIONS

**Materials:** 304 stainless steel  
(316L available upon request)

**Vacuum range:** ≥ 1 x 10<sup>-8</sup> mbar - High vacuum

**Temperature range:** -20°C to 150°C

All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.

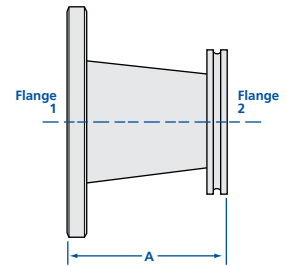
# Adapter Fittings

## Flange-to-Flange



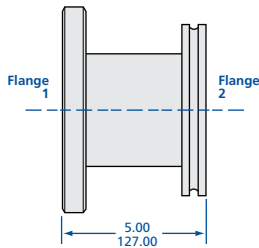
### CF to ISO Conical Adapter Nipples

MODEL NUMBER	FLANGE 1		FLANGE 2		A
	TYPE	NOM. TUBE OD	TYPE	NOM. TUBE OD	
ANC-275-ISO-63-OF	2.75 CF	1½ (40)	ISO-63-OF	2½ (63)	2.83 (71.88)
ANC-275-ISO-80-OF	2.75 CF	1½ (40)	ISO-80-OF	3 (75)	4.08 (103.63)
ANC-338-ISO-63-OF	3.38 CF	2 (50)	ISO-63-OF	2½ (63)	2.85 (72.39)
ANC-338-ISO-80-OF	3.38 CF	2 (50)	ISO-80-OF	3 (75)	4.10 (104.14)
ANC-338-ISO-100-OF	3.38 CF	2 (50)	ISO-100-OF	4 (100)	4.10 (104.14)
ANC-450-ISO-80-OF	4.50 CF	2½ (63)	ISO-80-OF	3 (75)	4.25 (107.95)
ANC-450-ISO-100-OF	4.50 CF	2½ (63)	ISO-100-OF	4 (100)	4.25 (107.95)
ANC-462-ISO-63-OF	4.62 CF	3 (75)	ISO-63-OF	2½ (63)	4.16 (105.66)
ANC-462-ISO-100-OF	4.62 CF	3 (75)	ISO-100-OF	4 (100)	4.16 (105.66)
ANC-600-ISO-63-OF	6.00 CF	4 (100)	ISO-63-OF	2½ (63)	4.31 (109.47)
ANC-600-ISO-80-OF	6.00 CF	4 (100)	ISO-80-OF	3 (75)	4.31 (109.47)



### CF to ISO Adapter Nipples

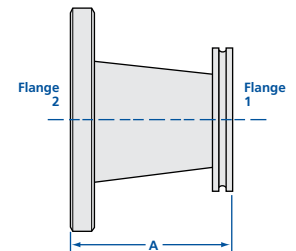
MODEL NUMBER	FLANGE 1 TYPE	FLANGE 2 TYPE	NOM. TUBE OD
AN-450-ISO-63-OF	4.50 CF	ISO-63-OF	2½ (63.50)
AN-462-ISO-80-OF	4.62 CF	ISO-80-OF	3 (76.20)
AN-600-ISO-100-OF	6.00 CF	ISO-100-OF	4 (101.60)
AN-800-ISO-160-OF	8.00 CF	ISO-160-OF	6 (152.40)
AN-1000-ISO-200-OF	10.00 CF	ISO-200-OF	8 (203.20)



### ISO to ASA Conical Adapter Nipples

MODEL NUMBER	FLANGE 1 TYPE	NOM. TUBE OD	FLANGE 2 TYPE	NOM. TUBE OD	A
ANC-ISO-63-OF-ASA-5	ISO-63	2½ (63.50)	ASA-5	2 (50.80)	2.88 (73.15)
ANC-ISO-63-OF-ASA-6	ISO-63	2½ (63.50)	ASA-6	3 (76.20)	4.13 (104.90)
ANC-ISO-63-OF-ASA-7.5	ISO-63	2½ (63.50)	ASA-7.5	4 (101.60)	4.13 (104.90)
ANC-ISO-80-OF-ASA-5	ISO-80	3 (76.20)	ASA-5	2 (50.80)	4.13 (104.90)
ANC-ISO-80-OF-ASA-7.5	ISO-80	3 (76.20)	ASA-7.5	4 (101.60)	4.13 (104.90)
ANC-ISO-100-OF-ASA-5	ISO-100	4 (101.60)	ASA-5	2 (50.80)	4.13 (104.90)
ANC-ISO-100-OF-ASA-6	ISO-100	4 (101.60)	ASA-6	3 (76.20)	4.13 (104.90)

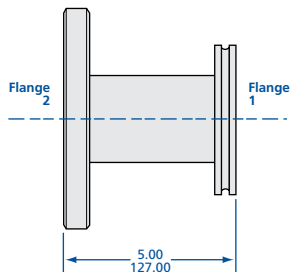
Note: Add suffix "-G" to model number if O-ring groove is required on ASA flange.  
Call for groove prices.



### ISO to ASA Adapter Nipples

MODEL NUMBER	FLANGE 1 TYPE	FLANGE 2 TYPE	NOM. TUBE OD
AN-ISO-63-OF-ASA-11	ISO-63	ASA-11	2½ (63.50)
AN-ISO-80-OF-ASA-6	ISO-80	ASA-6	3 (76.20)
AN-ISO-80-OF-ASA-11	ISO-80	ASA-11	3 (76.20)
AN-ISO-100-OF-ASA-7.5	ISO-100	ASA-7.5	4 (101.60)
AN-ISO-100-OF-ASA-9	ISO-100	ASA-9	4 (101.60)
AN-ISO-100-OF-ASA-11	ISO-100	ASA-11	4 (101.60)
AN-ISO-160-OF-ASA-9	ISO-160	ASA-9	6 (152.40)
AN-ISO-160-OF-ASA-11	ISO-160	ASA-11	6 (152.40)
AN-ISO-200-OF-ASA-11	ISO-200	ASA-11	8 (203.20)
AN-ISO-200-OF-ASA-13.5	ISO-200	ASA-13.5	8 (203.20)

Note: Add suffix "-G" to model number if O-ring groove is required on ASA flange.  
Call for groove prices.



#### SPECIFICATIONS

**Materials:** 304 or stainless steel  
(316L available upon request)

**Vacuum range:**  $\geq 1 \times 10^{-8}$  mbar - High vacuum

**Temperature range:** -20°C to 150°C

All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.

# Adapter Fittings

## Flange-to-Flange

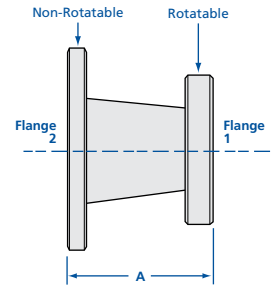


### CF to ASA Conical Adapter Nipples

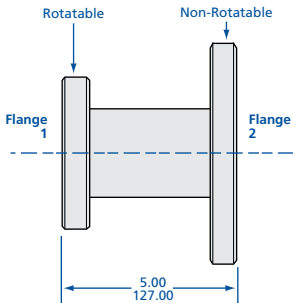


MODEL NUMBER	TYPE	FLANGE 1 NOM. TUBE OD	TYPE	FLANGE 2 NOM. TUBE OD	A
ANC-212-ASA-5	2.12 CF	1 (25.40)	ASA-5	2 (50.80)	2.79 (70.87)
ANC-275-ASA-5	2.75 CF	1½ (38.10)	ASA-5	2 (50.80)	2.83 (71.88)
ANC-275-ASA-6	2.75 CF	1½ (38.10)	ASA-6	3 (76.20)	4.08 (103.63)
ANC-338-ASA-5	3.38 CF	2 (50.80)	ASA-5	2½ (63.50)	2.85 (72.38)
ANC-338-ASA-6	3.38 CF	2 (50.80)	ASA-6	3 (76.20)	4.10 (104.14)
ANC-338-ASA-7.5	3.38 CF	2 (50.80)	ASA-7.5	4 (101.60)	4.10 (104.14)
ANC-450-ASA-5	4.50 CF	2 (50.80)	ASA-5	2 (50.80)	3.00 (76.20)
ANC-450-ASA-6	4.50 CF	2½ (63.50)	ASA-6	3 (76.20)	4.25 (107.95)
ANC-450-ASA-7.5	4.50 CF	2½ (63.50)	ASA-7.5	4 (101.60)	4.25 (107.95)
ANC-462-ASA-5	4.62 CF	3 (76.20)	ASA-5	2 (50.80)	4.16 (105.66)
ANC-462-ASA-7.5	4.62 CF	3 (76.20)	ASA-7.5	4 (101.60)	4.16 (105.66)
ANC-600-ASA-5	6.00 CF	4 (101.60)	ASA-5	2 (50.80)	4.31 (109.47)
ANC-600-ASA-6	6.00 CF	4 (101.60)	ASA-6	3 (76.20)	4.31 (109.47)

Note: Add suffix "-G" to model number if O-ring groove is required on ASA flange.  
Call for ASA groove prices.



### CF to ASA Adapter Nipples



MODEL NUMBER	FLANGE 1 TYPE	FLANGE 2 TYPE	NOMINAL TUBE OD
AN-133-ASA-5	1.33 CF	ASA-5	¾ (19.05)
AN-133-ASA-6	1.33 CF	ASA-6	¾ (19.05)
AN-212-ASA-6	2.12 CF	ASA-6	1 (25.40)
AN-462-ASA-6	4.62 CF	ASA-6	3 (76.20)
AN-133-ASA-7.5	1.33 CF	ASA-7.5	¾ (19.05)
AN-212-ASA-7.5	2.12 CF	ASA-7.5	1 (25.40)
AN-275-ASA-7.5	2.75 CF	ASA-7.5	1½ (38.10)
AN-133-ASA-9	1.33 CF	ASA-9	¾ (19.05)
AN-212-ASA-9	2.12 CF	ASA-9	1 (25.40)
AN-275-ASA-9	2.75 CF	ASA-9	1½ (38.10)
AN-338-ASA-9	3.38 CF	ASA-9	2 (50.80)
AN-450-ASA-9	4.50 CF	ASA-9	2½ (63.50)
AN-462-ASA-9	4.62 CF	ASA-9	3 (76.20)
AN-600-ASA-9	6.00 CF	ASA-9	4 (101.60)
AN-133-ASA-11	1.33 CF	ASA-11	¾ (19.05)
AN-212-ASA-11	2.12 CF	ASA-11	1 (25.40)
AN-275-ASA-11	2.75 CF	ASA-11	1½ (38.10)
AN-338-ASA-11	3.38 CF	ASA-11	2 (50.80)
AN-450-ASA-11	4.50 CF	ASA-11	2½ (63.50)
AN-462-ASA-11	4.62 CF	ASA-11	3 (76.20)
AN-600-ASA-11	6.00 CF	ASA-11	4 (101.60)
AN-800-ASA-11	8.00 CF	ASA-11	6 (152.40)
AN-133-ASA-13.5	1.33 CF	ASA-13.5	¾ (19.05)
AN-212-ASA-13.5	2.12 CF	ASA-13.5	1 (25.40)
AN-275-ASA-13.5	2.75 CF	ASA-13.5	1½ (38.10)
AN-338-ASA-13.5	3.38 CF	ASA-13.5	2 (50.80)
AN-450-ASA-13.5	4.50 CF	ASA-13.5	2½ (63.50)
AN-462-ASA-13.5	4.62 CF	ASA-13.5	3 (76.20)
AN-600-ASA-13.5	6.00 CF	ASA-13.5	4 (101.60)
AN-800-ASA-13.5	8.00 CF	ASA-13.5	6 (152.40)
AN-1000-ASA-13.5	10.00 CF	ASA-13.5	8 (203.20)
AN-133-ASA-16	1.33 CF	ASA-16	¾ (19.05)
AN-212-ASA-16	2.12 CF	ASA-16	1 (25.40)
AN-275-ASA-16	2.75 CF	ASA-16	1½ (38.01)
AN-338-ASA-16	3.38 CF	ASA-16	2 (50.80)
AN-450-ASA-16	4.50 CF	ASA-16	2½ (63.50)
AN-462-ASA-16	4.62 CF	ASA-16	3 (76.20)
AN-600-ASA-16	6.00 CF	ASA-16	4 (101.60)
AN-800-ASA-16	8.00 CF	ASA-16	6 (152.40)
AN-1000-ASA-16	10.00 CF	ASA-16	8 (203.20)
AN-1325-ASA-16	13.25 CF	ASA-16	10 (254.00)

Note: Add suffix "-G" to model number if O-ring groove is required on ASA flange.  
Call for groove prices.



### SPECIFICATIONS

**Materials:** 304 or stainless steel  
(316L available upon request)

**Vacuum range:** ≥ 1 x 10<sup>-8</sup> mbar - High vacuum

**Temperature range:** -20°C to 150°C

All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.





# Adapter Fittings

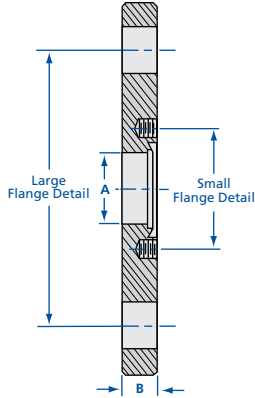
## Adapter Flange and Flange-to-Fitting

### SPECIFICATIONS

**Materials:** 304 stainless steel

**Vacuum range:**  $\geq 1 \times 10^{-8}$  mbar - High vacuum

**Temperature range:** -20°C to 150°C



### CF to ASA Adapter Flanges

MODEL NUMBER	SMALL FLANGE	LARGE FLANGE	A	B
ASA-5-133-075Z	133-000NT	ASA-5-000N	0.63 (16.00)	0.50 (12.70)
ASA-5-212-100Z	212-000NT	ASA-5-000N	1.00 (25.40)	0.50 (12.70)
ASA-5-275-150Z	275-000NT	ASA-5-000N	1.50 (38.10)	0.50 (12.70)
ASA-6-133-075Z	133-000NT	ASA-6-000N	0.63 (16.00)	0.50 (12.70)
ASA-6-212-100Z	212-000NT	ASA-6-000N	1.00 (25.40)	0.50 (12.70)
ASA-6-275-150Z	275-000NT	ASA-6-000N	1.50 (38.10)	0.50 (12.70)
ASA-6-338-200Z	338-000NT	ASA-6-000N	2.00 (50.80)	0.75 (19.05)
ASA-7.5-133-075Z	133-000NT	ASA-7.5-000N	0.63 (16.00)	0.50 (12.70)
ASA-7.5-212-100Z	212-000NT	ASA-7.5-000N	1.00 (25.40)	0.50 (12.70)
ASA-7.5-275-150Z	275-000NT	ASA-7.5-000N	1.50 (38.10)	0.50 (12.70)
ASA-7.5-338-200Z	338-000NT	ASA-7.5-000N	2.00 (50.80)	0.75 (19.05)
ASA-7.5-450-250Z	450-000NT	ASA-7.5-000N	2.50 (63.50)	0.75 (19.05)
ASA-9-133-075Z	133-000NT	ASA-9-000N	0.63 (16.00)	0.75 (19.05)
ASA-9-212-100Z	212-000NT	ASA-9-000N	1.00 (25.40)	0.75 (19.05)
ASA-9-275-150Z	275-000NT	ASA-9-000N	1.50 (38.10)	0.75 (19.05)
ASA-9-338-200Z	338-000NT	ASA-9-000N	2.00 (50.80)	0.75 (19.05)
ASA-9-450-250Z	450-000NT	ASA-9-000N	2.50 (63.50)	0.75 (19.05)
ASA-9-462-300Z	462-000NT	ASA-9-000N	3.00 (76.20)	0.75 (19.05)
ASA-9-600-400Z	600-000NT	ASA-9-000N	4.00 (101.60)	0.75 (19.05)
ASA-11-133-075Z	133-000NT	ASA-11-000N	0.63 (16.00)	0.75 (19.05)
ASA-11-212-100Z	212-000NT	ASA-11-000N	1.00 (25.40)	0.75 (19.05)
ASA-11-275-150Z	275-000NT	ASA-11-000N	1.50 (38.10)	0.75 (19.05)
ASA-11-338-200Z	338-000NT	ASA-11-000N	2.00 (50.80)	0.75 (19.05)
ASA-11-450-250Z	450-000NT	ASA-11-000N	2.50 (63.50)	0.75 (19.05)
ASA-11-462-300Z	462-000NT	ASA-11-000N	3.00 (76.20)	0.75 (19.05)
ASA-11-600-400Z	600-000NT	ASA-11-000N	4.00 (101.60)	0.75 (19.05)
ASA-11-800-600Z	800-000NT	ASA-11-000N	6.00 (152.40)	0.75 (19.05)



### SPECIFICATIONS

**Materials:** 304 stainless steel

**Vacuum range:**  $\geq 1 \times 10^{-8}$  mbar - High vacuum

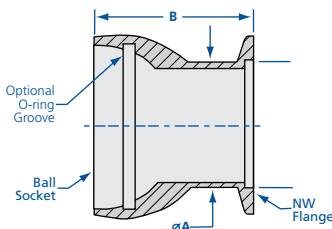
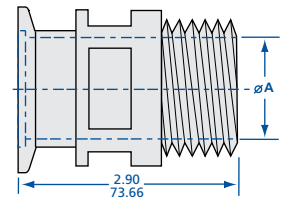
**Temperature range:** -20°C to 150°C



### NW Welch Pump Adapters

MODEL NUMBER	USE WITH WELCH PUMP MODEL NUMBER	THREAD	TUBE ID A
AN-NW-16-1400	1399, 1400, 1410	3/8-18 NPSM x 1.00	0.450 (11.43)
AN-NW-16-1405	1405	3/4-20 NPSM x 1.00	0.562 (14.28)
AN-NW-25-1405	1405	3/4-20 NPSM x 1.00	0.562 (14.28)
AN-NW-25-1402	1380, 1402, 1403, 8806, 8811, 8816, 8821	1-20 NPSM x 1.00	0.750 (19.05)
AN-NW-40-1402	1380, 1402, 1403, 8806, 8811, 8816, 8821	1-20 NPSM x 1.00	0.750 (19.05)
AN-NW-40-1376	1373, 1376, 8831	1 1/2-12 NPSM x 1.00	1.125 (28.58)
AN-NW-40-1397	1374, 1397	1 1/4-20 NPSM x 1.00	1.375 (34.93)
AN-NW-50-1397	1374, 1397	1 3/4-20 NPSM x 1.00	1.375 (34.93)

**Note:** Includes aluminum gasket



### NW Ball Socket Adapters

MODEL NUMBER	BALL SOCKET	FLANGE TYPE	TUBE OD A	B	O-RING SIZE
BS-50/30-NW	50/30	NW-40	1 1/2 (38.10)	1.90 (48.26)	-
BS-50/30G-NW	50/30	NW-40	1 1/2 (38.10)	1.90 (48.26)	2-224
BS-75/50-NW	75/50	NW-50	2 (50.80)	2.65 (67.31)	-
BS-75/50G-NW	75/50	NW-50	2 (50.80)	2.65 (67.31)	2-232

**Note:** "G" in model number indicates O-ring and O-ring groove.



All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.

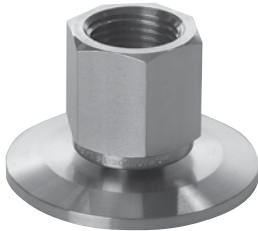
# Adapter Fittings

## Flange-to-Fitting

### SECTION 2.7



### NW Female Pipe Adapters



MODEL NUMBER	NPT	A
NW-10-1/8 FPT	1/8 (3.18)	0.92 (23.37)
NW-16-1/8 FPT	1/8 (3.18)	0.92 (23.37)
NW-25-1/8 FPT	1/8 (3.18)	0.92 (23.37)
NW-40-1/8 FPT	1/8 (3.18)	0.92 (23.37)
NW-50-1/8 FPT	1/8 (3.18)	0.92 (23.37)
NW-10-1/4 FPT	1/4 (6.35)	1.07 (27.18)
NW-16-1/4 FPT	1/4 (6.35)	1.07 (27.18)
NW-25-1/4 FPT	1/4 (6.35)	1.07 (27.18)
NW-40-1/4 FPT	1/4 (6.35)	1.07 (27.18)
NW-50-1/4 FPT	1/4 (6.35)	1.07 (27.18)
NW-16-1/2 FPT	1/2 (12.70)	1.44 (36.58)
NW-25-1/2 FPT	1/2 (12.70)	1.39 (35.31)
NW-40-1/2 FPT	1/2 (12.70)	1.39 (35.31)
NW-50-1/2 FPT	1/2 (12.70)	1.39 (35.31)
NW-25-3/4 FPT	3/4 (19.05)	1.45 (36.83)
NW-40-3/4 FPT	3/4 (19.05)	1.45 (36.83)
NW-50-3/4 FPT	3/4 (19.05)	1.45 (36.83)
NW-25-1 FPT	1 (25.40)	1.57 (39.88)
NW-40-1 FPT	1 (25.40)	1.57 (39.88)
NW-50-1 FPT	1 (25.40)	1.57 (39.88)

### SPECIFICATIONS

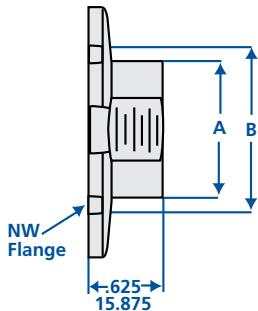
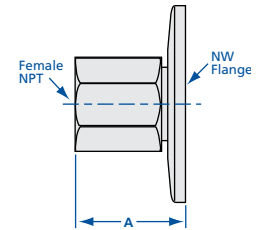
#### Materials

Flanges: 304 stainless steel

NPT Fittings: 316L stainless steel

Vacuum range:  $\geq 1 \times 10^{-6}$  mbar - High vacuum

Temperature range: -20°C to 150°C

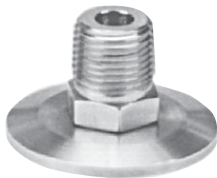


### Machined NW Female Pipe Adapters

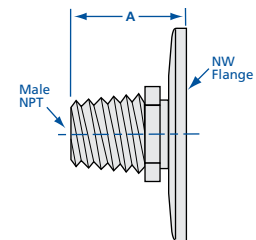
MODEL NUMBER	NPT	A FLAT	B OD
NW-16-1/8-FPTM	1/8 (3.18)	.625 (15.88)	0.75 (19.05)
NW-16-1/4-FPTM	1/4 (6.35)	.625 (15.88)	0.75 (19.05)
NW-25-1/8-FPTM	1/8 (3.18)	.875 (22.23)	1.00 (25.40)
NW-25-1/4-FPTM	1/4 (6.35)	.875 (22.23)	1.00 (25.40)
NW-40-1/8-FPTM	1/8 (3.18)	1.25 (31.75)	1.50 (38.10)
NW-40-1/4-FPTM	1/4 (6.35)	1.25 (31.75)	1.50 (38.10)



### NW Male Pipe Adapters



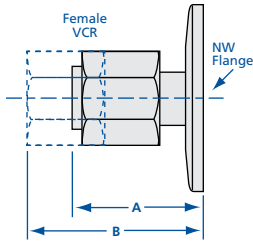
MODEL NUMBER	NPT	A
NW-10-1/8 MPT	1/8 (3.18)	0.89 (22.61)
NW-16-1/8 MPT	1/8 (3.18)	0.89 (22.61)
NW-25-1/8 MPT	1/8 (3.18)	0.89 (22.61)
NW-40-1/8 MPT	1/8 (3.18)	0.89 (22.61)
NW-50-1/8 MPT	1/8 (3.18)	0.89 (22.61)
NW-10-1/4 MPT	1/4 (6.35)	1.10 (27.94)
NW-16-1/4 MPT	1/4 (6.35)	1.10 (27.94)
NW-25-1/4 MPT	1/4 (6.35)	1.10 (27.94)
NW-40-1/4 MPT	1/4 (6.35)	1.10 (27.94)
NW-50-1/4 MPT	1/4 (6.35)	1.10 (27.94)
NW-16-1/2 MPT	1/2 (12.70)	1.35 (34.29)
NW-25-1/2 MPT	1/2 (12.70)	1.35 (34.29)
NW-40-1/2 MPT	1/2 (12.70)	1.35 (34.29)
NW-50-1/2 MPT	1/2 (12.70)	1.35 (34.29)
NW-25-3/4 MPT	3/4 (19.05)	1.35 (34.29)
NW-40-3/4 MPT	3/4 (19.05)	1.35 (34.29)
NW-50-3/4 MPT	3/4 (19.05)	1.35 (34.29)
NW-25-1 MPT	1 (25.40)	1.64 (41.66)
NW-40-1 MPT	1 (25.40)	1.64 (41.66)
NW-50-1 MPT	1 (25.40)	1.64 (41.66)



All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.

# Adapter Fittings

## Flange-to-Fitting



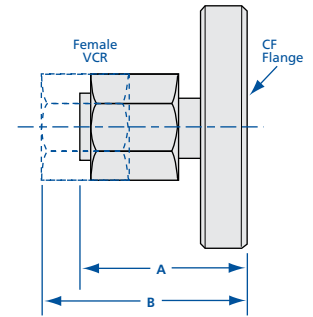
### NW Female VCR Adapters

MODEL NUMBER	FLANGE TYPE	VCR SIZE	A	B
NW-10-1/4 FVCR	NW-10	1/4 (6.35)	1.46 (37.08)	1.96 (49.78)
NW-16-1/4 FVCR	NW-16	1/4 (6.35)	1.46 (37.08)	1.96 (49.78)
NW-25-1/4 FVCR	NW-25	1/4 (6.35)	1.46 (37.08)	1.96 (49.78)
NW-40-1/4 FVCR	NW-40	1/4 (6.35)	1.46 (37.08)	1.96 (49.78)
NW-50-1/4 FVCR	NW-50	1/4 (6.35)	1.46 (37.08)	1.96 (49.78)
NW-16-3/8 FVCR	NW-16	3/8 (9.53)	1.65 (41.91)	2.20 (55.88)
NW-25-3/8 FVCR	NW-25	3/8 (9.53)	1.65 (41.91)	2.20 (55.88)
NW-40-3/8 FVCR	NW-40	3/8 (9.53)	1.65 (41.91)	2.20 (55.88)
NW-50-3/8 FVCR	NW-50	3/8 (9.53)	1.65 (41.91)	2.20 (55.88)
NW-16-1/2 FVCR	NW-16	1/2 (12.70)	1.65 (41.91)	2.20 (55.88)
NW-25-1/2 FVCR	NW-25	1/2 (12.70)	1.65 (41.91)	2.20 (55.88)
NW-40-1/2 FVCR	NW-40	1/2 (12.70)	1.65 (41.91)	2.20 (55.88)
NW-50-1/2 FVCR	NW-50	1/2 (12.70)	1.65 (41.91)	2.20 (55.88)



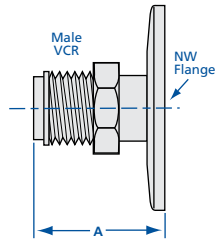
### CF Female VCR Adapters

MODEL NUMBER	FLANGE TYPE	VCR SIZE	A	B
133-1/4 FVCR	1.33 CF	1/4 (6.35)	1.36 (34.54)	1.88 (47.75)
133-3/8 FVCR	1.33 CF	3/8 (9.53)	1.55 (39.37)	2.13 (54.10)
275-1/4 FVCR	2.75 CF	1/4 (6.35)	1.36 (34.54)	1.88 (47.75)
275-3/8 FVCR	2.75 CF	3/8 (9.53)	1.55 (39.37)	2.13 (54.10)



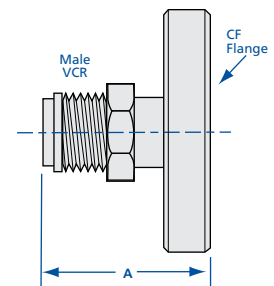
### NW Male VCR Adapters

MODEL NUMBER	FLANGE TYPE	VCR SIZE	A
NW-10-1/4 MVCR	NW-10	1/4 (6.35)	1.46 (37.08)
NW-16-1/4 MVCR	NW-16	1/4 (6.35)	1.46 (37.08)
NW-25-1/4 MVCR	NW-25	1/4 (6.35)	1.46 (37.08)
NW-40-1/4 MVCR	NW-40	1/4 (6.35)	1.46 (37.08)
NW-50-1/4 MVCR	NW-50	1/4 (6.35)	1.46 (37.08)
NW-16-3/8 MVCR	NW-16	3/8 (9.53)	1.65 (41.91)
NW-25-3/8 MVCR	NW-25	3/8 (9.53)	1.65 (41.91)
NW-40-3/8 MVCR	NW-40	3/8 (9.53)	1.65 (41.91)
NW-50-3/8 MVCR	NW-50	3/8 (9.53)	1.65 (41.91)
NW-16-1/2 MVCR	NW-16	1/2 (12.70)	1.65 (41.91)
NW-25-1/2 MVCR	NW-25	1/2 (12.70)	1.65 (41.91)
NW-40-1/2 MVCR	NW-40	1/2 (12.70)	1.65 (41.91)
NW-50-1/2 MVCR	NW-50	1/2 (12.70)	1.65 (41.91)



### CF Male VCR Adapters

MODEL NUMBER	FLANGE TYPE	VCR SIZE	A
133-1/4 MVCR	1.33 CF	1/4 (6.35)	1.46 (37.08)
133-3/8 MVCR	1.33 CF	3/8 (9.53)	1.65 (41.91)
275-1/4 MVCR	2.75 CF	1/4 (6.35)	1.46 (37.08)
275-3/8 MVCR	2.75 CF	3/8 (9.53)	1.65 (41.91)



### SPECIFICATIONS

#### Materials

Flanges: 304 stainless steel  
VCR Fittings: 316L stainless steel

#### Vacuum range:

NW Flange:  $\geq 1 \times 10^{-8}$  mbar - High vacuum  
CF Flange:  $\geq 1 \times 10^{-10}$  mbar - UHV

#### Temperature range: -20°C to 200°C

All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.

# Adapter Fittings

## Flange-to-Fitting



### NW Quick Disconnect Adapters

MODEL NUMBER	FLANGE TYPE	ID A	ID B	C
NW-10-1/4 QD	NW-10	1/4 (6.35)	0.187 (4.75)	1.48 (37.59)
NW-16-1/4 QD	NW-16	1/4 (6.35)	0.187 (4.75)	1.48 (37.59)
NW-25-1/4 QD	NW-25	1/4 (6.35)	0.187 (4.75)	1.48 (37.59)
NW-40-1/4 QD	NW-40	1/4 (6.35)	0.187 (4.75)	1.48 (37.59)
NW-10-3/8 QD	NW-10	3/8 (9.53)	0.281 (7.14)	1.62 (41.15)
NW-16-3/8 QD	NW-16	3/8 (9.53)	0.281 (7.14)	1.62 (41.15)
NW-25-3/8 QD	NW-25	3/8 (9.53)	0.281 (7.14)	1.62 (41.15)
NW-40-3/8 QD	NW-40	3/8 (9.53)	0.281 (7.14)	1.62 (41.15)
NW-16-1/2 QD	NW-16	1/2 (12.70)	0.406 (10.31)	1.79 (45.47)
NW-25-1/2 QD	NW-25	1/2 (12.70)	0.406 (10.31)	1.79 (45.47)
NW-40-1/2 QD	NW-40	1/2 (12.70)	0.406 (10.31)	1.79 (45.47)
NW-50-1/2 QD	NW-50	1/2 (12.70)	0.406 (10.31)	1.79 (45.47)
NW-25-3/4 QD	NW-25	3/4 (19.05)	0.625 (15.88)	1.93 (49.02)
NW-40-3/4 QD	NW-40	3/4 (19.05)	0.625 (15.88)	1.93 (49.02)
NW-50-3/4 QD	NW-50	3/4 (19.05)	0.625 (15.88)	1.93 (49.02)
NW-40-1 QD	NW-40	1 (25.40)	0.875 (22.23)	1.95 (49.53)
NW-50-1 QD	NW-50	1 (25.40)	0.875 (22.23)	1.95 (49.53)

Note: On request, NW Quick Disconnects can be provided bored through for the tube OD. Add "-BT" suffix to the part number and call for price. Example: NW-10-1/4 QD-BT

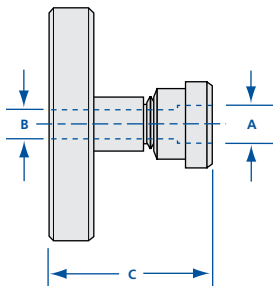
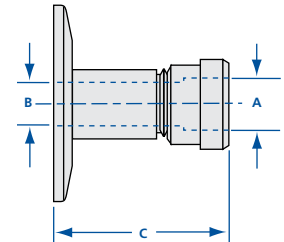
### SPECIFICATIONS

#### Materials

Flanges: 304 stainless steel  
QD Fittings: 316L stainless steel

Vacuum range:  $\geq 1 \times 10^{-8}$  mbar - High vacuum

Temperature range: -20°C to 150°C



### CF Quick Disconnect Adapters

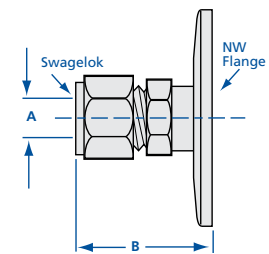
MODEL NUMBER	FLANGE OD	ID A	ID B	C
133-1/4 QD	1.33 CF	1/4 (6.35)	3/16 (4.76)	1.39 (35.31)
133-3/8 QD	1.33 CF	3/8 (9.53)	9/32 (7.14)	1.53 (38.86)
133-1/2 QD	1.33 CF	1/2 (12.70)	13/32 (10.32)	1.70 (43.18)
275-1/4 QD	2.75 CF	1/4 (6.35)	3/16 (4.76)	1.39 (35.31)
275-3/8 QD	2.75 CF	3/8 (9.53)	9/32 (7.14)	1.53 (38.86)
275-1/2 QD	2.75 CF	1/2 (12.70)	13/32 (10.32)	1.70 (43.18)
275-3/4 QD	2.75 CF	3/4 (19.05)	5/8 (15.88)	1.99 (50.55)
275-1 QD	2.75 CF	1 (25.40)	7/8 (22.23)	2.01 (51.05)

Note: On request, CF Quick Disconnects can be provided bored through for the tube OD. Add "-BT" suffix to the part number and call for price. Example: 133-1/4 QD-BT



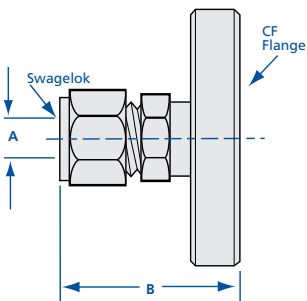
### NW Swagelok Adapters

MODEL NUMBER	FLANGE TYPE	ID A	ID B
NW-10-1/4 SWAG	NW-10	1/4 (6.35)	1.47 (37.34)
NW-16-1/4 SWAG	NW-16	1/4 (6.35)	1.47 (37.34)
NW-25-1/4 SWAG	NW-25	1/4 (6.35)	1.47 (37.34)
NW-40-1/4 SWAG	NW-40	1/4 (6.35)	1.47 (37.34)
NW-50-1/4 SWAG	NW-50	1/4 (6.35)	1.47 (37.34)
NW-10-3/8 SWAG	NW-10	3/8 (9.53)	1.63 (41.40)
NW-16-3/8 SWAG	NW-16	3/8 (9.53)	1.63 (41.40)
NW-25-3/8 SWAG	NW-25	3/8 (9.53)	1.63 (41.40)
NW-40-3/8 SWAG	NW-40	3/8 (9.53)	1.63 (41.40)
NW-50-3/8 SWAG	NW-50	3/8 (9.53)	1.63 (41.40)



### CF Swagelok Adapters

MODEL NUMBER	FLANGE TYPE	ID A	ID B
133-1/4 SWAG	1.33 CF	1/4 (6.35)	1.37 (34.80)
133-3/8 SWAG	1.33 CF	3/8 (9.53)	1.58 (40.13)
275-1/4 SWAG	2.75 CF	1/4 (6.35)	1.37 (34.80)
275-3/8 SWAG	2.75 CF	3/8 (9.53)	1.54 (39.12)



### SPECIFICATIONS

#### Materials

Flanges: 304 stainless steel  
Swagelok Fittings: 316L stainless steel

Vacuum range:  $\geq 1 \times 10^{-6}$  mbar - High vacuum

#### Temperature range

NW Flange: -20°C to 200°C  
CF Flange: -200°C to 450°C

All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.





### SPECIFICATIONS

#### Nominal ID sizes

Bellows: 3/4 to 4 inch (19.05-101.6mm)  
 PVC Hose: 1/2 to 2 inch (12.7-50.8mm)  
 Flex Couplings: 3/8 to 12 inch  
 (9.53-304.8mm)

#### Flange Types: NW, ISO, CF, ASA

#### Materials

Bellows: 316L or 321 stainless steel  
 PVC Hose: Wire reinforced polyvinylchloride  
 Flanges: 304 stainless steel  
 (316L available on request)

#### Vacuum Range

Metal seal:  $\geq 1 \times 10^{-10}$  mbar - UHV  
 Elastomer seal:  $\geq 1 \times 10^{-8}$  mbar - High vacuum  
 PVC Hose:  $\geq 1 \times 10^{-2}$  Rough vacuum

#### Temperature Range

Metal seal: -200°C to 450°C  
 Elastomer seal: -20°C to 150°C  
 PVC Hose: -4°C to 65°C

#### Options: Protective braided sleeving

### Flexible Vacuum Connections

Flexible vacuum connections are typically made by using edge welded bellows, hydroformed flexible couplings and hoses or PVC hoses. Edge welded bellows provide the greatest stroke and flexibility, but are the most susceptible to damage. Edge welded bellows are also more expensive than the other flexible connections. Nor-Cal Products offers flexible couplings and flexible hoses as standards. Edge welded bellows assemblies can be provided in a variety of materials as specials. PVC hose offers a low cost alternative to stainless steel flexible hoses.

### Flexible Hoses

Flexible stainless steel hoses are available in 3/4 to 4 inch (19.05-101.6mm) diameters in standard lengths of 12, 18, 24 and 36 inches (304.8, 457.2, 609.6 and 914.4mm) with NW, ISO, CF and ASA flanges. Hoses with NW and ISO flanges are also available in 10, 20 and 40 inch (metric equivalent) lengths. CF and ASA flanged hoses have one rotatable and one nonrotatable flange for ease of bolt hole alignment. ASA flanged hoses may require an O-ring groove on one flange for proper installation. Be sure to specify. NW to CF adapter hoses provide a flexible transition between components with NW and CF flanges. NW hoses are available in medium wall "FH-" (0.010 Inch (.254mm) wall thickness), heavy wall "TH-" (0.017 Inches (.432mm)), and thin wall "LH-" (0.006 Inches (.152mm)). Thin wall hose is the perfect choice for applications requiring increased flexibility. Protective braiding is offered as a standard for NW and CF medium wall tubing "FHB-" in diameters up to and including 4 inches (101.6mm).

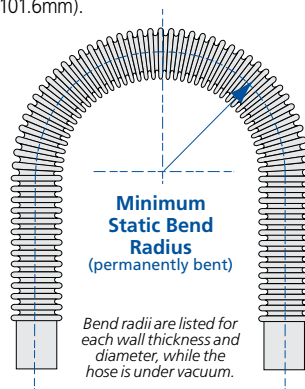


### Flexible Couplings

Pressurizing the inside of thin wall stainless steel tubing inside a mold forms convolutions in flexible couplings and hoses. Generally speaking, when comparing flexible couplings to hoses, they are thinner walled, have more convolutions per inch resulting in greater flexibility and stroke, and are used for alignment or vibration isolation rather than as roughing lines. Being thinner, flexible couplings are more susceptible to mechanical damage than hoses. Nor-Cal's flexible couplings have more convolutions than comparable products, resulting in greater flexibility and lower spring rates. Maximum compression for flexible couplings is typically 20% of the convolution (flexible) length. Extension is typically 10%. Couplings are available in 321 or 316L stainless steel in various lengths with NW, ISO, CF and ASA flanges.

### PVC Hoses

Plasticized PVC hoses can be used as a low cost rough vacuum line. An embedded spiral wire prevents the wall from collapsing under vacuum. Unlike edge welded bellows, flexible couplings and hoses, which are UHV compatible, PVC hoses should be used for rough vacuum due to their higher outgassing rate. Although it can be bent relatively easily, it cannot be compressed or extended. Order by the foot with or without NW flanges. Each length includes two hose clamps for installation.



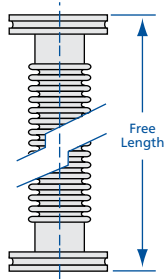
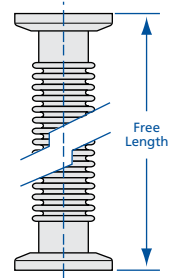
All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.  
 Spring rates are called out in pounds/inch



### NW Flexible Couplings



MODEL NUMBER	FLANGE TYPE	BELLOWS ID	WALL THICKNESS	FREE LENGTH	SPRING RATE	COMPRESSED LENGTH
2FC-NW-10-1	NW-10	3/8 (9.53)	0.008 (.20)	3.30 (83.82)	35	3.0 (76.20)
2FC-NW-10-2	NW-10	3/8 (9.53)	0.008 (.20)	3.80 (96.52)	28	3.4 (86.36)
2FC-NW-10-3	NW-10	3/8 (9.53)	0.008 (.20)	4.80 (121.92)	22	4.2 (106.68)
2FC-NW-16-1	NW-16	1/2 (12.70)	0.005 (.13)	3.20 (81.28)	61	3.0 (76.20)
2FC-NW-16-2	NW-16	1/2 (12.70)	0.005 (.13)	4.20 (106.68)	49	3.8 (96.52)
2FC-NW-16-3	NW-16	1/2 (12.70)	0.005 (.13)	5.20 (132.08)	38	4.6 (116.84)
2FC-NW-25-1	NW-25	3/4 (19.05)	0.006 (.15)	3.20 (81.28)	45	3.0 (76.20)
2FC-NW-25-2	NW-25	3/4 (19.05)	0.006 (.15)	4.20 (106.68)	36	3.8 (96.52)
2FC-NW-25-3	NW-25	3/4 (19.05)	0.006 (.15)	5.20 (132.08)	28	4.6 (116.84)
2FC-NW-40-1	NW-40	1 1/2 (38.10)	0.006 (.15)	3.20 (81.28)	85	3.0 (76.20)
2FC-NW-40-2	NW-40	1 1/2 (38.10)	0.006 (.15)	4.20 (106.68)	69	3.8 (96.52)
2FC-NW-40-3	NW-40	1 1/2 (38.10)	0.006 (.15)	5.20 (132.08)	53	4.6 (116.84)
2FC-NW-40-6	NW-40	1 1/2 (38.10)	0.006 (.15)	8.20 (208.28)	28	7.0 (177.80)
2FC-NW-50-1	NW-50	1 3/4 (44.45)	0.006 (.15)	3.20 (81.28)	62	3.0 (76.20)
2FC-NW-50-2	NW-50	1 3/4 (44.45)	0.006 (.15)	4.20 (106.68)	50	3.8 (96.52)
2FC-NW-50-3	NW-50	1 3/4 (44.45)	0.006 (.15)	5.20 (132.08)	38	4.6 (116.84)



### ISO Flexible Couplings

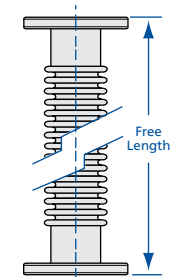
MODEL NUMBER	FLANGE TYPE	BELLOWS ID	WALL THICKNESS	FREE LENGTH	SPRING RATE	COMPRESSED LENGTH
2FC-ISO-250-4	ISO-63	2 1/2 (63.50)	0.008 (.20)	7.00 (177.80)	80	6.20 (157.48)
2FC-ISO-300-4	ISO-80	3 (76.20)	0.008 (.20)	7.00 (177.80)	78	6.20 (157.48)
2FC-ISO-400-4	ISO-100	4 (101.60)	0.010 (.25)	7.00 (177.80)	75	6.20 (157.48)
2FC-ISO-600-4	ISO-160	6 (152.40)	0.010 (.25)	7.00 (177.80)	130	6.20 (157.48)
2FC-ISO-800-4	ISO-200	8 (203.20)	0.010 (.25)	7.00 (177.80)	83	6.20 (157.48)
2FC-ISO-1000-10	ISO-250	10 (254.00)	0.012 (.30)	13.50 (342.90)	87	11.40 (289.56)



### ASA Flexible Couplings

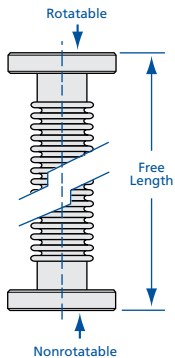
MODEL NUMBER	FLANGE TYPE	BELLOWS ID	WALL THICKNESS	FREE LENGTH	SPRING RATE	COMPRESSED LENGTH
2FC-ASA-5-200N-3	ASA 5	2 (50.80)	0.006 (.15)	6.00 (152.40)	56	5.4 (137.16)
2FC-ASA-5-250N-4	ASA 5	2 1/2 (63.50)	0.008 (.20)	7.00 (177.80)	80	6.20 (157.48)
2FC-ASA-6-300N-4	ASA 6	3 (76.20)	0.008 (.20)	7.00 (177.80)	78	6.20 (157.48)
2FC-ASA-7.5-400N-4	ASA 7.5	4 (101.60)	0.008 (.20)	7.00 (177.80)	75	6.20 (157.48)
2FC-ASA-9-400N-4	ASA 9	4 (101.60)	0.008 (.20)	7.00 (177.80)	75	6.20 (157.48)
2FC-ASA-9-600N-4	ASA 9	6 (152.40)	0.010 (.25)	7.00 (177.80)	130	6.20 (157.48)
2FC-ASA-11-600N-4	ASA 11	6 (152.40)	0.010 (.25)	7.00 (177.80)	130	6.20 (157.48)
2FC-ASA-11-800N-4	ASA 11	8 (203.20)	0.010 (.25)	7.00 (177.80)	83	6.20 (157.48)
2FC-ASA-13.5-800N-4	ASA 13.5	8 (203.20)	0.010 (.25)	7.00 (177.80)	83	6.20 (157.48)
2FC-ASA-13.5-1000N-10	ASA 13.5	10 (254.00)	0.012 (.30)	14.00 (355.60)	87	12.0 (304.80)
2FC-ASA-16-1000N-10	ASA 16	10 (254.00)	0.012 (.30)	14.00 (355.60)	87	12.0 (304.80)
2FC-ASA-16-1200N-11.8	ASA 16	12 (304.8)	0.012 (.30)	15.87 (403.10)	92	13.8 (350.52)

Note: Call for ASA O-ring groove pricing



### CF Flexible Couplings

MODEL NUMBER	FLANGE TYPE	BELLOWS ID	WALL THICKNESS	FREE LENGTH	SPRING RATE	COMPRESSED LENGTH
2FC-075-1	1.33 CF	1/2 (12.70)	0.005 (.13)	3.20 (81.28)	61	3.0 (76.20)
2FC-075-2	1.33 CF	1/2 (12.70)	0.005 (.13)	4.20 (106.68)	49	3.8 (96.52)
2FC-075-3	1.33 CF	1/2 (12.70)	0.005 (.13)	5.20 (132.08)	38	4.6 (116.84)
2FC-100-1	2.12 CF	3/4 (19.05)	0.006 (.15)	3.20 (81.28)	45	3.0 (76.20)
2FC-100-2	2.12 CF	3/4 (19.05)	0.006 (.15)	4.20 (106.68)	36	3.8 (96.52)
2FC-100-3	2.12 CF	3/4 (19.05)	0.006 (.15)	5.20 (132.08)	28	4.6 (116.84)
2FC-150-1	2.75 CF	1 1/2 (38.10)	0.006 (.15)	3.20 (81.28)	85	3.0 (76.20)
2FC-150-2	2.75 CF	1 1/2 (38.10)	0.006 (.15)	4.20 (106.68)	69	3.8 (96.52)
2FC-150-3	2.75 CF	1 1/2 (38.10)	0.006 (.15)	5.20 (132.08)	53	4.6 (116.84)
2FC-150-6	2.75 CF	1 1/2 (38.10)	0.006 (.15)	8.20 (208.28)	28	7.0 (177.80)
2FC-200-3	3.38 CF	2 (50.80)	0.006 (.15)	6.00 (152.40)	56	5.4 (137.16)
2FC-250-4	4.50 CF	2 1/2 (63.50)	0.008 (.20)	7.00 (177.80)	80	6.2 (157.48)
2FC-300-4	4.62 CF	3 (76.20)	0.008 (.20)	7.00 (177.80)	78	6.2 (157.48)
2FC-400-4	6.00 CF	4 (101.60)	0.008 (.20)	7.00 (177.80)	75	6.2 (157.48)
2FC-500-4	6.75 CF	5 (127.00)	0.008 (.20)	7.00 (177.80)	73	6.2 (157.48)
2FC-600-4	8.00 CF	6 (152.40)	0.010 (.25)	7.00 (177.80)	130	6.2 (157.48)
2FC-800-4	10.00 CF	8 (203.20)	0.010 (.25)	7.00 (177.80)	83	6.2 (157.48)



### SPECIFICATIONS

**Nominal ID sizes:** 3/8 to 12 inches (9.53-304.8mm)

#### Materials

Bellows: 316L or 321 stainless steel  
Flanges: 304 stainless steel  
(316L available on request)

#### Vacuum Range

Metal seal:  $\geq 1 \times 10^{-10}$  mbar - UHV  
Elastomer seal:  $\geq 1 \times 10^{-8}$  mbar - High vacuum

#### Temperature Range

Metal seal: -200°C to 450°C  
Elastomer seal: -20°C to 150°C

All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.

# Flexible Hoses & Couplings

## Flexible Stainless Steel Hoses



### SPECIFICATIONS

**Nominal ID sizes:** 3/4 to 4 inch  
(19.05-101.6mm)

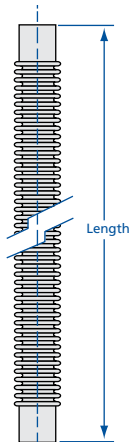
**Materials**

Bellows: 321 stainless steel  
Tube ends: 304 stainless steel

**Vacuum Range:**  $\geq 1 \times 10^{-10}$  mbar - UHV

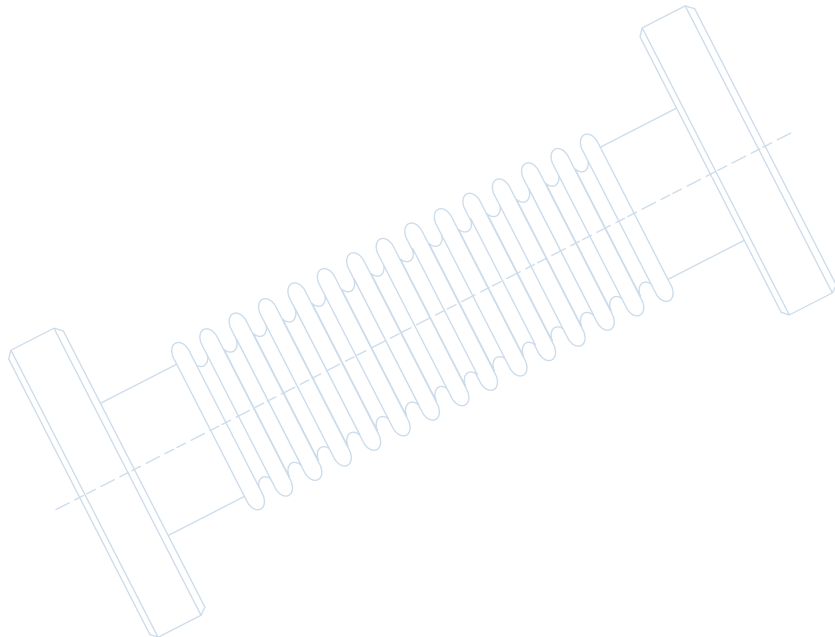
**Temperature Range:** -200°C to 450°C

**Options:** Protective braided sleeving



### Flexible Stainless Steel Hoses without Flanges

MODEL NUMBER	NOMINAL ID	HOSE OD	OVERALL LENGTH	WALL THICKNESS	STATIC BEND RADIUS
FH-075-12	3/4 (19.05)	1.11 (28.19)	12 (304.80)	0.008 (.20)	1.26 (32.00)
FH-075-18	3/4 (19.05)	1.11 (28.19)	18 (457.20)	0.008 (.20)	1.26 (32.00)
FH-075-24	3/4 (19.05)	1.11 (28.19)	24 (609.60)	0.008 (.20)	1.26 (32.00)
FH-075-36	3/4 (19.05)	1.11 (28.19)	36 (914.40)	0.008 (.20)	1.26 (32.00)
FH-100-12	1 (25.40)	1.37 (34.80)	12 (304.80)	0.008 (.20)	1.46 (37.08)
FH-100-18	1 (25.40)	1.37 (34.80)	18 (457.20)	0.008 (.20)	1.46 (37.08)
FH-100-24	1 (25.40)	1.37 (34.80)	24 (609.60)	0.008 (.20)	1.46 (37.08)
FH-100-36	1 (25.40)	1.37 (34.80)	36 (914.40)	0.008 (.20)	1.46 (37.08)
FH-150-12	1 1/2 (38.10)	2.06 (52.32)	12 (304.80)	0.010 (.25)	2.16 (54.86)
FH-150-18	1 1/2 (38.10)	2.06 (52.32)	18 (457.20)	0.010 (.25)	2.16 (54.86)
FH-150-24	1 1/2 (38.10)	2.06 (52.32)	24 (609.60)	0.010 (.25)	2.16 (54.86)
FH-150-36	1 1/2 (38.10)	2.06 (52.32)	36 (914.40)	0.010 (.25)	2.16 (54.86)
FH-200-12	2 (50.80)	2.55 (64.77)	12 (304.80)	0.012 (.30)	3.50 (88.90)
FH-200-18	2 (50.80)	2.55 (64.77)	18 (457.20)	0.012 (.30)	3.50 (88.90)
FH-200-24	2 (50.80)	2.55 (64.77)	24 (609.60)	0.012 (.30)	3.50 (88.90)
FH-200-36	2 (50.80)	2.55 (64.77)	36 (914.40)	0.012 (.30)	3.50 (88.90)
FH-250-12	2 1/2 (63.50)	3.34 (84.84)	12 (304.80)	0.016 (.41)	4.25 (107.95)
FH-250-18	2 1/2 (63.50)	3.34 (84.84)	18 (457.20)	0.016 (.41)	4.25 (107.95)
FH-250-24	2 1/2 (63.50)	3.34 (84.84)	24 (609.60)	0.016 (.41)	4.25 (107.95)
FH-250-36	2 1/2 (63.50)	3.34 (84.84)	36 (914.40)	0.016 (.41)	4.25 (107.95)
FH-300-12	3 (76.20)	3.99 (101.35)	12 (304.80)	0.016 (.41)	6.00 (152.40)
FH-300-18	3 (76.20)	3.99 (101.35)	18 (457.20)	0.016 (.41)	6.00 (152.40)
FH-300-24	3 (76.20)	3.99 (101.35)	24 (609.60)	0.016 (.41)	6.00 (152.40)
FH-300-36	3 (76.20)	3.99 (101.35)	36 (914.40)	0.016 (.41)	6.00 (152.40)
FH-400-12	4 (101.60)	4.83 (122.68)	12 (304.80)	0.016 (.41)	8.60 (218.44)
FH-400-18	4 (101.60)	4.83 (122.68)	18 (457.20)	0.016 (.41)	8.60 (218.44)
FH-400-24	4 (101.60)	4.83 (122.68)	24 (609.60)	0.016 (.41)	8.60 (218.44)
FH-400-36	4 (101.60)	4.83 (122.68)	36 (914.40)	0.016 (.41)	8.60 (218.44)



All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.



### NW Flexible Stainless Steel Hoses – Thin Wall

MODEL NUMBER	FLANGE TYPE	NOMINAL ID	HOSE OD	OVERALL LENGTH	WALL THICKNESS	STATIC BEND RADIUS
LH-075-10-2NW	NW-16	3/4 (19.05)	1.02 (25.91)	10 (254.00)	0.006 (.15)	3.0 (76.20)
LH-075-12-2NW	NW-16	3/4 (19.05)	1.02 (25.91)	12 (304.80)	0.006 (.15)	3.0 (76.20)
LH-075-18-2NW	NW-16	3/4 (19.05)	1.02 (25.91)	18 (457.20)	0.006 (.15)	3.0 (76.20)
LH-075-24-2NW	NW-16	3/4 (19.05)	1.02 (25.91)	24 (609.60)	0.006 (.15)	3.0 (76.20)
LH-075-36-2NW	NW-16	3/4 (19.05)	1.02 (25.91)	36 (914.40)	0.006 (.15)	3.0 (76.20)
LH-100-10-2NW	NW-25	1 (25.40)	1.37 (34.80)	10 (254.00)	0.006 (.15)	4.0 (101.60)
LH-100-12-2NW	NW-25	1 (25.40)	1.37 (34.80)	12 (304.80)	0.006 (.15)	4.0 (101.60)
LH-100-18-2NW	NW-25	1 (25.40)	1.37 (34.80)	18 (457.20)	0.006 (.15)	4.0 (101.60)
LH-100-24-2NW	NW-25	1 (25.40)	1.37 (34.80)	24 (609.60)	0.006 (.15)	4.0 (101.60)
LH-100-36-2NW	NW-25	1 (25.40)	1.37 (34.80)	36 (914.40)	0.006 (.15)	4.0 (101.60)
LH-150-10-2NW	NW-40	1 1/2 (38.10)	1.91 (48.51)	10 (254.00)	0.006 (.15)	6.0 (152.40)
LH-150-12-2NW	NW-40	1 1/2 (38.10)	1.91 (48.51)	12 (304.80)	0.006 (.15)	6.0 (152.40)
LH-150-18-2NW	NW-40	1 1/2 (38.10)	1.91 (48.51)	18 (457.20)	0.006 (.15)	6.0 (152.40)
LH-150-24-2NW	NW-40	1 1/2 (38.10)	1.91 (48.51)	24 (609.60)	0.006 (.15)	6.0 (152.40)
LH-150-36-2NW	NW-40	1 1/2 (38.10)	1.91 (48.51)	36 (914.40)	0.006 (.15)	6.0 (152.40)
LH-200-10-2NW	NW-50	2 (50.80)	2.45 (62.23)	10 (254.00)	0.006 (.15)	7.5 (190.50)
LH-200-12-2NW	NW-50	2 (50.80)	2.45 (62.23)	12 (304.80)	0.006 (.15)	7.5 (190.50)
LH-200-18-2NW	NW-50	2 (50.80)	2.45 (62.23)	18 (457.20)	0.006 (.15)	7.5 (190.50)
LH-200-24-2NW	NW-50	2 (50.80)	2.45 (62.23)	24 (609.60)	0.006 (.15)	7.5 (190.50)
LH-200-36-2NW	NW-50	2 (50.80)	2.45 (62.23)	36 (914.40)	0.006 (.15)	7.5 (190.50)

### NW Flexible Stainless Steel Hoses – Medium Wall

MODEL NUMBER	FLANGE TYPE	NOMINAL ID	HOSE OD	OVERALL LENGTH	WALL THICKNESS	STATIC BEND RADIUS
FH-075-10-2NW	NW-16	3/4 (19.05)	1.11 (28.19)	10 (254.00)	0.008 (.20)	1.26 (32.00)
FH-075-12-2NW	NW-16	3/4 (19.05)	1.11 (28.19)	12 (304.80)	0.008 (.20)	1.26 (32.00)
FH-075-18-2NW	NW-16	3/4 (19.05)	1.11 (28.19)	18 (457.20)	0.008 (.20)	1.26 (32.00)
FH-075-20-2NW	NW-16	3/4 (19.05)	1.11 (28.19)	20 (508.00)	0.008 (.20)	1.26 (32.00)
FH-075-24-2NW	NW-16	3/4 (19.05)	1.11 (28.19)	24 (609.60)	0.008 (.20)	1.26 (32.00)
FH-075-36-2NW	NW-16	3/4 (19.05)	1.11 (28.19)	36 (914.40)	0.008 (.20)	1.26 (32.00)
FH-075-40-2NW	NW-16	3/4 (19.05)	1.11 (28.19)	40 (1016.00)	0.008 (.20)	1.26 (32.00)
FH-100-10-2NW	NW-25	1 (25.40)	1.37 (34.80)	10 (254.00)	0.008 (.20)	1.46 (37.08)
FH-100-12-2NW	NW-25	1 (25.40)	1.37 (34.80)	12 (304.80)	0.008 (.20)	1.46 (37.08)
FH-100-18-2NW	NW-25	1 (25.40)	1.37 (34.80)	18 (457.20)	0.008 (.20)	1.46 (37.08)
FH-100-20-2NW	NW-25	1 (25.40)	1.37 (34.80)	20 (508.00)	0.008 (.20)	1.46 (37.08)
FH-100-24-2NW	NW-25	1 (25.40)	1.37 (34.80)	24 (609.60)	0.008 (.20)	1.46 (37.08)
FH-100-36-2NW	NW-25	1 (25.40)	1.37 (34.80)	36 (914.40)	0.008 (.20)	1.46 (37.08)
FH-100-40-2NW	NW-25	1 (25.40)	1.37 (34.80)	40 (1016.00)	0.008 (.20)	1.46 (37.08)
FH-150-10-2NW	NW-40	1 1/2 (38.10)	2.06 (52.32)	10 (254.00)	0.010 (.25)	2.16 (54.86)
FH-150-12-2NW	NW-40	1 1/2 (38.10)	2.06 (52.32)	12 (304.80)	0.010 (.25)	2.16 (54.86)
FH-150-18-2NW	NW-40	1 1/2 (38.10)	2.06 (52.32)	18 (457.20)	0.010 (.25)	2.16 (54.86)
FH-150-20-2NW	NW-40	1 1/2 (38.10)	2.06 (52.32)	20 (508.00)	0.010 (.25)	2.16 (54.86)
FH-150-24-2NW	NW-40	1 1/2 (38.10)	2.06 (52.32)	24 (609.60)	0.010 (.25)	2.16 (54.86)
FH-150-36-2NW	NW-40	1 1/2 (38.10)	2.06 (52.32)	36 (914.40)	0.010 (.25)	2.16 (54.86)
FH-150-40-2NW	NW-40	1 1/2 (38.10)	2.06 (52.32)	40 (1016.00)	0.010 (.25)	2.16 (54.86)
FH-200-10-2NW	NW-50	2 (50.80)	2.55 (64.77)	10 (254.00)	0.012 (.30)	3.50 (88.90)
FH-200-12-2NW	NW-50	2 (50.80)	2.55 (64.77)	12 (304.80)	0.012 (.30)	3.50 (88.90)
FH-200-18-2NW	NW-50	2 (50.80)	2.55 (64.77)	18 (457.20)	0.012 (.30)	3.50 (88.90)
FH-200-20-2NW	NW-50	2 (50.80)	2.55 (64.77)	20 (508.00)	0.012 (.30)	3.50 (88.90)
FH-200-24-2NW	NW-50	2 (50.80)	2.55 (64.77)	24 (609.60)	0.012 (.30)	3.50 (88.90)
FH-200-36-2NW	NW-50	2 (50.80)	2.55 (64.77)	36 (914.40)	0.012 (.30)	3.50 (88.90)
FH-200-40-2NW	NW-50	2 (50.80)	2.55 (64.77)	40 (1016.00)	0.012 (.30)	3.50 (88.90)

#### SPECIFICATIONS

**Nominal ID sizes:** 3/4 to 2 inch (19.05 -50.8mm)

#### Materials

Hose: 321 stainless steel  
 Tube ends: 304 stainless steel  
 Flanges: 304 stainless steel  
 (316L available on request)

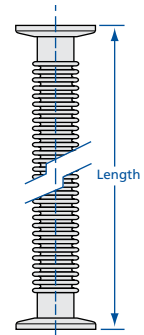
#### Vacuum Range

Metal seal:  $\geq 1 \times 10^{-10}$  mbar - UHV  
 Elastomer seal:  $\geq 1 \times 10^{-8}$  mbar - High vacuum

#### Temperature Range

Metal seal: -200°C to 450°C  
 Elastomer seal: -20°C to 150°C

**Options:** Protective braided sleeving



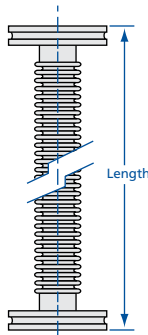
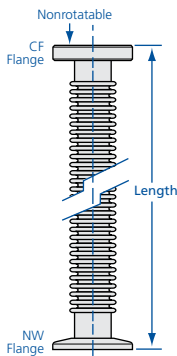
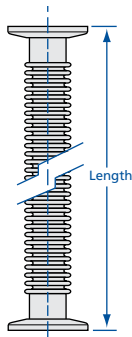
Larger hose IDs and other flange configurations available upon request.

All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.



# Flexible Hoses & Couplings

## Flexible Stainless Steel Hoses



### NW Flexible Stainless Steel Hoses – Thick Wall

MODEL NUMBER	FLANGE TYPE	NOMINAL ID	HOSE OD	OVERALL LENGTH	WALL THICKNESS	STATIC BEND RADIUS
TH-075-10-2NW	NW-16	3/4 (19.05)	1.10 (27.94)	10 (254.00)	0.017 (.43)	2.13 (54.10)
TH-075-20-2NW	NW-16	3/4 (19.05)	1.10 (27.94)	20 (508.00)	0.017 (.43)	2.13 (54.10)
TH-075-40-2NW	NW-16	3/4 (19.05)	1.10 (27.94)	40 (1016.00)	0.017 (.43)	2.13 (54.10)
TH-100-10-2NW	NW-25	1 (25.40)	1.50 (38.10)	10 (254.00)	0.017 (.43)	2.88 (73.15)
TH-100-20-2NW	NW-25	1 (25.40)	1.50 (38.10)	20 (508.00)	0.017 (.43)	2.88 (73.15)
TH-100-40-2NW	NW-25	1 (25.40)	1.50 (38.10)	40 (1016.00)	0.017 (.43)	2.88 (73.15)
TH-150-10-2NW	NW-40	1 1/2 (38.10)	2.10 (53.34)	10 (254.00)	0.020 (.51)	3.50 (88.90)
TH-150-20-2NW	NW-40	1 1/2 (38.10)	2.10 (53.34)	20 (508.00)	0.020 (.51)	3.50 (88.90)
TH-150-40-2NW	NW-40	1 1/2 (38.10)	2.10 (53.34)	40 (1016.00)	0.020 (.51)	3.50 (88.90)
TH-200-10-2NW	NW-50	2 (50.80)	2.63 (66.80)	10 (254.00)	0.020 (.51)	5.25 (133.35)
TH-200-20-2NW	NW-50	2 (50.80)	2.63 (66.80)	20 (508.00)	0.020 (.51)	5.25 (133.35)
TH-200-40-2NW	NW-50	2 (50.80)	2.63 (66.80)	40 (1016.00)	0.020 (.51)	5.25 (133.35)

### NW/CF Flexible Stainless Steel Adapter Hoses – Medium Wall

MODEL NUMBER	FLANGE 1 TYPE	FLANGE 2 TYPE	NOMINAL ID	HOSE OD	OVERALL LENGTH	WALL THICKNESS	STATIC BEND RADIUS
FH-075-12-NW-CF	NW-16	CF-1.33	3/4 (19.05)	1.11 (28.19)	12 (304.80)	0.008 (.20)	1.26 (32.00)
FH-075-18-NW-CF	NW-16	CF-1.33	3/4 (19.05)	1.11 (28.19)	18 (457.20)	0.008 (.20)	1.26 (32.00)
FH-075-24-NW-CF	NW-16	CF-1.33	3/4 (19.05)	1.11 (28.19)	24 (609.60)	0.008 (.20)	1.26 (32.00)
FH-075-36-NW-CF	NW-16	CF-1.33	3/4 (19.05)	1.11 (28.19)	36 (914.40)	0.008 (.20)	1.26 (32.00)
FH-150-12-NW-CF	NW-40	CF-2.75	1 1/2 (38.10)	2.06 (52.32)	12 (304.80)	0.010 (.25)	2.16 (54.86)
FH-150-18-NW-CF	NW-40	CF-2.75	1 1/2 (38.10)	2.06 (52.32)	18 (457.20)	0.010 (.25)	2.16 (54.86)
FH-150-24-NW-CF	NW-40	CF-2.75	1 1/2 (38.10)	2.06 (52.32)	24 (609.60)	0.010 (.25)	2.16 (54.86)
FH-150-36-NW-CF	NW-40	CF-2.75	1 1/2 (38.10)	2.06 (52.32)	36 (914.40)	0.010 (.25)	2.16 (54.86)

### ISO Flexible Stainless Steel Hoses – Medium Wall

MODEL NUMBER	FLANGE TYPE	NOMINAL ID	HOSE OD	OVERALL LENGTH	WALL THICKNESS	STATIC BEND RADIUS
FH-250-10-2ISO	ISO-63	2 1/2 (63.50)	3.34 (84.84)	10 (254.00)	0.016 (.41)	3.15 (80.01)
FH-250-12-2ISO	ISO-63	2 1/2 (63.50)	3.34 (84.84)	12 (304.80)	0.016 (.41)	3.15 (80.01)
FH-250-18-2ISO	ISO-63	2 1/2 (63.50)	3.34 (84.84)	18 (457.20)	0.016 (.41)	3.15 (80.01)
FH-250-20-2ISO	ISO-63	2 1/2 (63.50)	3.34 (84.84)	20 (508.00)	0.016 (.41)	3.15 (80.01)
FH-250-24-2ISO	ISO-63	2 1/2 (63.50)	3.34 (84.84)	24 (609.60)	0.016 (.41)	3.15 (80.01)
FH-250-36-2ISO	ISO-63	2 1/2 (63.50)	3.34 (84.84)	36 (914.40)	0.016 (.41)	3.15 (80.01)
FH-250-40-2ISO	ISO-63	3 (76.20)	3.99 (101.35)	40 (1016.00)	0.016 (.41)	3.15 (80.01)
FH-300-10-2ISO	ISO-80	3 (76.20)	3.99 (101.35)	10 (254.00)	0.016 (.41)	3.82 (97.03)
FH-300-12-2ISO	ISO-80	3 (76.20)	3.99 (101.35)	12 (304.80)	0.016 (.41)	3.82 (97.03)
FH-300-18-2ISO	ISO-80	3 (76.20)	3.99 (101.35)	18 (457.20)	0.016 (.41)	3.82 (97.03)
FH-300-20-2ISO	ISO-80	3 (76.20)	3.99 (101.35)	20 (508.00)	0.016 (.41)	3.82 (97.03)
FH-300-24-2ISO	ISO-80	3 (76.20)	3.99 (101.35)	24 (609.60)	0.016 (.41)	3.82 (97.03)
FH-300-36-2ISO	ISO-80	3 (76.20)	3.99 (101.35)	36 (914.40)	0.016 (.41)	3.82 (97.03)
FH-300-40-2ISO	ISO-80	4 (101.60)	4.83 (122.68)	40 (1016.00)	0.016 (.41)	3.82 (97.03)
FH-400-10-2ISO	ISO-100	4 (101.60)	4.83 (122.68)	10 (254.00)	0.016 (.41)	4.45 (113.03)
FH-400-12-2ISO	ISO-100	4 (101.60)	4.83 (122.68)	12 (304.80)	0.016 (.41)	4.45 (113.03)
FH-400-18-2ISO	ISO-100	4 (101.60)	4.83 (122.68)	18 (457.20)	0.016 (.41)	4.45 (113.03)
FH-400-20-2ISO	ISO-100	4 (101.60)	4.83 (122.68)	20 (508.00)	0.016 (.41)	4.45 (113.03)
FH-400-24-2ISO	ISO-100	4 (101.60)	4.83 (122.68)	24 (609.60)	0.016 (.41)	4.45 (113.03)
FH-400-36-2ISO	ISO-100	4 (101.60)	4.83 (122.68)	36 (914.40)	0.016 (.41)	4.45 (113.03)
FH-400-40-2ISO	ISO-100	4 (101.60)	4.83 (122.68)	40 (1016.00)	0.016 (.41)	4.45 (113.03)

#### SPECIFICATIONS

**Nominal ID sizes:** 3/4 to 4 inch (19.05-101.6mm)

#### Materials

Hose: 321 stainless steel  
 Tube ends: 304 stainless steel  
 Flanges: 304 stainless steel  
 (316L available on request)

#### Vacuum Range

Metal seal:  $\geq 1 \times 10^{-10}$  mbar - UHV  
 Elastomer seal:  $\geq 1 \times 10^{-8}$  mbar - High vacuum

#### Temperature Range

Metal seal: -200°C to 450°C  
 Elastomer seal: -20°C to 150°C

**Options:** Protective braided sleeving

### ISO Flexible Stainless Steel Hoses – Thick Wall

MODEL NUMBER	FLANGE TYPE	NOMINAL ID	HOSE OD	OVERALL LENGTH	WALL THICKNESS	STATIC BEND RADIUS
TH-250-20-2ISO	ISO-63	2 1/2 (63.50)	3.10 (78.74)	20 (508.00)	0.020 (.51)	8.00 (203.20)
TH-250-40-2ISO	ISO-63	2 1/2 (63.50)	3.10 (78.74)	40 (1016.00)	0.020 (.51)	8.00 (203.20)
TH-300-20-2ISO	ISO-80	3 (76.20)	3.92 (99.57)	20 (508.00)	0.020 (.51)	9.00 (228.60)
TH-300-40-2ISO	ISO-80	3 (76.20)	3.92 (99.57)	40 (1016.00)	0.020 (.51)	9.00 (228.60)
TH-400-20-2ISO	ISO-100	4 (101.60)	4.82 (122.43)	20 (508.00)	0.020 (.51)	13.00 (330.20)
TH-400-40-2ISO	ISO-100	4 (101.60)	4.82 (122.43)	40 (1016.00)	0.020 (.51)	13.00 (330.20)

# Flexible Hoses & Couplings

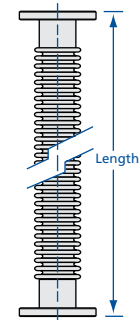
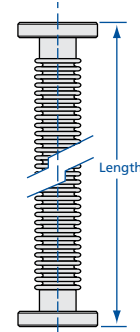
## Flexible Stainless Steel Hoses



### CF Flexible Stainless Steel Hoses

MODEL NUMBER	NOMINAL ID	HOSE OD	OVERALL LENGTH	FLANGE OD	WALL THICKNESS	STATIC BEND RADIUS
FH-075-12-2CF	¾ (19.05)	1.11 (28.19)	12 (304.80)	1.33 (33.78)	0.008 (.20)	1.26 (32.00)
FH-075-18-2CF	¾ (19.05)	1.11 (28.19)	18 (547.20)	1.33 (33.78)	0.008 (.20)	1.26 (32.00)
FH-075-24-2CF	¾ (19.05)	1.11 (28.19)	24 (609.60)	1.33 (33.78)	0.008 (.20)	1.26 (32.00)
FH-075-36-2CF	¾ (19.05)	1.11 (28.19)	36 (914.40)	1.33 (33.78)	0.008 (.20)	1.26 (32.00)
FH-100-12-2CF	1 (25.40)	1.37 (34.80)	12 (304.80)	2.12 (53.85)	0.008 (.20)	1.46 (37.08)
FH-100-18-2CF	1 (25.40)	1.37 (34.80)	18 (547.20)	2.12 (53.85)	0.008 (.20)	1.46 (37.08)
FH-100-24-2CF	1 (25.40)	1.37 (34.80)	24 (609.60)	2.12 (53.85)	0.008 (.20)	1.46 (37.08)
FH-100-36-2CF	1 (25.40)	1.37 (34.80)	36 (914.40)	2.12 (53.85)	0.008 (.20)	1.46 (37.08)
FH-150-12-2CF	1½ (38.10)	2.06 (52.32)	12 (304.80)	2.75 (69.85)	0.010 (.25)	2.16 (54.86)
FH-150-18-2CF	1½ (38.10)	2.06 (52.32)	18 (547.20)	2.75 (69.85)	0.010 (.25)	2.16 (54.86)
FH-150-24-2CF	1½ (38.10)	2.06 (52.32)	24 (609.60)	2.75 (69.85)	0.010 (.25)	2.16 (54.86)
FH-150-36-2CF	1½ (38.10)	2.06 (52.32)	36 (914.40)	2.75 (69.85)	0.010 (.25)	2.16 (54.86)
FH-200-12-2CF	2 (50.80)	2.55 (64.77)	12 (304.80)	3.38 (85.85)	0.012 (.30)	3.50 (88.90)
FH-200-18-2CF	2 (50.80)	2.55 (64.77)	18 (547.20)	3.38 (85.85)	0.012 (.30)	3.50 (88.90)
FH-200-24-2CF	2 (50.80)	2.55 (64.77)	24 (609.60)	3.38 (85.85)	0.012 (.30)	3.50 (88.90)
FH-200-36-2CF	2 (50.80)	2.55 (64.77)	36 (914.40)	3.38 (85.85)	0.012 (.30)	3.50 (88.90)
FH-250-12-2CF	2½ (63.50)	3.34 (84.84)	12 (304.80)	4.50 (114.30)	0.016 (.41)	4.25 (107.95)
FH-250-18-2CF	2½ (63.50)	3.34 (84.84)	18 (547.20)	4.50 (114.30)	0.016 (.41)	4.25 (107.95)
FH-250-24-2CF	2½ (63.50)	3.34 (84.84)	24 (609.60)	4.50 (114.30)	0.016 (.41)	4.25 (107.95)
FH-250-36-2CF	2½ (63.50)	3.34 (84.84)	36 (914.40)	4.50 (114.30)	0.016 (.41)	4.25 (107.95)
FH-300-12-2CF	3 (76.20)	3.99 (101.35)	12 (304.80)	4.62 (117.35)	0.016 (.41)	6.00 (152.40)
FH-300-18-2CF	3 (76.20)	3.99 (101.35)	18 (547.20)	4.62 (117.35)	0.016 (.41)	6.00 (152.40)
FH-300-24-2CF	3 (76.20)	3.99 (101.35)	24 (609.60)	4.62 (117.35)	0.016 (.41)	6.00 (152.40)
FH-300-36-2CF	3 (76.20)	3.99 (101.35)	36 (914.40)	4.62 (117.35)	0.016 (.41)	6.00 (152.40)
FH-400-12-2CF	4 (101.60)	4.83 (122.68)	12 (304.80)	6.00 (152.40)	0.016 (.41)	8.60 (218.44)
FH-400-18-2CF	4 (101.60)	4.83 (122.68)	18 (547.20)	6.00 (152.40)	0.016 (.41)	8.60 (218.44)
FH-400-24-2CF	4 (101.60)	4.83 (122.68)	24 (609.60)	6.00 (152.40)	0.016 (.41)	8.60 (218.44)
FH-400-36-2CF	4 (101.60)	4.83 (122.68)	36 (914.40)	6.00 (152.40)	0.016 (.41)	8.60 (218.44)

Note: See Braided Hose selection next page.



### ASA Flexible Stainless Steel Hoses

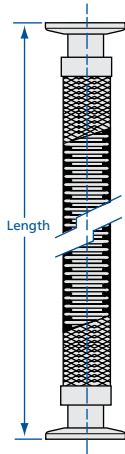
MODEL NUMBER	DESCRIPTION	NOMINAL ID	HOSE OD	OVERALL LENGTH	WALL THICKNESS	STATIC BEND RADIUS
FH-250-12-ASA	ASA-5 on one port	2½ (63.50)	3.34 (84.84)	12 (304.80)	0.016 (.41)	4.25 (107.95)
FH-250-12-2ASA	ASA-5 on both ports	2½ (63.50)	3.34 (84.84)	12 (304.80)	0.016 (.41)	4.25 (107.95)
FH-250-18-ASA	ASA-5 on one port	2½ (63.50)	3.34 (84.84)	18 (457.20)	0.016 (.41)	4.25 (107.95)
FH-250-18-2ASA	ASA-5 on both ports	2½ (63.50)	3.34 (84.84)	18 (457.20)	0.016 (.41)	4.25 (107.95)
FH-250-24-ASA	ASA-5 on one port	2½ (63.50)	3.34 (84.84)	24 (609.60)	0.016 (.41)	4.25 (107.95)
FH-250-24-2ASA	ASA-5 on both ports	2½ (63.50)	3.34 (84.84)	24 (609.60)	0.016 (.41)	4.25 (107.95)
FH-250-36-ASA	ASA-5 on one port	2½ (63.50)	3.34 (84.84)	36 (914.40)	0.016 (.41)	4.25 (107.95)
FH-250-36-2ASA	ASA-5 on both ports	2½ (63.50)	3.34 (84.84)	36 (914.40)	0.016 (.41)	4.25 (107.95)
FH-300-12-ASA	ASA-6 on one port	3 (76.20)	3.99 (101.35)	12 (304.80)	0.016 (.41)	6.00 (152.40)
FH-300-12-2ASA	ASA-6 on both ports	3 (76.20)	3.99 (101.35)	12 (304.80)	0.016 (.41)	6.00 (152.40)
FH-300-18-ASA	ASA-6 on one port	3 (76.20)	3.99 (101.35)	18 (457.20)	0.016 (.41)	6.00 (152.40)
FH-300-18-2ASA	ASA-6 on both ports	3 (76.20)	3.99 (101.35)	18 (457.20)	0.016 (.41)	6.00 (152.40)
FH-300-24-ASA	ASA-6 on one port	3 (76.20)	3.99 (101.35)	24 (609.60)	0.016 (.41)	6.00 (152.40)
FH-300-24-2ASA	ASA-6 on both ports	3 (76.20)	3.99 (101.35)	24 (609.60)	0.016 (.41)	6.00 (152.40)
FH-300-36-ASA	ASA-6 on one port	3 (76.20)	3.99 (101.35)	36 (914.40)	0.016 (.41)	6.00 (152.40)
FH-300-36-2ASA	ASA-6 on both ports	3 (76.20)	3.99 (101.35)	36 (914.40)	0.016 (.41)	6.00 (152.40)
FH-400-12-ASA	ASA-7.5 on one port	4 (101.60)	4.83 (122.68)	12 (304.80)	0.016 (.41)	8.60 (218.44)
FH-400-12-2ASA	ASA-7.5 on both ports	4 (101.60)	4.83 (122.68)	12 (304.80)	0.016 (.41)	8.60 (218.44)
FH-400-18-ASA	ASA-7.5 on one port	4 (101.60)	4.83 (122.68)	18 (457.20)	0.016 (.41)	8.60 (218.44)
FH-400-18-2ASA	ASA-7.5 on both ports	4 (101.60)	4.83 (122.68)	18 (457.20)	0.016 (.41)	8.60 (218.44)
FH-400-24-ASA	ASA-7.5 on one port	4 (101.60)	4.83 (122.68)	24 (609.60)	0.016 (.41)	8.60 (218.44)
FH-400-24-2ASA	ASA-7.5 on both ports	4 (101.60)	4.83 (122.68)	24 (609.60)	0.016 (.41)	8.60 (218.44)
FH-400-36-ASA	ASA-7.5 on one port	4 (101.60)	4.83 (122.68)	36 (914.40)	0.016 (.41)	8.60 (218.44)
FH-400-36-2ASA	ASA-7.5 on both ports	4 (101.60)	4.83 (122.68)	36 (914.40)	0.016 (.41)	8.60 (218.44)

Note: Call for O-ring groove pricing if required

All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.

# Flexible Hoses & Couplings

## Braided Stainless Steel Flexible Hoses



### NW Flexible Stainless Steel Braided Hoses

MODEL NUMBER	FLANGE TYPE	NOMINAL ID	HOSE OD	OVERALL LENGTH	WALL THICKNESS	STATIC BEND RADIUS
FHB-075-12-2NW	NW-16	3/4 (19.05)	1 1/4 (31.75)	12 (304.80)	0.008 (.20)	2.09 (53.09)
FHB-075-18-2NW	NW-16	3/4 (19.05)	1 1/4 (31.75)	18 (457.20)	0.008 (.20)	2.09 (53.09)
FHB-075-20-2NW	NW-16	3/4 (19.05)	1 1/4 (31.75)	20 (508.00)	0.008 (.20)	2.09 (53.09)
FHB-075-24-2NW	NW-16	3/4 (19.05)	1 1/4 (31.75)	24 (609.60)	0.008 (.20)	2.09 (53.09)
FHB-075-36-2NW	NW-16	3/4 (19.05)	1 1/4 (31.75)	36 (914.40)	0.008 (.20)	2.09 (53.09)
FHB-075-40-2NW	NW-16	3/4 (19.05)	1 1/4 (31.75)	40 (1016.00)	0.008 (.20)	2.09 (53.09)
FHB-100-12-2NW	NW-25	1 (25.40)	1 5/8 (41.28)	12 (304.80)	0.008 (.20)	2.52 (64.01)
FHB-100-18-2NW	NW-25	1 (25.40)	1 5/8 (41.28)	18 (457.20)	0.008 (.20)	2.52 (64.01)
FHB-100-20-2NW	NW-25	1 (25.40)	1 5/8 (41.28)	20 (508.00)	0.008 (.20)	2.52 (64.01)
FHB-100-24-2NW	NW-25	1 (25.40)	1 5/8 (41.28)	24 (609.60)	0.008 (.20)	2.52 (64.01)
FHB-100-36-2NW	NW-25	1 (25.40)	1 5/8 (41.28)	36 (914.40)	0.008 (.20)	2.52 (64.01)
FHB-100-40-2NW	NW-25	1 (25.40)	1 5/8 (41.28)	40 (1016.00)	0.008 (.20)	2.52 (64.01)
FHB-150-12-2NW	NW-40	1 1/2 (38.10)	2 1/4 (57.15)	12 (304.80)	0.010 (.25)	3.86 (98.04)
FHB-150-18-2NW	NW-40	1 1/2 (38.10)	2 1/4 (57.15)	18 (457.20)	0.010 (.25)	3.86 (98.04)
FHB-150-20-2NW	NW-40	1 1/2 (38.10)	2 1/4 (57.15)	20 (508.00)	0.010 (.25)	3.86 (98.04)
FHB-150-24-2NW	NW-40	1 1/2 (38.10)	2 1/4 (57.15)	24 (609.60)	0.010 (.25)	3.86 (98.04)
FHB-150-36-2NW	NW-40	1 1/2 (38.10)	2 1/4 (57.15)	36 (914.40)	0.010 (.25)	3.86 (98.04)
FHB-150-40-2NW	NW-40	1 1/2 (38.10)	2 1/4 (57.15)	40 (1016.00)	0.010 (.25)	3.86 (98.04)
FHB-200-12-2NW	NW-50	2 (50.80)	2 3/4 (69.85)	12 (304.80)	0.012 (.30)	4.72 (119.89)
FHB-200-18-2NW	NW-50	2 (50.80)	2 3/4 (69.85)	18 (457.20)	0.012 (.30)	4.72 (119.89)
FHB-200-20-2NW	NW-50	2 (50.80)	2 3/4 (69.85)	20 (508.00)	0.012 (.30)	4.72 (119.89)
FHB-200-24-2NW	NW-50	2 (50.80)	2 3/4 (69.85)	24 (609.60)	0.012 (.30)	4.72 (119.89)
FHB-200-36-2NW	NW-50	2 (50.80)	2 3/4 (69.85)	36 (914.40)	0.012 (.30)	4.72 (119.89)
FHB-200-40-2NW	NW-50	2 (50.80)	2 3/4 (69.85)	40 (1016.00)	0.012 (.30)	4.72 (119.89)

### CF Flexible Stainless Steel Braided Hoses

MODEL NUMBER	NOMINAL ID	HOSE OD	OVERALL LENGTH	FLANGE OD	WALL THICKNESS	STATIC BEND RADIUS
FHB-075-12-2CF	3/4 (19.05)	1 1/4 (31.75)	12 (304.80)	1.33 (33.78)	0.008 (.20)	2.09 (53.09)
FHB-075-18-2CF	3/4 (19.05)	1 1/4 (31.75)	18 (457.20)	1.33 (33.78)	0.008 (.20)	2.09 (53.09)
FHB-075-24-2CF	3/4 (19.05)	1 1/4 (31.75)	24 (609.60)	1.33 (33.78)	0.008 (.20)	2.09 (53.09)
FHB-075-36-2CF	3/4 (19.05)	1 1/4 (31.75)	36 (914.40)	1.33 (33.78)	0.008 (.20)	2.09 (53.09)
FHB-100-12-2CF	1 (25.40)	1 5/8 (41.28)	12 (304.80)	2.12 (53.85)	0.008 (.20)	2.52 (64.01)
FHB-100-18-2CF	1 (25.40)	1 5/8 (41.28)	18 (457.20)	2.12 (53.85)	0.008 (.20)	2.52 (64.01)
FHB-100-24-2CF	1 (25.40)	1 5/8 (41.28)	24 (609.60)	2.12 (53.85)	0.008 (.20)	2.52 (64.01)
FHB-100-36-2CF	1 (25.40)	1 5/8 (41.28)	36 (914.40)	2.12 (53.85)	0.008 (.20)	2.52 (64.01)
FHB-150-12-2CF	1 1/2 (38.10)	2 1/4 (57.15)	12 (304.80)	2.75 (69.85)	0.010 (.25)	3.86 (98.04)
FHB-150-18-2CF	1 1/2 (38.10)	2 1/4 (57.15)	18 (457.20)	2.75 (69.85)	0.010 (.25)	3.86 (98.04)
FHB-150-24-2CF	1 1/2 (38.10)	2 1/4 (57.15)	24 (609.60)	2.75 (69.85)	0.010 (.25)	3.86 (98.04)
FHB-150-36-2CF	1 1/2 (38.10)	2 1/4 (57.15)	36 (914.40)	2.75 (69.85)	0.010 (.25)	3.86 (98.04)
FHB-200-12-2CF	2 (50.80)	2 3/4 (69.85)	12 (304.80)	3.38 (85.85)	0.012 (.30)	4.72 (119.89)
FHB-200-18-2CF	2 (50.80)	2 3/4 (69.85)	18 (457.20)	3.38 (85.85)	0.012 (.30)	4.72 (119.89)
FHB-200-24-2CF	2 (50.80)	2 3/4 (69.85)	24 (609.60)	3.38 (85.85)	0.012 (.30)	4.72 (119.89)
FHB-200-36-2CF	2 (50.80)	2 3/4 (69.85)	36 (914.40)	3.38 (85.85)	0.012 (.30)	4.72 (119.89)

#### SPECIFICATIONS

**Nominal ID sizes:** 3/4 to 2 inch  
(19.05-50.8mm)

#### Materials

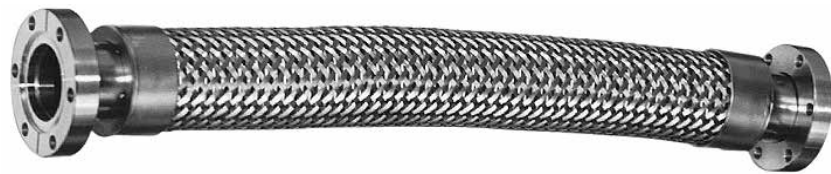
Bellows: 321 stainless steel  
Tube ends: 304 stainless steel  
Flanges: 304 stainless steel  
(316L available on request)

#### Vacuum Range

Metal seal:  $\geq 1 \times 10^{-10}$  mbar - UHV  
Elastomer seal:  $\geq 1 \times 10^{-8}$  mbar - High vacuum

#### Temperature Range

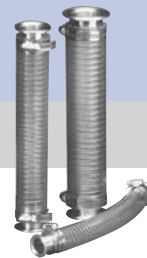
Metal seal: -200°C to 450°C  
Elastomer seal: -20°C to 150°C



Larger hose IDs and other flange configurations available upon request.

# Flexible Hoses & Couplings

## PVC Flexible Hoses

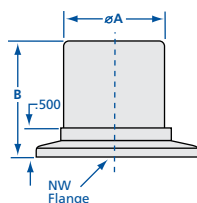
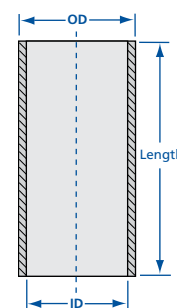


### PVC Flexible Hoses

Each length includes two hose clamps for installation.

MODEL NUMBER	NOMINAL ID	HOSE OD	STATIC BEND RADIUS
PVC-050	1/2 (12.70)	0.813 (20.65)	2.00 (50.80)
PVC-075	3/4 (19.05)	1.125 (28.58)	3.00 (76.20)
PVC-100	1 (25.40)	1.375 (34.93)	4.00 (101.60)
PVC-150	1 1/2 (38.10)	2.000 (50.80)	6.00 (152.40)
PVC-200	2 (50.80)	2.500 (63.50)	8.00 (203.20)

Note: To order specify length required in feet as follows: PVC-100-5.0 and PVC-200-10.0



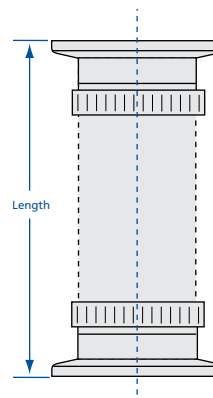
### PVC Hose Nipples

MODEL NUMBER	FLANGE TYPE	NIPPLE MATERIAL	A	B
1HN-NW-10-050	NW-10	304 SS	0.50 (12.70)	1.26 (32.00)
1HN-NW-16-075	NW-16	304 SS	0.75 (19.05)	1.26 (32.00)
1HN-NW-25-100	NW-25	304 SS	1.00 (25.40)	1.50 (38.10)
1HN-NW-40-150	NW-40	304 SS	1.50 (38.10)	1.97 (50.04)
1HN-NW-50-200	NW-50	304 SS	2.00 (50.80)	2.17 (55.12)



### PVC Hoses with NW Flanges

MODEL NUMBER	FLANGE TYPE	NOMINAL ID	HOSE OD	OVERALL LENGTH	STATIC BEND RADIUS
PVC-050-12-2NW	NW-10	1/2 (12.70)	0.813 (20.65)	12 (304.80)	2.00 (50.80)
PVC-050-24-2NW	NW-10	1/2 (12.70)	0.813 (20.65)	24 (609.60)	2.00 (50.80)
PVC-050-36-2NW	NW-10	1/2 (12.70)	0.813 (20.65)	36 (914.40)	2.00 (50.80)
PVC-050-72-2NW	NW-10	1/2 (12.70)	0.813 (20.65)	72 (1828.80)	2.00 (50.80)
PVC-075-12-2NW	NW-16	3/4 (19.05)	1.125 (28.58)	12 (304.80)	3.00 (76.20)
PVC-075-24-2NW	NW-16	3/4 (19.05)	1.125 (28.58)	24 (609.60)	3.00 (76.20)
PVC-075-36-2NW	NW-16	3/4 (19.05)	1.125 (28.58)	36 (914.40)	3.00 (76.20)
PVC-075-72-2NW	NW-16	3/4 (19.05)	1.125 (28.58)	72 (1828.80)	3.00 (76.20)
PVC-100-12-2NW	NW-25	1 (25.40)	1.375 (34.93)	12 (304.80)	4.00 (101.60)
PVC-100-24-2NW	NW-25	1 (25.40)	1.375 (34.93)	24 (609.60)	4.00 (101.60)
PVC-100-36-2NW	NW-25	1 (25.40)	1.375 (34.93)	36 (914.40)	4.00 (101.60)
PVC-100-72-2NW	NW-25	1 (25.40)	1.375 (34.93)	72 (1828.80)	4.00 (101.60)
PVC-150-12-2NW	NW-40	1 1/2 (38.10)	2.000 (50.80)	12 (304.80)	6.00 (152.40)
PVC-150-24-2NW	NW-40	1 1/2 (38.10)	2.000 (50.80)	24 (609.60)	6.00 (152.40)
PVC-150-36-2NW	NW-40	1 1/2 (38.10)	2.000 (50.80)	36 (914.40)	6.00 (152.40)
PVC-150-72-2NW	NW-40	1 1/2 (38.10)	2.000 (50.80)	72 (1828.80)	6.00 (152.40)
PVC-200-12-2NW	NW-50	2 (50.80)	2.500 (63.50)	12 (304.80)	8.00 (203.20)
PVC-200-24-2NW	NW-50	2 (50.80)	2.500 (63.50)	24 (609.60)	8.00 (203.20)
PVC-200-36-2NW	NW-50	2 (50.80)	2.500 (63.50)	36 (914.40)	8.00 (203.20)
PVC-200-72-2NW	NW-50	2 (50.80)	2.500 (63.50)	72 (1828.80)	8.00 (203.20)



### SPECIFICATIONS

Nominal ID sizes: 1/2 to 2 inch (12.7-50.8mm)

#### Materials

Hose: Wire reinforced polyvinyl chloride (PVC)  
Nipples: 304 stainless steel  
Flanges: 304 stainless steel  
(316L available on request)

Vacuum Range: ≥1 x 10<sup>-2</sup> Rough vacuum

Maximum Temperature: -4° to 65°C





### SPECIFICATIONS

**Tube OD sizes:** 1/2 to 12 inches (12.7-304.8mm)

**Materials:** 304 or 316L stainless steel

**Vacuum range:**  $\geq 1 \times 10^{-13}$  mbar

**Temperature range:** -200° to 450°C

Nor-Cal Products has manufactured stainless steel weld fittings for nearly forty five years. We worked with Lawrence Livermore National Laboratory in the 1960's to develop their specification for vacuum piping, which has become the standard in the industry. Weld fittings are commonly used in vacuum roughing lines on semiconductor process equipment and for forelines and pump exhaust lines in semiconductor subfabs.

All tees and crosses are fabricated with the pulled-port technique and full penetration butt welds. This provides crevice-free weld joints and the maximum in cleanliness for UHV applications. Weld fittings are available from stock in 304 stainless steel, and some sizes are stocked in 316L stainless steel for additional corrosion resistance. All weld fittings are available with various flange combinations. See appropriate section.



### Tube Finishes

The standard finish for all weld fittings is tumbled, although there are some fittings that are not available with the tumbled finish. These weld fittings are bead-blasted and are designated by a "-B" suffix on the part number. (See photo at right) All weld fittings can be electropolished on request. Call for pricing.



Beadblasted Finish

Tumbled Finish

*All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.*

# Weld Fittings

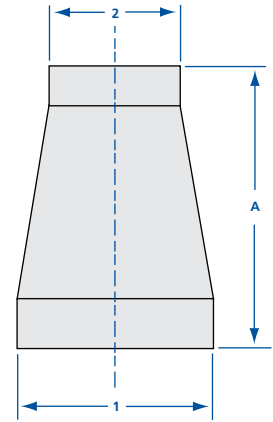
## Conical Reducers & End Caps



Conical reducers provide a compact means of adapting to a smaller diameter tube with minimal loss in conductance. They are available from stock in 304 stainless steel and some sizes are stocked in 316L stainless steel for additional corrosion resistance. Conical adapter nipples are available with various flange combinations. See appropriate section.

### Conical Reducers

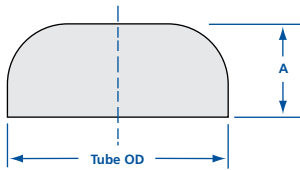
MODEL NUMBER	TUBE OD 1	TUBE OD 2	A	WALL THICKNESS
B-31W-100-075	1 (25.40)	3/4 (19.05)	1.38 (35.05)	0.065 (1.65)
B-31W-150-075	1 1/2 (38.10)	3/4 (19.05)	2.38 (60.45)	0.065 (1.65)
B-31W-150-100	1 1/2 (38.10)	1 (25.40)	2.38 (60.45)	0.065 (1.65)
B-31W-200-100	2 (50.80)	1 (25.40)	2.38 (60.45)	0.065 (1.65)
B-31W-200-150	2 (50.80)	1 1/2 (38.10)	2.38 (60.45)	0.065 (1.65)
B-31W-250-150	2 1/2 (63.50)	1 1/2 (38.10)	2.38 (60.45)	0.065 (1.65)
B-31W-250-200	2 1/2 (63.50)	2 (50.80)	2.38 (60.45)	0.065 (1.65)
B-31W-300-150	3 (76.20)	1 1/2 (38.10)	3.62 (91.95)	0.065 (1.65)
B-31W-300-200	3 (76.20)	2 (50.80)	3.62 (91.95)	0.065 (1.65)
B-31W-300-250	3 (76.20)	2 1/2 (63.50)	3.62 (91.95)	0.065 (1.65)
B-31W-400-150	4 (101.60)	1 1/2 (38.10)	3.62 (91.95)	0.065 (1.65)
B-31W-400-200	4 (101.60)	2 (50.80)	3.62 (91.95)	0.065 (1.65)
B-31W-400-250	4 (101.60)	2 1/2 (63.50)	3.62 (91.95)	0.065 (1.65)
B-31W-400-300	4 (101.60)	3 (76.20)	3.62 (91.95)	0.065 (1.65)
B-31W-600-300-B	6 (152.40)	3 (76.20)	5.50 (139.70)	0.074 (1.88)
B-31W-600-400-B	6 (152.40)	4 (101.60)	5.50 (139.70)	0.074 (1.88)
B-31W-600-400-HW	6 (152.40)	4 (101.60)	5.50 (139.70)	0.083 (2.11)



### 316L Conical Reducers

MODEL NUMBER	TUBE OD 1	TUBE OD 2	A	WALL THICKNESS
B-31W-200-100-316L	2 (50.80)	1 (25.40)	2.38 (60.45)	0.065 (1.65)
B-31W-200-150-316L	2 (50.80)	1 1/2 (38.10)	2.38 (60.45)	0.065 (1.65)
B-31W-300-200-316L	3 (76.20)	2 (50.80)	3.62 (91.95)	0.065 (1.65)
B-31W-400-150-316L-B	4 (101.60)	1 1/2 (38.10)	5.25 (133.35)	0.065 (1.65)
B-31W-400-200-316L	4 (101.60)	2 (50.80)	3.62 (91.95)	0.065 (1.65)

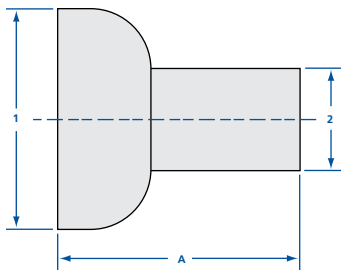
### End Caps



MODEL NUMBER	TUBE OD	A	WALL THICKNESS
G-2W-050	1/2 (12.70)	0.32 (8.13)	0.050 (1.27)
G-2W-075	3/4 (19.05)	0.31 (7.87)	0.050 (1.27)
G-2W-100	1 (25.40)	0.43 (10.92)	0.060 (1.52)
G-2W-150	1 1/2 (38.10)	0.56 (14.22)	0.060 (1.52)
G-2W-200	2 (50.80)	0.75 (19.05)	0.060 (1.52)
G-2W-250	2 1/2 (63.50)	0.70 (17.78)	0.060 (1.52)
G-2W-300	3 (76.20)	0.67 (17.02)	0.074 (1.88)
G-2W-400	4 (101.60)	0.48 (12.19)	0.074 (1.88)
G-2W-450	4 1/2 (114.30)	0.51 (12.95)	0.060 (1.52)
G-2W-600	6 (152.40)	0.88 (22.35)	0.074 (1.88)
G-2W-800	8 (203.20)	0.83 (21.08)	0.074 (1.88)



### End Cap Reducers



MODEL NUMBER	TUBE OD 1	TUBE OD 2	A
ECR-075-050	3/4 (19.05)	1/2 (12.70)	2.38 (60.45)
ECR-100-050	1 (25.40)	1/2 (12.70)	2.38 (60.45)
ECR-100-075	1 (25.40)	3/4 (19.05)	2.38 (60.45)
ECR-150-050	1 1/2 (38.10)	1/2 (12.70)	2.38 (60.45)
ECR-150-075	1 1/2 (38.10)	3/4 (19.05)	2.38 (60.45)
ECR-150-100	1 1/2 (38.10)	1 (25.40)	2.38 (60.45)
ECR-200-150	2 (50.80)	1 1/2 (38.10)	2.38 (60.45)
ECR-250-200	2 1/2 (63.50)	2 (50.80)	2.38 (60.45)
ECR-300-150	3 (76.20)	1 1/2 (38.10)	3.62 (91.95)
ECR-300-200	3 (76.20)	2 (50.80)	3.62 (91.95)
ECR-300-250	3 (76.20)	2 1/2 (63.50)	3.62 (91.95)
ECR-400-200-B	4 (101.60)	2 (50.80)	3.62 (91.95)
ECR-400-300-B	4 (101.60)	3 (76.20)	3.62 (91.95)
ECR-600-400-B	6 (152.40)	4 (101.60)	3.62 (91.95)
ECR-800-600-B	8 (203.20)	6 (152.40)	3.62 (91.95)

Other reducer combinations can be supplied upon request.

### SPECIFICATIONS

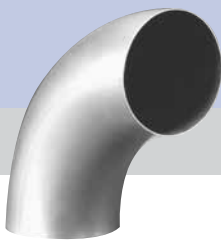
Tube OD sizes: 1 to 6 inches (25.4-152.4mm)

Materials: 304 or 316L stainless steel

Vacuum range:  $\geq 1 \times 10^{-13}$  mbar

Temperature range: -200° to 450°C

# Weld Fittings Elbows



### SPECIFICATIONS

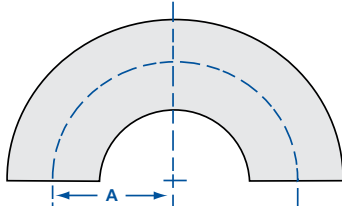
**Tube OD sizes:** 1/2 to 10 inches (12.7-254mm)

**Materials:** 304 or 316L stainless steel

**Vacuum range:** ≥1 x 10<sup>-13</sup> mbar

**Temperature range:** -200° to 450°C

Nor-Cal Products offers 180° return bend radius elbows in sizes up to 2 inches (50.8mm) OD and 45° and 90° radius elbows in sizes up to 10 inches (254mm) OD. Radius elbows offer the highest conductance geometry in a tube bend. All elbows are available from stock in 304 stainless steel, and some sizes are stocked in 316L stainless steel for additional corrosion resistance. We have added several 45° and 90° elbows with tangents to match other commonly available dimensions. Look for the HW suffix for elbows that match HPS weld fitting dimensions, for example. Elbows are also available with various flange combinations. See appropriate section.



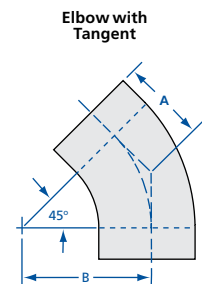
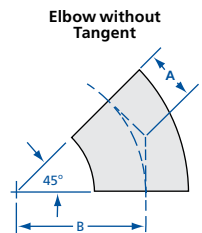
### 180° Return Bend Radius Elbows

MODEL NUMBER	TUBE OD	WALL THICKNESS	A
G-2WU-050	1/2 (12.70)	0.049 (1.24)	0.75 (19.05)
G-2WU-075	3/4 (19.05)	0.035 (0.89)	1.00 (25.40)
G-2WU-100	1 (25.40)	0.065 (1.65)	1.50 (38.10)
G-2WU-150	1 1/2 (38.10)	0.065 (1.65)	2.25 (57.15)
G-2WU-200	2 (50.80)	0.065 (1.65)	3.00 (76.20)

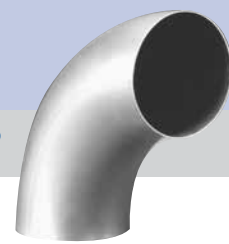


### 45° Radius Elbows

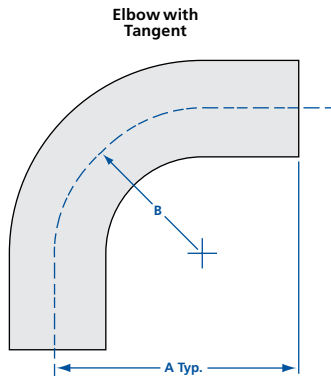
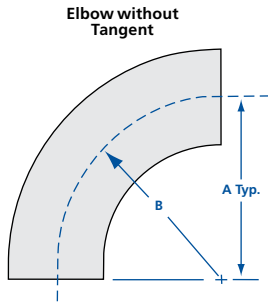
MODEL NUMBER	TUBE OD	WALL THICKNESS	A	B	316L TANGENT
G-2WK-050	1/2 (12.70)	0.049 (1.24)	0.31 (7.87)	0.75 (19.05)	
G-2WK-075	3/4 (19.05)	0.035 (0.89)	0.41 (10.41)	1.00 (25.40)	
G-2WK-075T	3/4 (19.05)	0.065 (1.65)	0.41 (10.41)	1.13 (28.70)	
G-2KL-075	3/4 (19.05)	0.035 (0.89)	0.76 (19.30)	1.00 (25.40)	✓
G-2WK-100	1 (25.40)	0.065 (1.65)	0.62 (15.75)	1.50 (38.10)	
G-2WK-100-316L	1 (25.40)	0.065 (1.65)	0.62 (15.75)	1.50 (38.10)	✓
G-2KL-100	1 (25.40)	0.065 (1.65)	0.97 (24.64)	1.50 (38.10)	✓
G-2KL-100HW	1 (25.40)	0.065 (1.65)	1.19 (30.23)	1.50 (38.10)	✓
G-2KL-100-316L	1 (25.40)	0.065 (1.65)	0.97 (24.64)	1.50 (38.10)	✓ ✓
G-2WK-150	1 1/2 (38.10)	0.065 (1.65)	0.93 (23.62)	2.25 (57.15)	
G-2WK-150-316L	1 1/2 (38.10)	0.065 (1.65)	0.93 (23.62)	2.25 (57.15)	✓
G-2KL-150	1 1/2 (38.10)	0.065 (1.65)	1.53 (35.86)	2.25 (57.15)	✓
G-2KL-150HW	1 1/2 (38.10)	0.065 (1.65)	1.63 (41.40)	2.25 (57.15)	✓
G-2KL-150-316L	1 1/2 (38.10)	0.065 (1.65)	1.53 (35.86)	2.25 (57.15)	✓ ✓
G-2WK-200	2 (50.80)	0.065 (1.65)	1.24 (31.50)	3.00 (76.20)	
G-2WK-200-316L	2 (50.80)	0.065 (1.65)	1.24 (31.50)	3.00 (76.20)	✓
G-2KL-200	2 (50.80)	0.065 (1.65)	1.84 (46.74)	3.00 (76.20)	✓
G-2KL-200HW	2 (50.80)	0.065 (1.65)	2.31 (58.67)	3.00 (76.20)	✓
G-2KL-200-316L	2 (50.80)	0.065 (1.65)	1.84 (46.74)	3.00 (76.20)	✓ ✓
G-2WK-250	2 1/2 (63.50)	0.065 (1.65)	1.55 (39.37)	3.75 (95.25)	
G-2WK-250-316L	2 1/2 (63.50)	0.065 (1.65)	1.55 (39.37)	3.75 (95.25)	✓
G-2KL-250	2 1/2 (63.50)	0.065 (1.65)	3.00 (76.20)	3.75 (95.25)	✓
G-2WK-300	3 (76.20)	0.065 (1.65)	1.86 (47.24)	4.50 (114.30)	
G-2WK-300-316L	3 (76.20)	0.065 (1.65)	1.86 (47.24)	4.50 (114.30)	✓
G-2KL-300	3 (76.20)	0.065 (1.65)	3.68 (93.47)	4.50 (114.30)	✓
G-2KL-300-316L	3 (76.20)	0.065 (1.65)	3.68 (93.47)	4.50 (114.30)	✓ ✓
G-2WK-400	4 (101.60)	0.083 (2.11)	2.49 (63.25)	6.00 (152.40)	
G-2WK-400-316L	4 (101.60)	0.083 (2.11)	2.49 (63.25)	6.00 (152.40)	✓
G-2KL-400	4 (101.60)	0.083 (2.11)	4.78 (121.41)	6.00 (152.40)	✓
G-2KL-400HW	4 (101.60)	0.083 (2.11)	4.81 (122.17)	6.00 (152.40)	✓
G-2KL-400-316L	4 (101.60)	0.083 (2.11)	4.78 (121.41)	6.00 (152.40)	✓ ✓
G-2WK-600-B	6 (152.40)	0.083 (2.11)	3.73 (94.74)	9.00 (228.60)	
G-2WK-800-B	8 (203.20)	.109-.134 (2.77-3.40)	4.97 (126.24)	12.00 (304.80)	
G-2WK-1000-B	10 (254.00)	.109-.134 (2.77-3.40)	6.21 (157.73)	15.00 (381.00)	



All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.



### 90° Radius Elbows



MODEL NUMBER	TUBE OD	WALL THICKNESS	A	B	316L TANGENT
G-2WC-050	1/2 (12.70)	0.049 (1.24)	0.75 (19.05)	0.75 (19.05)	
G-2WC-075	3/4 (19.05)	0.035 (0.89)	1.00 (25.40)	1.00 (25.40)	
G-2WC-075H	3/4 (19.05)	0.035 (0.89)	1.42 (36.07)	1.00 (25.40)	✓
G-2WC-100	1 (25.40)	0.065 (1.65)	1.50 (38.10)	1.50 (38.10)	
G-2WC-100-316L	1 (25.40)	0.065 (1.65)	1.50 (38.10)	1.50 (38.10)	✓
G-2WC-100H	1 (25.40)	0.065 (1.65)	1.82 (46.23)	1.50 (38.10)	✓
G-2WC-100HW	1 (25.40)	0.065 (1.65)	2.06 (52.32)	1.50 (38.10)	✓
G-2WC-100H-316L	1 (25.40)	0.065 (1.65)	1.82 (46.23)	1.50 (38.10)	✓ ✓
G-2WC-150	1 1/2 (38.10)	0.065 (1.65)	2.25 (57.15)	2.25 (57.15)	
G-2WC-150-316L	1 1/2 (38.10)	0.065 (1.65)	2.25 (57.15)	2.25 (57.15)	✓
G-2WC-150H	1 1/2 (38.10)	0.065 (1.65)	2.41 (61.21)	2.25 (57.15)	✓
G-2WC-150HW	1 1/2 (38.10)	0.065 (1.65)	2.94 (74.68)	2.25 (57.15)	✓
G-2WC-150HL	1 1/2 (38.10)	0.065 (1.65)	4.97 (126.24)	2.25 (57.15)	✓
G-2WC-150H-316L	1 1/2 (38.10)	0.065 (1.65)	2.41 (61.21)	2.25 (57.15)	✓ ✓
G-2WC-200	2 (50.80)	0.065 (1.65)	3.00 (76.20)	3.00 (76.20)	
G-2WC-200-316L	2 (50.80)	0.065 (1.65)	3.00 (76.20)	3.00 (76.20)	✓
G-2WC-200H	2 (50.80)	0.065 (1.65)	4.06 (103.12)	3.00 (76.20)	✓
G-2WC-200HL	2 (50.80)	0.065 (1.65)	5.36 (136.14)	3.00 (76.20)	✓
G-2WC-200H-316L	2 (50.80)	0.065 (1.65)	4.06 (103.12)	3.00 (76.20)	✓ ✓
G-2WC-250	2 1/2 (63.50)	0.065 (1.65)	3.75 (95.25)	3.75 (95.25)	
G-2WC-250-316L	2 1/2 (63.50)	0.065 (1.65)	3.75 (95.25)	3.75 (95.25)	✓
G-2WC-250H	2 1/2 (63.50)	0.065 (1.65)	5.19 (131.83)	3.75 (95.25)	✓
G-2WC-300	3 (76.20)	0.065 (1.65)	4.50 (114.30)	4.50 (114.30)	
G-2WC-300-316L	3 (76.20)	0.065 (1.65)	4.50 (114.30)	4.50 (114.30)	✓
G-2WC-300H	3 (76.20)	0.065 (1.65)	6.31 (160.27)	4.50 (114.30)	✓
G-2WC-400	4 (101.60)	0.083 (2.11)	6.00 (152.40)	6.00 (152.40)	
G-2WC-400-316L	4 (101.60)	0.083 (2.11)	6.00 (152.40)	6.00 (152.40)	✓
G-2WC-400H	4 (101.60)	0.083 (2.11)	8.31 (211.07)	6.00 (152.40)	✓
G-2WC-600-B	6 (152.40)	0.109 (2.77)	9.00 (228.60)	9.00 (228.60)	
G-2WC-800-B	8 (203.20)	.109 - .134 (2.77-3.40)	12.00 (304.80)	12.00 (304.80)	
G-2WC-1000-B	10 (254.00)	.109 - .134 (2.77-3.40)	15.00 (381.00)	15.00 (381.00)	

### SPECIFICATIONS

Tube OD sizes: 1/2 to 10 inches (12.7-254mm)

Materials: 304 stainless steel  
(316L available upon request)

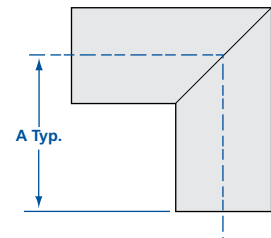
Vacuum range:  $\geq 1 \times 10^{-13}$  mbar

Temperature range: -200° to 450°C



### 90° Mitered Elbow

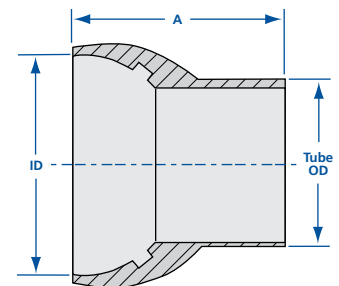
MODEL NUMBER	TUBE OD	WALL THICKNESS	A
E-075M	3/4 (19.05)	0.035 (0.89)	1.00 (25.40)
E-100M	1 (25.40)	0.065 (1.65)	1.88 (47.75)
E-150M	1 1/2 (38.10)	0.065 (1.65)	2.25 (57.15)
E-150MH	1 1/2 (38.10)	0.065 (1.65)	2.41 (61.21)
E-200M	2 (50.80)	0.065 (1.65)	3.00 (76.20)
E-200MH	2 (50.80)	0.065 (1.65)	2.61 (66.29)
E-250M	2 1/2 (63.50)	0.065 (1.65)	3.00 (76.20)
E-250MV	2 1/2 (63.50)	0.065 (1.65)	3.75 (95.25)
E-300M	3 (76.20)	0.065 (1.65)	3.25 (82.55)
E-400M	4 (101.60)	0.083 (2.11)	3.88 (98.55)
E-400MV-B	4 (101.60)	0.083 (2.11)	4.87 (123.70)
E-500M-B	5 (127.00)	0.083 (2.11)	4.25 (107.95)
E-600M-B	6 (152.40)	0.083 (2.11)	5.00 (127.00)
E-600MV-B	6 (152.40)	0.083 (2.11)	6.06 (153.92)
E-800M-B	8 (203.20)	0.120 (3.05)	7.00 (177.80)
E-1000M-B	10 (254.00)	0.120 (3.05)	9.50 (241.30)



### Ball Sockets

MODEL NUMBER	ID	TUBE OD	A	O-RING SIZE
BS-50/30	2 (50.80)	1 1/2 (38.10)	1.75 (19.05)	-
BS-50/30-G	2 (50.80)	1 1/2 (38.10)	1.75 (19.05)	2-224
BS-75/50	3 (76.20)	2 (50.80)	2.50 (63.50)	-
BS-75/50-G	3 (76.20)	2 (50.80)	2.50 (63.50)	2-232

Note: "G" suffix in model number indicates O-ring and O-ring groove are provided.





# Weld Fittings

## Tees

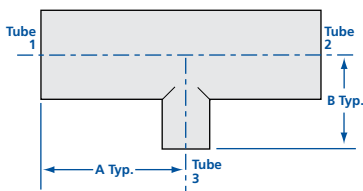
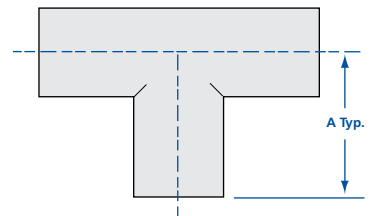


304 stainless steel tees and reducer tees are fabricated with the pulled-port technique and full penetration welds. This provides crevice-free weld joints and the maximum in cleanliness for UHV applications. Other sizes are available on request. We have added tees to match other commonly available dimensions. Look for the HW suffix for tees that match HPS weld fitting dimensions, for example. These fittings are also offered with various flange combinations. See appropriate flange section.



### Tees

MODEL NUMBER	TUBE OD	WALL THICKNESS	A
G-7W-050	1/2 (12.70)	0.049 (1.24)	0.75 (19.05)
G-7W-075	3/4 (19.05)	0.035 (0.89)	1.00 (25.40)
G-7W-075HW	3/4 (19.05)	0.065 (1.65)	1.88 (47.75)
G-7W-075T	3/4 (19.05)	0.065 (1.65)	1.00 (25.40)
G-7W-100	1 (25.40)	0.065 (1.65)	1.88 (47.75)
G-7W-150	1 1/2 (38.10)	0.065 (1.65)	2.25 (57.15)
G-7W-150H	1 1/2 (38.10)	0.065 (1.65)	2.41 (61.21)
G-7W-200	2 (50.80)	0.065 (1.65)	3.00 (76.20)
G-7W-200H	2 (50.80)	0.065 (1.65)	2.61 (66.29)
G-7W-250	2 1/2 (63.50)	0.065 (1.65)	3.00 (76.20)
G-7W-250V	2 1/2 (63.50)	0.065 (1.65)	3.75 (95.25)
G-7W-300	3 (76.20)	0.065 (1.65)	3.25 (82.55)
G-7W-400	4 (101.60)	0.083 (2.11)	3.88 (98.55)
G-7W-400V	4 (101.60)	0.083 (2.11)	4.87 (123.70)
G-7W-500-B	5 (127.00)	0.083 (2.11)	4.25 (107.95)
G-7W-600-B	6 (152.40)	0.083 (2.11)	5.00 (127.00)
G-7W-600V-B	6 (152.40)	0.083 (2.11)	6.06 (153.92)
G-7W-800-B	8 (203.20)	0.120 (3.05)	7.00 (177.80)
G-7W-1000-B	10 (254.00)	0.120 (3.05)	9.50 (241.30)



### Reducer Tees

MODEL NUMBER	TUBE 1 & 2 ARM OD	TUBE 3 LEG OD	A	B
G-7WR-100-050	1 (25.40)	1/2 (12.70)	1.88 (47.75)	1.00 (25.40)
G-7WR-100-075	1 (25.40)	3/4 (19.05)	1.88 (47.75)	1.12 (28.45)
G-7WR-150-050	1 1/2 (38.10)	1/2 (12.70)	2.25 (57.15)	1.25 (31.75)
G-7WR-150-075	1 1/2 (38.10)	3/4 (19.05)	2.25 (57.15)	1.38 (35.05)
G-7WR-150-100	1 1/2 (38.10)	1 (25.40)	2.25 (57.15)	2.13 (54.10)
G-7WR-200-050	2 (50.80)	1/2 (12.70)	3.00 (76.20)	1.50 (38.10)
G-7WR-200-075	2 (50.80)	3/4 (19.05)	3.00 (76.20)	1.63 (41.40)
G-7WR-200-100	2 (50.80)	1 (25.40)	3.00 (76.20)	2.38 (60.45)
G-7WR-200-150	2 (50.80)	1 1/2 (38.10)	3.00 (76.20)	2.50 (63.50)
G-7WR-250-150	2 1/2 (63.50)	1 1/2 (38.10)	3.00 (76.20)	2.75 (69.85)
G-7WR-250-200	2 1/2 (63.50)	2 (50.80)	3.00 (76.20)	3.25 (82.55)
G-7WR-300-150	3 (76.20)	1 1/2 (38.10)	3.25 (82.55)	3.00 (76.20)
G-7WR-300-200	3 (76.20)	2 (50.80)	3.25 (82.55)	3.50 (88.90)
G-7WR-300-250	3 (76.20)	2 1/2 (63.50)	3.25 (82.55)	3.25 (82.55)
G-7WR-400-150-B	4 (101.60)	1 1/2 (38.10)	3.88 (98.55)	3.50 (88.90)
G-7WR-400-200-B	4 (101.60)	2 (50.80)	3.88 (98.55)	4.00 (101.60)
G-7WR-400-250-B	4 (101.60)	2 1/2 (63.50)	3.88 (98.55)	3.75 (95.25)
G-7WR-400-300-B	4 (101.60)	3 (76.20)	3.88 (98.55)	3.75 (95.25)
G-7WR-500-400-B	5 (127.00)	4 (101.60)	4.25 (107.95)	4.38 (111.25)
G-7WR-600-150-B	6 (152.40)	1 1/2 (38.10)	5.00 (127.00)	4.50 (114.30)
G-7WR-600-200-B	6 (152.40)	2 (50.80)	5.00 (127.00)	5.00 (127.00)
G-7WR-600-250-B	6 (152.40)	2 1/2 (63.50)	5.00 (127.00)	4.75 (120.65)
G-7WR-600-400-B	6 (152.40)	4 (101.60)	5.00 (127.00)	4.88 (123.95)
G-7WR-600-500-B	6 (152.40)	5 (127.00)	5.00 (127.00)	4.75 (120.65)
G-7WR-800-600-B	8 (203.20)	6 (152.40)	7.00 (177.80)	6.00 (152.40)



#### SPECIFICATIONS

**Tube OD sizes:** 1/2 to 10 inches (12.7-254mm)

**Materials:** 304 or stainless steel  
(316L available upon request)

**Vacuum range:** ≥1 x 10<sup>-13</sup> mbar

**Temperature range:** -200° to 450°C

All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.

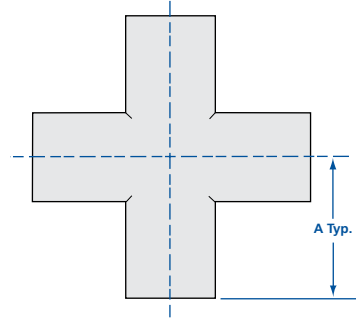


304 stainless steel crosses and reducer crosses are offered in a wide range of sizes as standard products. All crosses are fabricated with the pulled-port technique and full penetration butt welds. This provides crevice-free weld joints and the maximum in cleanliness for UHV applications. As always, other sizes are available on request. These fittings are offered with various flange combinations. See appropriate sections.

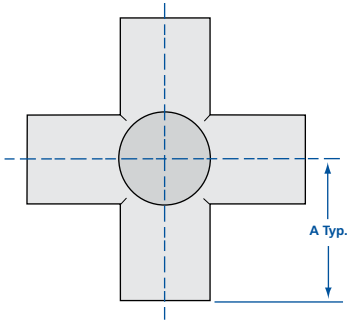
### 4-Way Crosses



MODEL NUMBER	TUBE OD	WALL THICKNESS	A
G-9W-050	1/2 (12.70)	0.049 (1.24)	0.75 (19.05)
G-9W-075	3/4 (19.05)	0.035 (.89)	1.00 (25.40)
G-9W-100	1 (25.40)	0.065 (1.65)	1.88 (47.75)
G-9W-150	1 1/2 (38.10)	0.065 (1.65)	2.25 (57.15)
G-9W-150H	1 1/2 (38.10)	0.065 (1.65)	2.41 (61.21)
G-9W-200	2 (50.80)	0.065 (1.65)	3.00 (76.20)
G-9W-200H	2 (50.80)	0.065 (1.65)	2.61 (66.29)
G-9W-250	2 1/2 (63.50)	0.065 (1.65)	3.00 (76.20)
G-9W-250V	2 1/2 (63.50)	0.065 (1.65)	3.75 (95.25)
G-9W-300	3 (76.20)	0.065 (1.65)	3.25 (82.55)
G-9W-400	4 (101.60)	0.083 (2.11)	3.88 (98.55)
G-9W-400V	4 (101.60)	0.083 (2.11)	4.87 (123.70)
G-9W-500-B	5 (127.00)	0.083 (2.11)	4.25 (107.95)
G-9W-600-B	6 (152.40)	0.083 (2.11)	5.00 (127.00)
G-9W-600V-B	6 (152.40)	0.083 (2.11)	6.06 (153.92)
G-9W-800-B	8 (203.20)	0.120 (3.05)	7.00 (177.80)
G-9W-1000-B	10 (254.00)	0.120 (3.05)	9.50 (241.30)



### 5-Way Crosses



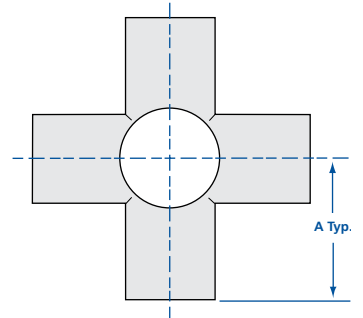
MODEL NUMBER	TUBE OD	WALL THICKNESS	A
G-10W-075	3/4 (19.05)	0.035 (0.89)	1.00 (25.40)
G-10W-100	1 (25.40)	0.065 (1.65)	1.88 (47.75)
G-10W-150	1 1/2 (38.10)	0.065 (1.65)	2.25 (57.15)
G-10W-200	2 (50.80)	0.065 (1.65)	3.00 (76.20)
G-10W-250	2 1/2 (63.50)	0.065 (1.65)	3.00 (76.20)
G-10W-250V	2 1/2 (63.50)	0.065 (1.65)	3.75 (95.25)
G-10W-300-B	3 (76.20)	0.065 (1.65)	3.25 (82.55)
G-10W-400-B	4 (101.60)	0.083 (2.11)	3.88 (98.55)
G-10W-400V-B	4 (101.60)	0.083 (2.11)	4.87 (123.70)
G-10W-500-B	5 (127.00)	0.083 (2.11)	4.25 (107.95)
G-10W-600-B	6 (152.40)	0.083 (2.11)	5.00 (127.00)
G-10W-600V-B	6 (152.40)	0.083 (2.11)	6.06 (153.92)
G-10W-800-B	8 (203.20)	0.120 (3.05)	7.00 (177.80)
G-10W-1000-B	10 (254.00)	0.120 (3.05)	9.50 (241.30)



### 6-Way Crosses



MODEL NUMBER	TUBE OD	WALL THICKNESS	A
G-11W-075	3/4 (19.05)	0.035 (0.89)	1.00 (25.40)
G-11W-100	1 (25.40)	0.065 (1.65)	1.88 (47.75)
G-11W-150	1 1/2 (38.10)	0.065 (1.65)	2.25 (57.15)
G-11W-200	2 (50.80)	0.065 (1.65)	3.00 (76.20)
G-11W-250	2 1/2 (63.50)	0.065 (1.65)	3.00 (76.20)
G-11W-250V	2 1/2 (63.50)	0.065 (1.65)	3.75 (95.25)
G-11W-300-B	3 (76.20)	0.065 (1.65)	3.25 (82.55)
G-11W-400-B	4 (101.60)	0.083 (2.11)	3.88 (98.55)
G-11W-400V-B	4 (101.60)	0.083 (2.11)	4.87 (123.70)
G-11W-500-B	5 (127.00)	0.083 (2.11)	4.25 (107.95)
G-11W-600-B	6 (152.40)	0.083 (2.11)	5.00 (127.00)
G-11W-600V-B	6 (152.40)	0.083 (2.11)	6.06 (153.92)
G-11W-800-B	8 (203.20)	0.120 (3.05)	7.00 (177.80)
G-11W-1000-B	10 (254.00)	0.120 (3.05)	9.50 (241.30)



# Weld Fittings

## Reducer Crosses & Stainless Steel Tubing



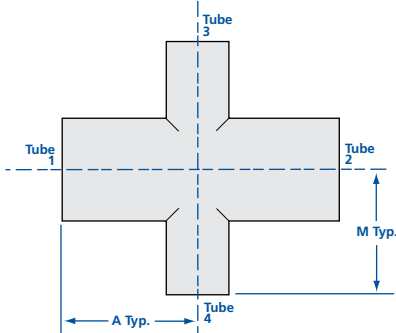
### SPECIFICATIONS

**Tube OD sizes:** 3/4 to 12 inches (19.05-304.8mm)

**Materials:** 304 or stainless steel (316L available upon request)

**Vacuum range:**  $\geq 1 \times 10^{-13}$  mbar

**Temperature range:** -200° to 450°C



### Reducer Crosses

MODEL NUMBER	TUBE 1 & 2 ARM OD	TUBE 3 & 4 LEG OD	A	M
G-9WR-100-050	1 (25.40)	1/2 (12.70)	1.88 (47.75)	1.00 (25.40)
G-9WR-100-075	1 (25.40)	3/4 (19.05)	1.88 (47.75)	1.12 (28.45)
G-9WR-150-050	1 1/2 (38.10)	1/2 (12.70)	2.25 (57.15)	1.25 (31.75)
G-9WR-150-075	1 1/2 (38.10)	3/4 (19.05)	2.25 (57.15)	1.38 (35.05)
G-9WR-150-100	1 1/2 (38.10)	1 (25.40)	2.25 (57.15)	2.13 (54.10)
G-9WR-200-050	2 (50.80)	1/2 (12.70)	3.00 (76.20)	1.50 (38.10)
G-9WR-200-075	2 (50.80)	3/4 (19.05)	3.00 (76.20)	1.63 (41.40)
G-9WR-200-150	2 (50.80)	1 1/2 (38.10)	3.00 (76.20)	2.50 (63.50)
G-9WR-250-150	2 1/2 (63.50)	1 1/2 (38.10)	3.00 (76.20)	2.75 (69.85)
G-9WR-250-200	2 1/2 (63.50)	2 (50.80)	3.00 (76.20)	3.25 (82.55)
G-9WR-300-150	3 (76.20)	1 1/2 (38.10)	3.25 (82.55)	3.00 (76.20)
G-9WR-300-200	3 (76.20)	2 (50.80)	3.25 (82.55)	3.50 (88.90)
G-9WR-300-250	3 (76.20)	2 1/2 (63.50)	3.25 (82.55)	3.25 (82.55)
G-9WR-400-150-B	4 (101.60)	1 1/2 (38.10)	3.88 (98.55)	3.50 (88.90)
G-9WR-400-200-B	4 (101.60)	2 (50.80)	3.88 (98.55)	4.00 (101.60)
G-9WR-400-250-B	4 (101.60)	2 1/2 (63.50)	3.88 (98.55)	3.75 (95.25)
G-9WR-400-300-B	4 (101.60)	3 (76.20)	3.88 (98.55)	3.75 (95.25)
G-9WR-500-400-B	5 (127.00)	4 (101.60)	4.25 (107.95)	4.38 (111.25)
G-9WR-600-150-B	6 (152.40)	1 1/2 (38.10)	5.00 (127.00)	4.50 (114.30)
G-9WR-600-200-B	6 (152.40)	2 (50.80)	5.00 (127.00)	5.00 (127.00)
G-9WR-600-250-B	6 (152.40)	2 1/2 (63.50)	5.00 (127.00)	4.75 (120.65)
G-9WR-600-300-B	6 (152.40)	3 (76.20)	5.00 (127.00)	4.75 (120.65)
G-9WR-600-400-B	6 (152.40)	4 (101.60)	5.00 (127.00)	4.88 (123.95)
G-9WR-600-500-B	6 (152.40)	5 (127.00)	5.00 (127.00)	4.75 (120.65)
G-9WR-800-600-B	8 (203.20)	6 (152.40)	7.00 (177.80)	6.00 (152.40)

Other reducer combinations can be supplied upon request.



### 304 & 316L Stainless Steel Tubing

Nor-Cal's consumption of stainless steel tubing for its own products makes it possible to offer 304 and 316L stainless steel tubing in lengths up to 20 feet. 304 stainless steel tubing standard finishes are white pickled (Number 1 unpolished), bright annealed or polished OD and ID, depending on the size. 316L stainless steel tubing is offered with a bright annealed finish only. Bright annealed and polished tubing has been pickled and passivated. Polished tube can be described as No. 4 polished. The surface meets ASTM A270, and has received a 150 grit polish on the OD and 180 grit on the ID. Special cleaning, materials and surface finishes are available for an additional charge.

MODEL NUMBER	SURFACE FINISH	TUBE OD	TUBE ID	WALL THICKNESS
SST-050	Bright annealed	1/2 (12.70)	0.402 (10.21)	0.049 (1.24)
SST-075	Bright annealed	3/4 (19.05)	0.680 (17.27)	0.035 (0.89)
SST-075-316L	Bright annealed	3/4 (19.05)	0.680 (17.27)	0.035 (0.89)
SST-100	Polished ID & OD	1 (25.40)	0.870 (22.10)	0.065 (1.65)
SST-100-316L	Bright annealed	1 (25.40)	0.870 (22.10)	0.065 (1.65)
SST-125	Bright annealed	1 1/4 (31.75)	1.120 (28.45)	0.065 (1.65)
SST-150	Polished ID & OD	1 1/2 (38.10)	1.370 (34.80)	0.065 (1.65)
SST-150-316L	Bright annealed	1 1/2 (38.10)	1.370 (34.80)	0.065 (1.65)
SST-162	Bright annealed	1 5/8 (41.28)	1.490 (37.85)	0.065 (1.65)
SST-175	Bright annealed	1 3/4 (44.45)	1.630 (41.40)	0.065 (1.65)
SST-200	Polished ID & OD	2 (50.80)	1.870 (47.50)	0.065 (1.65)
SST-200-316L	Bright annealed	2 (50.80)	1.870 (47.50)	0.065 (1.65)
SST-250	Polished ID & OD	2 1/2 (63.5)	2.370 (60.20)	0.065 (1.65)
SST-250-316L	Bright annealed	2 1/2 (63.5)	2.370 (60.20)	0.065 (1.65)
SST-300	Polished ID & OD	3 (76.20)	2.870 (72.90)	0.065 (1.65)
SST-300-316L	Bright annealed	3 (76.20)	2.870 (72.90)	0.065 (1.65)
SST-400	Polished ID & OD	4 (101.60)	3.834 (97.38)	0.083 (2.11)
SST-400-316L	Bright annealed	4 (101.60)	3.834 (97.38)	0.083 (2.11)
SST-500	White pickled	5 (127.00)	4.834 (122.78)	0.083 (2.11)
SST-600	White pickled	6 (152.40)	5.834 (148.18)	0.083 (2.11)
SST-800	White pickled	8 (203.20)	7.760 (197.10)	0.120 (3.05)
SST-1000	White pickled	10 (254.00)	9.760 (247.90)	0.120 (3.05)
SST-1200	White pickled	12 (304.80)	11.760 (298.70)	0.120 (3.05)

\* Cutting fee applies, call for pricing. To order specify length required in feet as follows:  
SST-400-20.0 (20" length of 4" OD tube) SST-150-316L-20.0 (20" length of 1.5" OD tube)

### SPECIFICATIONS

**Tube OD sizes:** 1/2 to 12 inches (12.7-304.8mm)

**Materials:** 304 or 316L stainless steel

**Finishes:** Bright Annealed, polished ID & OD & white pickled

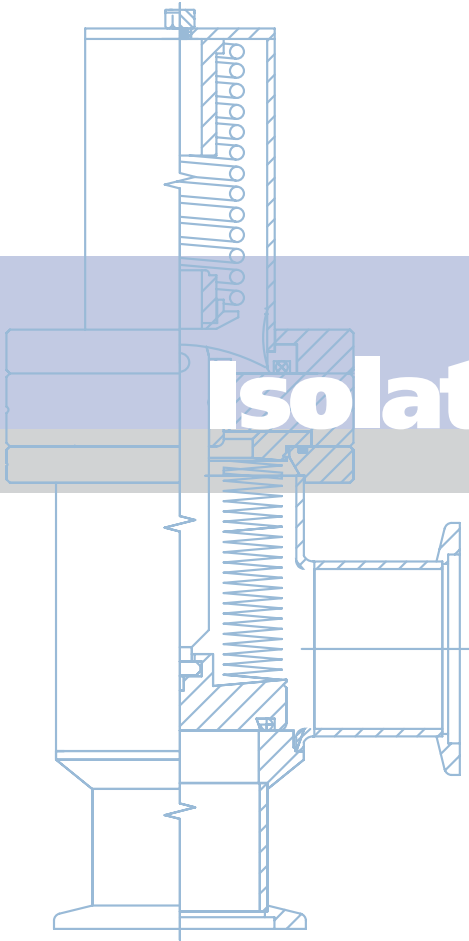
**Vacuum range:**  $\geq 1 \times 10^{-13}$  mbar

**Temperature range:** -200° to 450°C

All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.

# Isolation Valves

## Section Three



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Since 1962, Nor-Cal Products has been improving our valve designs and expanding our product line in order to offer valves for almost every vacuum application. Our valves provide outstanding performance in the most demanding applications such as semiconductor and compound semiconductor processing.

### Valve Applications

PROCESS APPLICATION	VALVE TYPE	UNIQUE FEATURES	SIZES (NOMINAL ID)	SEAT SEAL	TEMPERATURE RANGE	PRESSURE RANGE	ACTUATION	CYCLES <sup>(1)</sup>
HIGH-VACUUM ROUGHING	<b>N-Series</b>	Compact. High Cycle.	3/4 to 2 (19 to 50)	Viton	-20° to 150°C	1000 to 10 <sup>-9</sup> mbar	Pneumatic	3,000,000
	<b>Poppet</b>	Large stroke	3/8 to 4 (10 to 100)	Viton	-20° to 150°C	1000 to 10 <sup>-9</sup> mbar	Manual or Pneumatic	250,000
	<b>Genesis</b>	Small footprint. Low profile	3/4 to 4 (19 to 100)	Viton	-20° to 150°C	1000 to 10 <sup>-9</sup> mbar	Pneumatic	1,000,000
	<b>Bellowless Poppet</b>	O-ring sealed shaft	3/8 to 2 (10 to 50)	Viton	-20° to 150°C	1000 to 10 <sup>-9</sup> mbar	Pneumatic	250,000
	<b>Butterfly</b>	Low profile. 1/4 swing	3/4 to 1 1/2 (19 to 38)	Viton	-20° to 150°C	1000 to 10 <sup>-9</sup> mbar	Manual	30,000
UHV ROUGHING	<b>All-metal</b>	All-metal seals	3/4 to 1 1/2 (19 to 38)	Copper	-250° to 400°C	1000 to 10 <sup>-11</sup> mbar	Manual	10,000 <sup>(2)</sup>
HV, UHV PUMP ISOLATION	<b>Gate</b>	Highest conductance	5/8 to 12 (16 to 300)	Viton	-20° to 150°C	1000 to 10 <sup>-10</sup> mbar	Manual or Pneumatic	100,000 <sup>(3)</sup>
HIGH-VACUUM PUMP ISOLATION	<b>Pendulum</b>	Low particle generation. Low vibration	6 to 16 (150 to 400)	Viton	-20° to 150°C	1000 to 10 <sup>-9</sup> mbar	Pneumatic	200,000
PUMP EXHAUST	<b>Ball</b>	1/4 swing open/close	3/4 to 2 (19 to 50)	Teflon	20° to 150°C	1000 to 10 <sup>-4</sup> mbar	Manual	20,000
GAS INTRODUCTION	<b>Leak</b>	Variable leak	N/A	Copper	-250° to 450°C	1000 to ≥1x 10 <sup>-11</sup> mbar	Manual	300 <sup>(2)</sup>

(1) MTBF (2) Cycle life is reduced with high temperature bakeouts (3) Optional Million Cycle Valve is available.

### Poppet Valves

Our poppet valves are fully opening for high conductance and to prevent bellows contamination while the valve is in the open position, reducing particle contamination when the valve is cycled. Our bodies are die-formed from 304 stainless steel to eliminate sharp inside corners and improve conductance. The valves are electropolished for lower outgassing and better corrosion resistance. The welded bellows are made from AM-350 stainless steel to provide excellent corrosion resistance and flexibility. They are designed with additional segments to provide extended life.

### Ball Valves

Ball valves are a low cost, manually or pneumatically operated, straight through isolation device. Their simple, robust design provides high reliability in "dirty" applications. They are commonly used on MOCVD and CVD equipment downstream from the chamber or vacuum pump to isolate traps or abatement tools. A stainless steel body and Teflon seat make these valves ideal for corrosive environments. Other applications include vacuum and other facilities requirements.

### Genesis Valves

The Genesis modular vacuum valve system provides semiconductor equipment designers with unlimited possibilities for downstream vacuum subassemblies. Nippleless valve bodies and block fittings can be assembled by two attachment methods using universal ISO-KF centering ring/O-ring hardware, providing maximum flexibility and the smallest footprint possible. Additionally these valves feature million cycle reliability, integrated low-cost soft start circuit and modular heaters.

### Linear Gate Valves

Our linear gate valves have an ultra-slim profile, which makes them perfect for applications where space is limited, and their smaller volume results in lower outgassing and faster pump-down. Larger sizes have a unique feature in the actuator, which dampens the vibration, which can arise when the gate is opened. This makes these valves ideal for semiconductor and other vibration sensitive processes.

### All-Metal Valves

Nor-Cal's bakeable all-metal seal angle valves are intended for use in UHV or cryogenic applications where temperature extremes preclude the use of our elastomer seal valves. Approved for use in beamline facilities, these valves have a temperature operating range from -250°C to 400°C.





### New Products

#### N-Series Poppet Valves

The new N-Series poppet valves are an innovative, compact design with an MTBF of 3 million cycles. A bellows-sealed stem and electropolished stainless steel body provides long life even in the most demanding applications. Standard pneumatic actuation is normally closed. N-series valves are available in right angle or angle-in-line body styles with tube ends, NW flanges and CF rotatable flanges. Optional air solenoids are available in multiple voltages and can be ordered factory installed or as separate kits for easy field installation.



#### Leak Valves

Leak valves are used for controlling gas introduction into high and ultra-high vacuum systems. They utilize an optically flat sapphire poppet and a metal seal seat, allowing bakeout temperatures to 450°C.

#### Manual Butterfly Valves

These Viton O-ring sealed valves provide a low-cost alternative to bellows sealed gate valves. Quarter-turn actuation, small footprint and the shortest possible gas path make manual butterfly valves the preferred choice for many applications.



#### Machined Ball Valves

Our new ball valves are a low cost, manually or pneumatically operated, straight through isolation device. Their simple, robust design provides high reliability in "dirty" applications. They are commonly used on MOCVD and CVD equipment downstream from the chamber or vacuum pump to isolate traps or abatement tools. A stainless steel body and Teflon seat make these valves ideal for corrosive environments. A quarter turn of the handle quickly switches the valve from open to close. They are available with NW-16 through NW-50 flanges as standards. Heater jackets are available to reduce process by-product accumulation.



#### Custom Valves

Nor-Cal frequently provides custom and modified standard isolation valves to meet our customer's specific requirements. Single or multiple valves can be integrated with manifolds, chambers and other components. Many special features can be specified by adding options. See page 98.

#### Standard Options

- Normally open pneumatic actuation
- Microswitch position indication
- Special O-rings
- Various air solenoid voltages
- Fitting options for bypass lines
- Heater jackets, insulators and controllers

#### Custom Features

- Special port lengths and configurations for drop-in compatibility with other manufacturer's valves
- Custom flange configurations
- Special position indicators
- Pump out ports
- Custom finishes
- Gate shields for linear gate valve O-rings



Spring-to-close pneumatic actuator with gate shield

Custom fitting option



Custom valve manifold

# Isolation Valves

## N-Series Valves



### SPECIFICATIONS

**Nominal Port OD's:** ¾ (19), 1 (25) and 1 ½ (38) inches (mm)

#### Materials

**Body:** Electropolished 304 stainless steel  
**Bellows:** Welded AM-350 stainless steel  
**Bonnet seal:** Viton  
**Poppet seal:** Viton  
*Other O-ring compounds available*

**Actuation:** Spring / Pneumatic  
 Air-to-open, spring-to-close

**Helium leak tested:**  $\leq 10^{-9}$  mbar l/sec.

**Operating Temperature:** 150°C Max.

**Supply Pressure:** 60 to 100 psig (4-7 bar)

**Differential pressure:** Maximum 20psi (1.4bar) differential across the valve seat

**Maximum temperature with Viton seals:** 150°C Max

**Vacuum Range:** 1000 to  $1 \times 10^{-9}$  mbar

**Options:** Solenoids, optical sensors, Heater jackets and controllers available for all valves.



The new N-Series poppet valves are an innovative, compact design with an MTBF of 3 million cycles. A bellows-sealed stem and electropolished stainless steel body provides long life even in the most demanding applications. Standard pneumatic actuation is normally closed (Air-to-Open / Spring-to-Close). N-series valves are available in right angle or angle-in-line body styles with tube ends, NW flanges or CF rotatable flanges. Optional air solenoids are available in multiple voltages and can be ordered

factory installed or as separate kits for easy field installation.

Mounting slots for optional position indicators are incorporated into the actuator body resulting in a reduction in overall size and elimination of the risk of physical damage to the sensors. Sensors are easily installed without adjustment. Optical switch sensors indicate both the open & closed valve positions. It is possible for each valve to have two sensors installed for redundancy. Position indicators can

be ordered factory installed or as separate kits for easy field installation.

One rebuild kit fits the four valve sizes from NW-16 through NW-50 to reduce maintenance inventory costs. Viton O-ring seals are standard, however the valve is designed to accept alternate seal compounds to satisfy your application requirements.

### N-Series Options

Please use the following part numbering tree to add the appropriate options to a standard N-Series valve model number. See tables below for option codes.



#### Example: NAP-150-NW-NPN-K91-511

Right angle N-Series valve with 1.5 inch (38.1) bore, NW-40 flanges, optical position indicators, Kalrez 9100 O-rings, 120VAC and air solenoid option.

### O-ring Material Options

SEAL MATERIAL	CODE
Viton	Default (no code)
Kalrez 4079	-K79
Kalrez 8085	-K85
Kalrez 8575	-K75
Kalrez 9100	-K91
Chemraz E38	-C38
Dupra 192	-D19
Perlast G74P	-PP7

### Air Solenoid Option

DESCRIPTION	CODE	KIT
120VAC, 50/60 Hz	-S11	N-S11-K
24VDC	-S21	N-S21-K
240VAC, 50/60 Hz	-S31	N-S31-K
24VAC, 50/60 Hz	-S41	N-S41-K

### Position Indicator Option

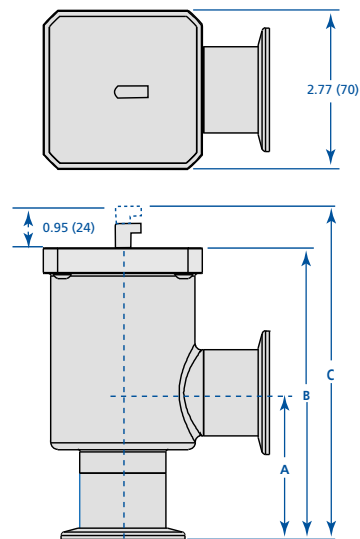
DESCRIPTION	CODE	KIT
Optical - main valve open & closed	NPN	N-NPN-K
Optical - main valve open & closed	PNP	N-PNP-K

All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.



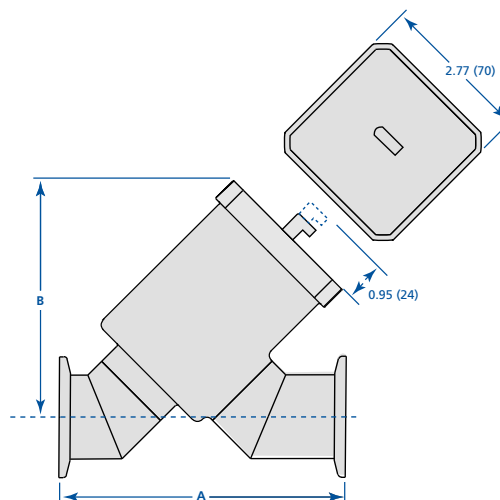
### Pneumatic N-Series Angle Valve

MODEL NUMBER	NOMINAL PORT OD	DESCRIPTION	A	B	C
<b>NAP-075</b>	3/4 (19)	No Flanges	1.42 (36)	3.95 (100)	4.90 (124)
<b>NAP-075-NW</b>	3/4 (19)	NW-16	1.57 (40)	4.10 (104)	5.05 (128)
<b>NAP-075-CF</b>	3/4 (19)	CF-133, Rotatable	1.91 (48)	4.73 (120)	5.68 (144)
<b>NAP-100</b>	1 (25)	No Flanges	1.82 (46)	4.35 (111)	5.30 (135)
<b>NAP-100-NW</b>	1 (25)	NW-25	1.97 (50)	4.50 (114)	5.45 (138)
<b>NAP-100-CF</b>	1 (25)	CF-212, Rotatable	2.28 (58)	4.81 (122)	5.76 (146)
<b>NAP-150</b>	1 1/2 (38)	No Flanges	2.41 (61)	4.94 (125)	5.89 (150)
<b>NAP-150-NW</b>	1 1/2 (38)	NW-40	2.56 (65)	5.09 (129)	6.04 (153)
<b>NAP-150-CF</b>	1 1/2 (38)	CF-275, Rotatable	2.62 (67)	5.15 (131)	6.09 (155)
<b>NAP-200</b>	1 1/2 (38)	No Flanges	2.61 (66)	5.14 (131)	6.09 (155)
<b>NAP-200-NW</b>	1 1/2 (38)	NW-50	2.76 (70)	5.29 (134)	6.24 (159)
<b>NAP-200-CF</b>	1 1/2 (38)	CF-338, Rotatable	2.84 (72)	5.37 (136)	6.32 (161)



### Pneumatic N-Series Angle In-Line Valve

MODEL NUMBER	NOMINAL PORT OD	DESCRIPTION	A	B
<b>NAIP-075</b>	3/4 (19)	No Flanges	3.64 (92)	4.60 (117)
<b>NAIP-075-NW</b>	3/4 (19)	NW-16	3.94 (100)	4.60 (117)
<b>NAIP-075-CF</b>	3/4 (19)	CF-133, Rotatable	4.20 (107)	4.60 (117)
<b>NAIP-100</b>	1 (25)	No Flanges	3.64 (92)	4.00 (102)
<b>NAIP-100-NW</b>	1 (25)	NW-25	3.94 (100)	4.00 (102)
<b>NAIP-100-CF</b>	1 (25)	CF-212, Rotatable	4.75 (121)	4.00 (102)
<b>NAIP-150</b>	1 1/2 (38)	No Flanges	4.82 (122)	4.37 (111)
<b>NAIP-150-NW</b>	1 1/2 (38)	NW-40	5.12 (130)	4.37 (111)
<b>NAIP-150-CF</b>	1 1/2 (38)	CF-275, Rotatable	5.24 (133)	4.37 (111)
<b>NAIP-200</b>	1 1/2 (38)	No Flanges	5.21 (132)	4.37 (111)
<b>NAIP-200-NW</b>	1 1/2 (38)	NW-50	5.51 (140)	4.37 (111)
<b>NAIP-200-CF</b>	1 1/2 (38)	CF-338, Rotatable	5.66 (144)	4.37 (111)



### N-Series Seal Kit

MODEL NUMBER	DESCRIPTION
<b>NA-075-95</b>	Seal kit for 0.75 (19) through 2 (50) inch (mm) sizes, Viton. Includes (1) poppet and (1) bonnet O-ring.

### N-Series Rebuild Kit

MODEL NUMBER	DESCRIPTION
<b>NA-075-99</b>	Valve rebuild kit for 0.75 (19) through 2 (50) inch (mm) sizes. Includes valve actuator/bellows assembly.

**Note:** Seals are not included. Recommend use of the NA-075-95 Seal Kit.

All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.





# Isolation Valves

## Poppet Valve General Information

### SPECIFICATIONS

**Nominal port ODs:** 3/8 to 4 inch (10-102mm)

**Body:** Electropolished 304 stainless steel

**Bellows:** Welded AM-350 stainless steel

**Bonnet seal:** Viton or Copper

**Poppet seal:** Viton

*Other O-ring compounds available*

**Flanges:** CF, NW, ISO or ASA

**Maximum temperature with Viton seals**

*See bakeability chart this page*

Sustained:  $\leq 150^{\circ}\text{C}$

Intermittent:  $\leq 204^{\circ}\text{C}$

**Helium leak tested:**  $\leq 10^{-9}$  mbar l/sec.

**Vacuum range**

Viton bonnet seal:  $\geq 1 \times 10^{-9}$  mbar - High

Vacuum

Copper bonnet seal:  $\geq 1 \times 10^{-10}$  mbar - UHV

**Manual actuation:** Bronze nuts/ACME threads

**Pneumatic actuation:** Normally closed

Operating Pressure: 60 to 80 psig

3/4 to 2 inch (19-50) ODs: Air-to-open/

spring-to-close

2 1/2 to 4 inch (63-101) ODs: Air-to-open/air-

to-close

**Differential pressure:** Maximum 20psi (1.4bar) differential across the valve seat

**Options:** See facing page.

**Thermal:** Heater jackets and controllers available for all valves. Call for details

### Construction

Bodies are die-formed from 304 stainless steel to eliminate sharp inside corners and improve conductance. The valves are electropolished for faster pumpdown, lower outgassing and better corrosion resistance. The bellows fully retract from the side port when the valve is open, eliminating buildup of by-products on the bellows and subsequent particle generation during operation. They are designed with additional segments to provide extended life. Nor-Cal valves can be operated in any position and actuators can be removed quickly for routine inspection without disassembling the system.

### Models

Our poppet valves are available in most port configurations with CF, NW, ISO or ASA flanges. Valves through 3 inch (76mm) OD's are available with manual or pneumatic actuators and Viton or copper bonnet seals. Valves over 3 inches (76mm) are available with pneumatic actuators only. Custom port lengths, flange configurations and bellows valves are also available.

### Vacuum Range

Poppet seals have helium leak rates of  $\leq 10^{-9}$  mbar l/sec. Viton bonnet sealed valves can be used in the  $10^{-9}$  mbar range, while copper bonnet seal valves are suited for use in the  $10^{-10}$  range.

### Copper Bonnet Seal

Copper bonnet seal poppet valves with CF flanges provide metal seals between the inside of the valve and the atmosphere. They are available in all standard sizes and port configurations.

### Valve Actuation

Manually operated valves utilize Acme threads and a self-lubricating bronze nut for fewer turns and smooth, trouble-free operation. Pneumatic valves are normally air-to-open, spring-to-close in port ODs through 2 inches (50mm) for immediate closure in case of electrical or air failure. Larger valves are normally air-to-open, air-to-close. This actuation option is available on all valves. Most sizes are available with air-to open, air-to-close with spring assist as an option. Operating air pressure for all pneumatic valves is 60 to 80 psig (4-5.5 bar).

### Thermal Products

All Nor-Cal poppet valves and gate valves can be provided with silicone foam or fiberglass insulated heater jackets to reduce resident time of corrosives or particle buildup in semiconductor applications. These jackets are available with PID controllers or thermostats with high temperature shutoffs. Jacket and control specifications can be tailored to meet your specific needs. Call for price and model number. Refer to Section 11, Thermal Products, for more information.



ESVP  
cutaway  
view



Valve rebuild kits are on page 111

All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.

### Bakeability

The valve's bakeout temperature should not exceed that of the elastomer that is used in it. See chart below. Standard Viton sealed valves are bakeable to  $150^{\circ}\text{C}$  sustained and  $204^{\circ}\text{C}$  for intermittent periods. However, the Viton O-rings begin to take a set at  $150^{\circ}\text{C}$ . High temperature Kalrez O-rings are available as an option.

BONNET/POPPET SEAL	APPLICATION	PNEUMATIC VALVES		MANUAL VALVES	
		OPEN	CLOSED	OPEN	CLOSED
Viton	General purpose	$150^{\circ}\text{C}$	$120^{\circ}\text{C}$	$150^{\circ}\text{C}$	$120^{\circ}\text{C}$
Kalrez 4079	High temperature	$280^{\circ}\text{C}$	$220^{\circ}\text{C}$	$280^{\circ}\text{C}$	$220^{\circ}\text{C}$
Kalrez 2037	Chemical resistant	$218^{\circ}\text{C}$	$218^{\circ}\text{C}$	$218^{\circ}\text{C}$	$218^{\circ}\text{C}$
Chemraz	Chemical resistant	$210^{\circ}\text{C}$	$210^{\circ}\text{C}$	$210^{\circ}\text{C}$	$210^{\circ}\text{C}$
Silicone	High temperature	$232^{\circ}\text{C}$	$232^{\circ}\text{C}$	$232^{\circ}\text{C}$	$232^{\circ}\text{C}$

### Poppet Valve Conductance (Liters per second)

The conductance values in the table below have been calculated for air at room temperature using the formulas for tubes and elbows presented in the third edition of Roth's Vacuum Technology:  $C_v = 182(D^4/L)^{0.5}$  for viscous flow or  $C_m = 12(D^3/L)$  for molecular flow. Port lengths without flanges and inner diameters for the valve sizes and configurations were used. This method is an approximation, use values accordingly.

NOMINAL PORT OD	ANGLE OR TEE		ANGLE-IN-LINE		IN-LINE		STRAIGHT-THROUGH	
	VISCOUS	MOLECULAR	VISCOUS	MOLECULAR	VISCOUS	MOLECULAR	VISCOUS	MOLECULAR
1/2 (13)	60	3	-	-	45	2	-	-
3/4 (19)	135	5	120	4	105	4	90	4
1 (25)	391	12	286	9	270	8	-	-
1 1/8 (28)	-	-	-	-	-	-	436	11
1 1/2 (38)	1925	37	1324	25	1263	24	1203	23
2 (50)	4677	65	3459	48	3113	44	-	-
2 1/2 (63)	12332	136	7505	83	7610	84	-	-
3 (76)	23263	217	12558	115	14258	130	-	-
4 (100)	57994	396	-	-	34577	236	-	-

Note: P=air at 1 mbar. L=Laxial +1.33(0/180)D for elbows.

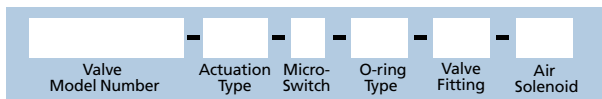
# Isolation Valves

## Poppet Valve Options



One or more options can be added to a particular valve by adding the option suffix to the basic valve model number as shown below. Heater jackets and controllers are also available for all poppet valves. Call for details and pricing.

Add option suffixes in the following order:



Example of a model number with options: **ESVP-1502-CF-AS-M-S11**

### Actuation Option

OPTION	DESCRIPTION
-A	Air-to-open/air-to-close
-AS	Air-to-open/air-to-close with spring assist
-SA	Spring-to-open/air-to-close

Pneumatic valves with port ODs through 2 inches (50) are normally air-to-open/spring-to-close for immediate closure in case of electrical or air failure. Larger valves are normally air-to-open/air-to close. These actuation options are available on nearly all sizes and port configurations of Nor-Cal pneumatically actuated poppet valves.

### Micro-Switch Option

Micro-switches are available on all pneumatically actuated Nor-Cal valves. A pair of 5-amp micro-switches are opened or closed by the movement of the valve stem. One switch closes when the valve is fully open and the other when it is fully closed. These can be connected to control panels with alarms or lights for positive position indication. Electrical leads are approximately 10 inches (254) long, but may be cut to any length upon request.



NOMINAL PORT OD	E
3/8 (10)	2.06 (52)
1/2 (13)	2.06 (52)
3/4 (19)	2.06 (52)
1 (25)	2.06 (52)
1 1/2 (38)	2.06 (52)
2 (50)	3.54 (90)
3 (76)	3.54 (90)
4 (100)	5.01 (127)

### O-ring Option

OPTION	COMPOUND	TEMPERATURE MIN.	TEMPERATURE MAX.	APPLICATION
Standard	Viton	-29°C	204°C	Industry standard
-KT	Kalrez 4079	-50°C	316°C	High temperatures
-KC	Kalrez 2037	-54°C	220°C	Chemical resistant
-CR	Chemraz 513	-30°C	210°C	Chemical resistant
-S	Silicone	-55°C	232°C	High temperatures

Standard Nor-Cal valves use chemical resistant Viton O-rings. Viton O-rings should not be heated to above 204°C. Even prolonged exposures of 150°C may degrade the O-rings. High temp Kalrez O-rings allow valve bakeouts to higher temperature. Silicone O-rings provide adequate sealing performance in thermal cycling from -55°C to 230°C.

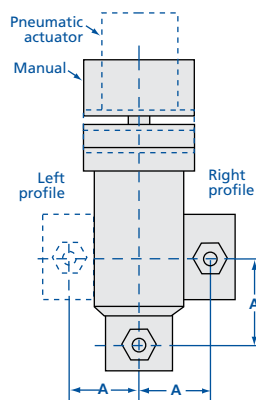


### Right Angle Valve Fitting Option

OPTION	PROFILE	DESCRIPTION	VALVE PORTS
-F1	Left	1/4 female VCR	Both
-F2	Left	3/8 female VCR	Both
-F3	Left	1/2 female NPT	Bottom
-F4	Right	1/4 female VCR	Both
-F5	Right	3/8 female VCR	Both
-F6	Right	1/2 female NPT	Bottom

Note: Available on ESV, ESVP, CSV and CSVP models only.

All Nor-Cal right angle valves (ESV, CSV, ESVP and CSVP models) are available with the six fitting options described in the table above. These options are designed to make it easy for our customers to retrofit our valves with thermocouple gauges, leak valves, up-to-air valves or gas introduction lines. Other fittings or configurations are available.



NOMINAL PORT OD	A
3/4 (19)	1.50 (38)
1 (25)	1.22 (31)
1 1/2 (38)	1.62 (41)
2 - 2 1/4 (50-57)	2.25 (57)
2 1/2 (63)	2.25 (57)
3 (76)	2.44 (62)
4 (100)	3.22 (82)

### Air Solenoid Option

OPTION	KIT	NOMINAL PORT OD	DESCRIPTION
-S11	S11-K	3/8 to 2 (10 to 50)	3-way, 120VAC, 50/60 Hz
-S21	S21-K	3/8 to 2 (10 to 50)	3-way, 24VDC
-S31	S31-K	3/8 to 2 (10 to 50)	3-way, 240VAC, 50/60 Hz
-S41	S41-K	3/8 to 2 (10 to 50)	3-way, 24VAC, 50/60 Hz
-S12	S12-K	2 1/2 to 3 (63 to 76)	4-way, 120VAC, 50/60 Hz
-S22	S22-K	2 1/2 to 3 (63 to 76)	4-way, 24VDC
-S32	S32-K	2 1/2 to 3 (63 to 76)	4-way, 240VAC, 50/60 Hz
-S42	S42-K	2 1/2 to 3 (63 to 76)	4-way, 24VAC, 50/60 Hz

Note: Use 4-way solenoid option for 1.12 and 1.5 (28-38) OD STVP and CSTVP models.

All pneumatic poppet valves can be provided with air solenoids with several current ratings for electropneumatic actuation. Valves with air-to-open, spring-to-close actuation require three-way air solenoids, while air-to-open, air-to-close actuators require four-way solenoids. Both three and four-way air solenoids are available in four current ratings. A pneumatic valve ordered with this option will arrive with an air solenoid installed. 18 inch (450) long electrical leads are provided for connection to the power supply.

Air solenoids can be purchased separately in a kit complete with instructions for installation by the customer.

When placing your order please specify the model number of the valve that the air solenoid will be installed on, so that our sales staff can confirm whether a three-way or four-way solenoid is required.



# Isolation Valves

## Manual Angle Valves



### SPECIFICATIONS

**Port ODs:** 3/8 to 3 inches (10 to 76mm)

#### Materials

**Body:** Electropolished 304 stainless steel  
**Bellows:** Welded AM-350 stainless steel  
**Bonnet seal:** Copper or Viton  
**Poppet seal:** Viton  
*Other O-ring compounds available*

**Actuation:** Self-lubricating bronze nuts with ACME threads

**Differential pressure:** Maximum 20psi (1.4bar) differential across the valve seat

#### Maximum temperature with Viton seals

Sustained:  $\leq 150^{\circ}\text{C}$   
 Intermittent:  $\leq 204^{\circ}\text{C}$

#### Vacuum range

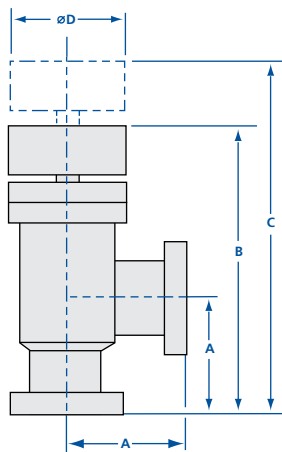
Viton bonnet seal:  $\geq 1 \times 10^{-9}$  mbar - High Vacuum  
 Copper bonnet seal:  $\geq 1 \times 10^{-10}$  mbar - UHV

**Options:** Fittings and O-rings. See page 101

**Thermal:** Heater jackets and controllers available for all valves. See page 127

### Manual Viton Seal Angle Valves

MODEL NUMBER	NOMINAL PORT OD	DESCRIPTION	A	B	C	D
ESV-038	3/8 (10)	No flanges	1.50 (38.1)	4.06 (103)	4.44 (113)	2.25 (57)
ESV-0382-CF	3/8 (10)	Rotatable 1.33 CF	1.60 (40.6)	4.16 (106)	4.54 (115)	2.25 (57)
ESV-0382-NWB	3/8 (10)	NW-10B	1.65 (41.9)	4.21 (107)	4.59 (117)	2.25 (57)
ESV-050	1/2 (13)	No flanges	1.50 (38.1)	4.06 (103)	4.56 (116)	2.25 (57)
ESV-0502-CF	1/2 (13)	Rotatable 1.33 CF	1.60 (40.6)	4.16 (106)	4.66 (118)	2.25 (57)
ESV-0502-NWB	1/2 (13)	NW-10B	1.65 (41.9)	4.21 (107)	4.71 (120)	2.25 (57)
ESV-075	3/4 (19)	No flanges	2.00 (50.8)	4.56 (116)	5.31 (135)	2.25 (57)
ESV-0752-CF	3/4 (19)	Rotatable 1.33 CF	2.50 (63.5)	5.06 (129)	5.81 (148)	2.25 (57)
ESV-0752-NWB	3/4 (19)	NW-16B	2.15 (54.6)	4.71 (120)	5.46 (139)	2.25 (57)
ESV-100	1 (25)	No flanges	1.88 (47.8)	4.32 (110)	5.32 (135)	2.25 (57)
ESV-1002-CF	1 (25)	Rotatable 2.12 CF	2.05 (52.1)	4.49 (114)	5.49 (139)	2.25 (57)
ESV-1002-NWB	1 (25)	NW-25B	2.03 (51.6)	4.47 (114)	5.47 (139)	2.25 (57)
ESV-150	1 1/2 (38)	No flanges	2.25 (57.2)	5.63 (143)	7.13 (181)	3.00 (76)
ESV-1502-CF	1 1/2 (38)	Rotatable 2.75 CF	2.46 (62.5)	5.84 (148)	7.34 (186)	3.00 (76)
ESV-1502-NWB	1 1/2 (38)	NW-40B	2.40 (62.0)	5.78 (147)	7.28 (185)	3.00 (76)
ESV-200	2 (50)	No flanges	3.25 (82.6)	7.85 (199)	9.85 (250)	3.50 (89)
ESV-2002-CF	2 (50)	Rotatable 3.38 CF	3.48 (88.4)	8.08 (205)	10.08 (256)	3.50 (89)
ESV-2002-NWB	2 (50)	NW-50B	3.40 (86.4)	8.00 (203)	10.00 (254)	3.50 (89)
ESV-2002-ASA	2 (50)	Rotatable ASA-5-200R	3.50 (88.9)	8.10 (206)	10.10 (257)	3.50 (89)
ESV-250	2 1/2 (63)	No flanges	3.00 (76.2)	8.27 (210)	10.77 (274)	4.00 (102)
ESV-2502-CF	2 1/2 (63)	Rotatable 4.50 CF	3.38 (85.9)	8.65 (220)	11.15 (283)	4.00 (102)
ESV-2502-ISO	2 1/2 (63)	ISO-63-250-OF	3.25 (82.6)	8.52 (216)	11.02 (280)	4.00 (102)
ESV-2502-ASA	2 1/2 (63)	Rotatable ASA-5-250R	3.25 (82.6)	8.52 (216)	11.02 (280)	4.00 (102)
ESV-300	3 (76)	No flanges	3.25 (82.6)	8.68 (220)	11.68 (297)	4.50 (114)
ESV-3002-CF	3 (76)	Rotatable 4.62 CF	3.53 (89.7)	8.96 (228)	11.96 (304)	4.50 (114)
ESV-3002-ISO	3 (76)	ISO-80-300-OF	3.50 (89.0)	8.93 (227)	11.93 (303)	4.50 (114)
ESV-3002-ASA	3 (76)	Rotatable ASA-6-300R	3.50 (89.0)	8.93 (227)	11.93 (303)	4.50 (114)



### Manual Copper Seal Bonnet Angle Valves

MODEL NUMBER	NOMINAL PORT OD	DESCRIPTION	A	B	C	D
CSV-038	3/8 (10)	No flanges	1.50 (38.1)	4.06 (103)	4.44 (113)	2.73 (69)
CSV-0382-CF	3/8 (10)	Rotatable 1.33 CF	1.60 (40.6)	4.16 (106)	4.54 (115)	2.73 (69)
CSV-050	1/2 (13)	No flanges	1.50 (38.1)	4.06 (103)	4.56 (116)	2.73 (69)
CSV-0502-CF	1/2 (13)	Rotatable 1.33 CF	1.60 (40.6)	4.16 (106)	4.66 (118)	2.73 (69)
CSV-075	3/4 (19)	No flanges	2.00 (50.8)	4.56 (116)	5.31 (135)	2.73 (69)
CSV-0752-CF	3/4 (19)	Rotatable 1.33 CF	2.50 (63.5)	5.06 (129)	5.81 (148)	2.73 (69)
CSV-100	1 (25)	No flanges	1.88 (47.8)	4.32 (110)	5.32 (135)	2.73 (69)
CSV-1002-CF	1 (25)	Rotatable 2.12 CF	2.05 (52.1)	4.49 (114)	5.49 (139)	2.73 (69)
CSV-150	1 1/2 (38)	No flanges	2.25 (57.2)	5.63 (143)	7.13 (181)	3.25 (83)
CSV-1502-CF	1 1/2 (38)	Rotatable 2.75 CF	2.46 (62.5)	5.84 (148)	7.34 (186)	3.25 (83)
CSV-200	2 (50)	No flanges	3.25 (82.6)	7.85 (199)	9.85 (250)	4.05 (103)
CSV-2002-CF	2 (50)	Rotatable 3.38 CF	3.48 (88.4)	8.08 (205)	10.08 (256)	4.05 (103)
CSV-250	2 1/2 (63)	No flanges	3.00 (76.2)	8.27 (210)	10.77 (274)	4.61 (117)
CSV-2502-CF	2 1/2 (63)	Rotatable 4.50 CF	3.38 (85.9)	8.65 (220)	11.15 (283)	4.61 (117)
CSV-300	3 (76)	No flanges	3.25 (82.6)	8.68 (220)	11.68 (297)	5.62 (143)
CSV-3002-CF	3 (76)	Rotatable 4.62 CF	3.53 (89.7)	8.96 (228)	11.96 (304)	5.62 (143)

### ESV O-ring Kits

MODEL NUMBER	NOMINAL PORT OD
ESV-075-95	3/8-1 (10-25)
ESV-150-95	1 1/2 (38)
ESV-200-95	2 (50)
ESV-250-95	2 1/2 (63)
ESV-300-95	3 (76)

### CSV O-ring & Gasket Kits

MODEL NUMBER	NOMINAL PORT OD
CSV-075-95	3/8-1 (10-25)
CSV-150-95	1 1/2 (38)
CSV-200-95	2 (50)
CSV-250-95	2 1/2 (63)
CSV-300-95	3 (76)



Valve rebuild kits available. See page 111



# Isolation Valves

## Pneumatic Angle Valves



### Pneumatic Viton Seal Angle Valves

MODEL NUMBER	NOMINAL PORT OD	DESCRIPTION	A	B	C	D
ESVP-038	3/8(10)	No flanges	1.50 (38.1)	3.62 (92)	5.77 (147)	2.25 (57)
ESVP-0382-CF	3/8(10)	Rotatable 1.33 CF	1.60 (40.6)	3.72 (95)	5.87 (149)	2.25 (57)
ESVP-0382-NWB	3/8(10)	NW-10B	1.65 (41.9)	3.77 (96)	5.92 (150)	2.25 (57)
ESVP-050	1/2(13)	No flanges	1.50 (38.1)	3.62 (92)	5.77 (147)	2.25 (57)
ESVP-0502-CF	1/2(13)	Rotatable 1.33 CF	1.60 (40.6)	3.72 (95)	5.87 (149)	2.25 (57)
ESVP-0502-NWB	1/2(13)	NW-10B	1.65 (41.9)	3.77 (96)	5.92 (150)	2.25 (57)
ESVP-075	3/4(19)	No flanges	2.00 (50.8)	4.12 (105)	6.26 (159)	2.25 (57)
ESVP-0752-CF	3/4(19)	Rotatable 1.33 CF	2.50 (63.5)	4.62 (117)	6.76 (171)	2.25 (57)
ESVP-0752-NWB	3/4(19)	NW-16B	2.15 (54.6)	4.27 (109)	6.41 (163)	2.25 (57)
ESVP-100	1 (25)	No flanges	1.88 (47.8)	3.88 (98.6)	6.02 (152)	2.25 (57)
ESVP-1002-CF	1 (25)	Rotatable 2.12 CF	2.05 (52.1)	4.05 (103)	6.19 (157)	2.25 (57)
ESVP-1002-NWB	1 (25)	NW-25B	2.03 (51.6)	4.03 (102)	6.17 (157)	2.25 (57)
ESVP-150	1 1/2(38)	No flanges	2.25 (57.2)	4.98 (127)	7.56 (192)	3.00 (76)
ESVP-1502-CF	1 1/2(38)	Rotatable 2.75 CF	2.46 (62.5)	5.19 (132)	7.77 (197)	3.00 (76)
ESVP-1502-NWB	1 1/2(38)	NW-40B	2.40 (61.0)	5.13 (130)	7.71 (196)	3.00 (76)
ESVP-200	2 (50)	No flanges	3.25 (82.6)	6.74 (171)	11.23 (285)	3.50 (89)
ESVP-2002-CF	2 (50)	Rotatable 3.38 CF	3.48 (88.4)	6.97 (177)	11.46 (291)	3.50 (89)
ESVP-2002-NWB	2 (50)	NW-50B	3.40 (86.4)	6.89 (175)	11.38 (289)	3.50 (89)
ESVP-2002-ASA	2 (50)	Rotatable ASA-5-200R	3.50 (88.9)	6.99 (178)	11.48 (292)	3.50 (89)
ESVP-250	2 1/2(63)	No flanges	3.00 (76.2)	7.18 (182)	10.1 (257)	4.00 (100)
ESVP-2502-CF	2 1/2(63)	4.50 CF	3.38 (85.9)	7.56 (192)	10.48 (266)	4.00 (100)
ESVP-2502-ISO	2 1/2(63)	ISO-63-250-OF	3.25 (82.6)	7.43 (189)	10.35 (263)	4.00 (100)
ESVP-2502-ASA	2 1/2(63)	Rotatable ASA-5-250R	3.25 (82.6)	7.43 (189)	10.35 (263)	4.00 (100)
ESVP-300	3 (76)	No flanges	3.25 (82.6)	7.62 (194)	11.00 (279)	4.5 (114)
ESVP-3002-CF	3 (76)	Rotatable 4.62 CF	3.53 (90.0)	7.90 (201)	11.28 (287)	4.5 (114)
ESVP-3002-ISO	3 (76)	ISO-80-300-OF	3.50 (88.9)	7.87 (200)	11.25 (286)	4.5 (114)
ESVP-3002-ASA	3 (76)	Rotatable ASA-6-300R	3.50 (88.9)	7.87 (200)	11.25 (286)	4.5 (114)
ESVP-400	4 (100)	No flanges	4.22 (107)	9.55 (243)	14.99 (381)	6.50 (165)
ESVP-4002-CF	4 (100)	Rotatable 6.00 CF	4.66 (118)	9.99 (254)	15.43 (392)	6.50 (165)
ESVP-4002-ISO	4 (100)	ISO-100-400-OF	4.47 (114)	9.80 (249)	15.24 (387)	6.50 (165)
ESVP-4002-ASA	4 (100)	Rotatable ASA-7.5-400R	4.47 (114)	9.80 (249)	15.24 (387)	6.50 (165)

#### SPECIFICATIONS

**Port ODs:** 3/8 to 4 inches (10-100mm)

#### Materials

**Body:** Electropolished 304 stainless steel  
**Bellows:** Welded AM-350 stainless steel  
**Bonnet seal:** Copper or Viton  
**Poppet seal:** Viton  
*Other O-ring compounds available*

#### Actuation: Normally closed

3/8 to 2 inch (10-50) ODs: Air-to-open, spring-to-close  
 2 1/2 to 4 inch (63-100) ODs: Air-to-open, air-to-close  
*See page 101 for more actuation options*

**Operating pressure:** 60 to 80 psig (4-5.5 bar)

**Differential pressure:** Maximum 6psi (0.4 bar) differential across the valve seat

#### Maximum temperature with Viton seals

Sustained: ≤150°C  
 Intermittent: ≤204°C

#### Vacuum range

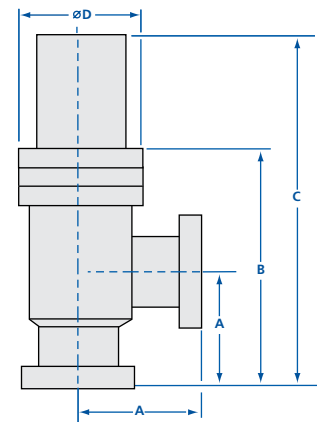
Viton bonnet seal: ≥1x10<sup>-9</sup>mbar - High Vacuum  
 Copper bonnet seal: ≥1x10<sup>-10</sup>mbar - UHV

**Options:** Fittings, O-rings, air solenoids, micro-switches and actuators. *See page 101*

**Thermal:** Heater jackets and controllers available for all valves. *See page 127*

### Pneumatic Copper Seal Bonnet Angle Valves

MODEL NUMBER	NOMINAL PORT OD	DESCRIPTION	A	B	C	D
CSVP-038	3/8(10)	No flanges	1.50 (38.1)	3.75 (95)	5.77 (147)	2.73 (69)
CSVP-0382-CF	3/8(10)	Rotatable 1.33 CF	1.60 (40.6)	3.85 (98)	5.82 (148)	2.73 (69)
CSVP-050	1/2(13)	No flanges	1.50 (38.1)	3.75 (95)	5.77 (147)	2.73 (69)
CSVP-0502-CF	1/2(13)	Rotatable 1.33 CF	1.60 (40.6)	3.85 (98)	5.82 (148)	2.73 (69)
CSVP-075	3/4(19)	No flanges	2.00 (50.8)	4.25 (108)	6.26 (159)	2.73 (69)
CSVP-0752-CF	3/4(19)	Rotatable 1.33 CF	2.50 (63.5)	4.75 (121)	6.76 (172)	2.73 (69)
CSVP-100	1 (25)	No flanges	1.88 (47.8)	4.00 (102)	6.02 (153)	2.73 (69)
CSVP-1002-CF	1 (25)	Rotatable 2.12 CF	2.05 (52.1)	4.17 (106)	6.19 (157)	2.73 (69)
CSVP-150	1 1/2(38)	No flanges	2.25 (57.2)	4.98 (126)	7.56 (192)	3.25 (83)
CSVP-1502-CF	1 1/2(38)	Rotatable 2.75 CF	2.46 (62.5)	5.19 (132)	7.77 (197)	3.25 (83)
CSVP-200	2 (50)	No flanges	3.25 (82.6)	6.62 (168)	11.23 (285)	4.05 (103)
CSVP-2002-CF	2 (50)	Rotatable 3.38 CF	3.48 (88.4)	6.85 (174)	11.45 (291)	4.05 (103)
CSVP-250	2 1/2(63)	No flanges	3.00 (76.2)	7.18 (182)	10.10 (257)	4.61 (117)
CSVP-2502-CF	2 1/2(63)	Rotatable 4.50 CF	3.38 (85.9)	7.56 (192)	10.48 (266)	4.61 (117)
CSVP-300	3 (76)	No flanges	3.25 (82.6)	7.62 (194)	11.00 (279)	5.62 (143)
CSVP-3002-CF	3 (76)	Rotatable 4.62 CF	3.53 (89.7)	7.90 (201)	11.28 (287)	5.62 (143)
CSVP-400	4 (100)	No flanges	4.22 (107)	9.55 (243)	14.99 (381)	6.73 (171)
CSVP-4002-CF	4 (100)	Rotatable 6.00 CF	4.66 (118)	9.99 (254)	15.43 (392)	6.73 (171)



*All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.*

### ESVP O-Ring Kits

MODEL NUMBER	NOMINAL PORT OD
ESVP-075-95	3/8-1 (10-25)
ESVP-150-95	1 1/2(38)
ESVP-200-95	2 (50)
ESVP-250-95	2 1/2(63)
ESVP-300-95	3 (76)
ESVP-400-95	4 (100)

### CSVP O-Ring & Gasket Kits

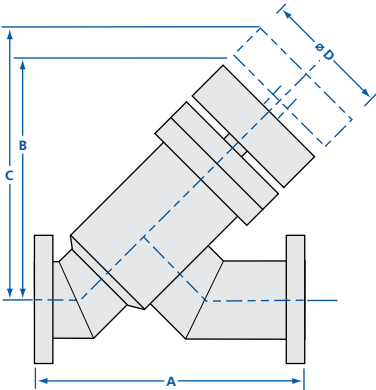
MODEL NUMBER	NOMINAL PORT OD
CSVP-075-95	3/8-1 (10-25)
CSVP-150-95	1 1/2(38)
CSVP-200-95	2 (50)
CSVP-250-95	2 1/2(63)
CSVP-300-95	3 (76)
CSVP-400-95	4 (100)





# Isolation Valves

## Manual Angle-In-Line Valves



### Manual Viton Seal Angle-In-Line Valves

MODEL NUMBER	NOMINAL PORT OD	DESCRIPTION	A	B	C	D
<b>AIV-075</b>	3/4 (19)	No flanges	3.70 (94)	3.47 (88)	4.01 (102)	2.25 (57)
<b>AIV-0752-CF</b>	3/4 (19)	Rotatable 1.33 CF	4.70 (119)	3.47 (88)	4.01 (102)	2.25 (57)
<b>AIV-0752-NWB</b>	3/4 (19)	NW-16B	4.00 (102)	3.47 (88)	4.01 (102)	2.25 (57)
<b>AIV-100</b>	1 (25)	No flanges	3.90 (99)	3.42 (87)	4.14 (105)	2.25 (57)
<b>AIV-1002-CF</b>	1 (25)	Rotatable 2.12 CF	4.23 (107)	3.42 (87)	4.14 (105)	2.25 (57)
<b>AIV-1002-NWB</b>	1 (25)	NW-25B	4.20 (107)	3.42 (87)	4.14 (105)	2.25 (57)
<b>AIV-150</b>	1 1/2 (38)	No flanges	4.82 (122)	4.55 (116)	5.61 (142)	3.00 (76)
<b>AIV-1502-CF</b>	1 1/2 (38)	Rotatable 2.75 CF	5.24 (133)	4.55 (116)	5.61 (142)	3.00 (76)
<b>AIV-1502-NWB</b>	1 1/2 (38)	NW-40B	5.12 (130)	4.55 (116)	5.61 (142)	3.00 (76)
<b>AIV-200</b>	2 (50)	No flanges	6.70 (170)	6.19 (157)	9.15 (232)	3.50 (89)
<b>AIV-2002-CF</b>	2 (50)	Rotatable 3.38 CF	7.15 (181)	6.19 (157)	9.15 (232)	3.50 (89)
<b>AIV-2002-NWB</b>	2 (50)	NW-50B	7.00 (178)	6.19 (157)	9.15 (232)	3.50 (89)
<b>AIV-250</b>	2 1/2 (63)	No flanges	7.75 (197)	6.99 (178)	10.31 (262)	4.00 (100)
<b>AIV-2502-CF</b>	2 1/2 (63)	Rotatable 4.50 CF	8.50 (216)	6.99 (178)	10.31 (262)	4.00 (100)
<b>AIV-2502-ISO</b>	2 1/2 (63)	ISO-63-250-OF	8.25 (210)	6.99 (178)	10.31 (262)	4.00 (100)
<b>AIV-300</b>	3 (76)	No flanges	10.05 (255)	7.71 (196)	11.38 (289)	4.50 (114)
<b>AIV-3002-CF</b>	3 (76)	Rotatable 4.62 CF	10.61 (269)	7.71 (196)	11.38 (289)	4.50 (114)
<b>AIV-3002-ISO</b>	3 (76)	ISO-80-300-OF	10.55 (268)	7.71 (196)	11.38 (289)	4.50 (114)

### Manual Copper Seal Bonnet Angle-In-Line Valves

MODEL NUMBER	NOMINAL PORT OD	DESCRIPTION	A	B	C	D
<b>CAIV-075</b>	3/4 (19)	No flanges	3.70 (94)	3.47 (88)	4.01 (102)	2.73 (69)
<b>CAIV-0752-CF</b>	3/4 (19)	Rotatable 1.33 CF	4.70 (119)	3.47 (88)	4.01 (102)	2.73 (69)
<b>CAIV-100</b>	1 (25)	No flanges	3.90 (99.1)	3.42 (87)	4.14 (105)	2.73 (69)
<b>CAIV-1002-CF</b>	1 (25)	Rotatable 2.12 CF	4.48 (114)	3.42 (87)	4.14 (105)	2.73 (69)
<b>CAIV-150</b>	1 1/2 (38)	No flanges	4.82 (122)	4.55 (116)	5.61 (142)	3.25 (83)
<b>CAIV-1502-CF</b>	1 1/2 (38)	Rotatable 2.75 CF	5.24 (133)	4.55 (116)	5.61 (142)	3.25 (83)
<b>CAIV-200</b>	2 (50)	No flanges	6.70 (170)	6.19 (157)	9.15 (232)	4.05 (103)
<b>CAIV-2002-CF</b>	2 (50)	Rotatable 3.38 CF	7.15 (182)	6.19 (157)	9.15 (232)	4.05 (103)
<b>CAIV-250</b>	2 1/2 (63)	No flanges	7.75 (197)	6.99 (178)	10.31 (262)	4.61 (117)
<b>CAIV-2502-CF</b>	2 1/2 (63)	Rotatable 4.50 CF	8.50 (216)	6.99 (178)	10.31 (262)	4.61 (117)
<b>CAIV-300</b>	3 (76)	No flanges	10.05 (255)	7.71 (196)	11.38 (289)	5.62 (143)
<b>CAIV-3002-CF</b>	3 (76)	Rotatable 4.62 CF	10.61 (269)	7.71 (196)	11.38 (289)	5.62 (143)

#### SPECIFICATIONS

**Port ODs:** 3/8 to 3 inches (10 to 76mm)

#### Materials

**Body:** Electropolished 304 stainless steel  
**Bellows:** Welded AM-350 stainless steel  
**Bonnet seal:** Copper or Viton  
**Poppet seal:** Viton  
*Other O-ring compounds available*

**Actuation:** Self-lubricating bronze nuts with ACME threads

**Differential pressure:** Maximum 6 psi (0.4 bar) differential across the valve seat

**Maximum temperature with Viton seals**  
 Sustained:  $\leq 150^{\circ}\text{C}$   
 Intermittent:  $\leq 204^{\circ}\text{C}$

#### Vacuum range

Viton bonnet seal:  $\geq 1 \times 10^{-9}$  mbar - High Vacuum  
 Copper bonnet seal:  $\geq 1 \times 10^{-10}$  mbar - UHV

**Options:** Fittings and O-rings. See page 101

**Thermal:** Heater jackets and controllers available for all valves. See page 127

### CAIVP O-Ring & Gasket Kits

### AIV O-Ring Kits

MODEL NUMBER	NOMINAL PORT OD
<b>ESV-075-95</b>	3/8-1 (10-25)
<b>ESV-150-95</b>	1 1/2 (38)
<b>ESV-200-95</b>	2 (50)
<b>ESV-250-95</b>	2 1/2 (63)
<b>ESV-300-95</b>	3 (76)

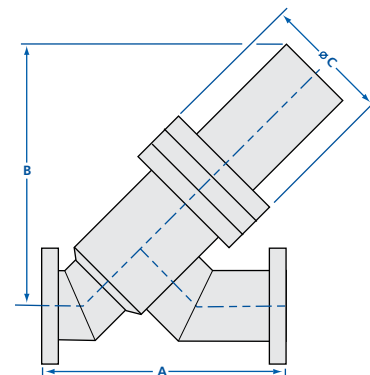
MODEL NUMBER	NOMINAL PORT OD
<b>CSVP-075-95</b>	3/8-1 (10-25)
<b>CSVP-150-95</b>	1 1/2 (38)
<b>CSVP-200-95</b>	2 (50)
<b>CSVP-250-95</b>	2 1/2 (63)
<b>CSVP-300-95</b>	3 (76)

All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.



### Pneumatic Viton Seal Angle-In-Line Valves

MODEL NUMBER	NOMINAL PORT OD	DESCRIPTION	A	B	C
AIVP-075	3/4 (19)	No flanges	3.70 (94)	4.32 (110)	2.25 (57)
AIVP-0752-CF	3/4 (19)	Rotatable 1.33 CF	4.70 (119)	4.32 (110)	2.25 (57)
AIVP-0752-NWB	3/4 (19)	NW-16B	4.00 (102)	4.32 (110)	2.25 (57)
AIVP-100	1 (25)	No flanges	3.90 (99)	4.27 (108)	2.25 (57)
AIVP-1002-CF	1 (25)	Rotatable 2.12 CF	4.23 (107)	4.27 (108)	2.25 (57)
AIVP-1002-NWB	1 (25)	NW-25B	4.20 (107)	4.27 (108)	2.25 (57)
AIVP-150	1 1/2 (38)	No flanges	4.82 (122)	5.69 (145)	3.00 (76)
AIVP-1502-CF	1 1/2 (38)	Rotatable 2.75 CF	5.24 (133)	5.69 (145)	3.00 (76)
AIVP-1502-NWB	1 1/2 (38)	NW-40B	5.12 (130)	5.69 (145)	3.00 (76)
AIVP-200	2 (50)	No flanges	6.70 (170)	7.94 (202)	3.50 (89)
AIVP-2002-CF	2 (50)	Rotatable 3.38 CF	7.15 (182)	7.94 (202)	3.50 (89)
AIVP-2002-NWB	2 (50)	NW-50B	7.00 (178)	7.94 (202)	3.50 (89)
AIVP-250	2 1/2 (63)	No flanges	7.75 (197)	7.64 (194)	4.00 (100)
AIVP-2502-CF	2 1/2 (63)	Rotatable 4.50 CF	8.50 (216)	7.64 (194)	4.00 (100)
AIVP-2502-ISO	2 1/2 (63)	ISO-63-250-OF	8.25 (210)	7.64 (194)	4.00 (100)
AIVP-300	3 (76)	No flanges	10.05 (255)	8.7 (221)	4.50 (114)
AIVP-3002-CF	3 (76)	Rotatable 4.62 CF	10.61 (269)	8.7 (221)	4.50 (114)
AIVP-3002-ISO	3 (76)	ISO-80-300-OF	10.55 (268)	8.7 (221)	4.50 (114)



### Pneumatic Copper Seal Bonnet Angle-In-Line Valves

MODEL NUMBER	NOMINAL PORT OD	DESCRIPTION	A	B	C
CAIVP-075	3/4 (19)	No flanges	3.70 (94)	4.32 (110)	2.73 (69)
CAIVP-0752-CF	3/4 (19)	Rotatable 1.33 CF	4.70 (119)	4.32 (110)	2.73 (69)
CAIVP-100	1 (25)	No flanges	3.90 (99)	4.27 (108)	2.73 (69)
CAIVP-1002-CF	1 (25)	Rotatable 2.12 CF	4.48 (114)	4.27 (108)	2.73 (69)
CAIVP-150	1 1/2 (38)	No flanges	4.82 (122)	5.69 (145)	3.25 (82)
CAIVP-1502-CF	1 1/2 (38)	Rotatable 2.75 CF	5.24 (133)	5.69 (145)	3.25 (82)
CAIVP-200	2 (50)	No flanges	6.70 (170)	7.94 (202)	4.05 (103)
CAIVP-2002-CF	2 (50)	Rotatable 3.38 CF	7.15 (182)	7.94 (202)	4.05 (103)
CAIVP-250	2 1/2 (63)	No flanges	7.75 (197)	7.64 (194)	4.61 (117)
CAIVP-2502-CF	2 1/2 (63)	Rotatable 4.50 CF	8.50 (216)	7.64 (194)	4.61 (117)
CAIVP-300	3 (76)	No flanges	10.05 (255)	8.70 (221)	5.62 (143)
CAIVP-3002-CF	3 (76)	Rotatable 4.62 CF	10.61 (269)	8.70 (221)	5.62 (143)

#### SPECIFICATIONS

**Port ODs:** 3/8 to 3 inches (10 to 76mm).

#### Materials

**Body:** Electropolished 304 stainless steel  
**Bellows:** Welded AM-350 stainless steel  
**Bonnet seal:** Copper or Viton  
**Poppet seal:** Viton  
*Other O-ring compounds available*

#### Actuation: Normally closed

3/8 to 2 inch (9.5-50.8mm) ODs:

Air-to-open, spring-to-close

2 1/2 to 3 inch (63.5-76.2mm) ODs:

Air-to-open, air-to-close

*See page 101 for more actuation options*

**Operating pressure:** 60 to 80 psig (4-5.5 bar)

**Differential pressure:** Maximum 6psi (0.4 bar) differential across the valve seat

#### Maximum temperature with Viton seals

Sustained: ≤150°C

Intermittent: ≤204°C

#### Vacuum range

Viton bonnet seal: ≥1x10<sup>-9</sup>mbar - High Vacuum

Copper bonnet seal: ≥1x10<sup>-10</sup>mbar - UHV

**Options:** Fittings, O-rings, air solenoids, micro-switches and actuators. *See page 101*

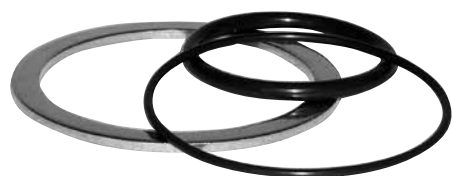
**Thermal:** Heater jackets and controllers available for all valves. *See page 127*

### AIVP O-Ring Kits

MODEL NUMBER	NOMINAL PORT OD
ESVP-075-95	3/8-1 (10-25)
ESVP-150-95	1 1/2 (38)
ESVP-200-95	2 (50)
ESVP-250-95	2 1/2 (63)
ESVP-300-95	3 (76)

### CAIVP O-Ring & Gasket Kits

MODEL NUMBER	NOMINAL PORT OD
CSVP-075-95	3/8-1 (10-25)
CSVP-150-95	1 1/2 (38)
CSVP-200-95	2 (50)
CSVP-250-95	2 1/2 (63)
CSVP-300-95	3 (76)



*All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.*

# Isolation Valves

## Manual In-Line Valves



### Manual Viton Seal In-Line Valves

MODEL NUMBER	NOMINAL PORT OD	DESCRIPTION	A	B	C	D	E	F
ILV-038	3/8 (10)	No flanges	1.50 (38.1)	0.94 (24)	1.50 (38)	4.06 (103)	2.25 (57)	4.44 (113)
ILV-0382-CF	3/8 (10)	Rotatable 1.33 CF	1.60 (40.6)	0.94 (24)	1.50 (38)	4.06 (103)	2.25 (57)	4.44 (113)
ILV-0382-NWB	3/8 (10)	NW-10B	1.65 (41.91)	0.94 (24)	1.50 (38)	4.06 (103)	2.25 (57)	4.44 (113)
ILV-050	1/2 (13)	No flanges	1.50 (38.1)	1.00 (25)	1.62 (41)	4.19 (106)	2.25 (57)	4.69 (119)
ILV-0502-CF	1/2 (13)	Rotatable 1.33 CF	1.60 (40.6)	1.00 (25)	1.62 (41)	4.19 (106)	2.25 (57)	4.69 (119)
ILV-0502-NWB	1/2 (13)	NW-10B	1.65 (41.9)	1.00 (25)	1.62 (41)	4.19 (106)	2.25 (57)	4.69 (119)
ILV-075	3/4 (19)	No flanges	2.00 (50.8)	1.12 (28)	1.87 (47)	4.44 (113)	2.25 (57)	5.19 (132)
ILV-0752-CF	3/4 (19)	Rotatable 1.33 CF	2.50 (63.5)	1.12 (28)	1.87 (47)	4.44 (113)	2.25 (57)	5.19 (132)
ILV-0752-NWB	3/4 (19)	NW-16B	2.15 (54.6)	1.12 (28)	1.87 (47)	4.44 (113)	2.25 (57)	5.19 (132)
ILV-100	1 (25)	No flanges	1.88 (47.8)	1.37 (35)	2.25 (57)	4.69 (119)	2.25 (57)	5.69 (145)
ILV-1002-CF	1 (25)	Rotatable 2.12 CF	2.05 (52.1)	1.37 (35)	2.25 (57)	4.69 (119)	2.25 (57)	5.69 (145)
ILV-1002-NWB	1 (25)	NW-25B	2.03 (51.6)	1.37 (35)	2.25 (57)	4.69 (119)	2.25 (57)	5.69 (145)
ILV-150	1 1/2 (38)	No flanges	2.25 (57.2)	1.88 (48)	3.12 (79)	6.52 (166)	3.00 (76)	8.02 (204)
ILV-1502-CF	1 1/2 (38)	Rotatable 2.75 CF	2.46 (62.5)	1.88 (48)	3.12 (79)	6.52 (166)	3.00 (76)	8.02 (204)
ILV-1502-NWB	1 1/2 (38)	NW-40B	2.40 (61.0)	1.88 (48)	3.12 (79)	6.52 (166)	3.00 (76)	8.02 (204)
ILV-200	2 (50)	No flanges	3.25 (82.6)	2.62 (67)	4.12 (105)	8.73 (222)	3.50 (89)	10.73 (273)
ILV-2002-CF	2 (50)	Rotatable 3.38 CF	3.48 (88.4)	2.62 (67)	4.12 (105)	8.73 (222)	3.50 (89)	10.73 (273)
ILV-2002-NWB	2 (50)	NW-50B	3.40 (86.4)	2.62 (67)	4.12 (105)	8.73 (222)	3.50 (89)	10.73 (273)
ILV-2002-ASA	2 (50)	Rotatable ASA-5-200R	3.50 (88.9)	2.62 (67)	4.12 (105)	8.73 (222)	3.50 (89)	10.73 (273)
ILV-250	2 1/2 (63)	No flanges	3.00 (76.2)	3.12 (79)	4.93 (125)	10.2 (259)	4.00 (102)	12.7 (323)
ILV-2502-CF	2 1/2 (63)	Rotatable 4.50 CF	3.38 (85.9)	3.12 (79)	4.93 (125)	10.2 (259)	4.00 (102)	12.7 (323)
ILV-2502-ISO	2 1/2 (63)	ISO-63-250-OF	3.25 (82.6)	3.12 (79)	4.93 (125)	10.2 (259)	4.00 (102)	12.7 (323)
ILV-2502-ASA	2 1/2 (63)	Rotatable ASA-5-250R	3.25 (82.6)	3.12 (79)	4.93 (125)	10.2 (259)	4.00 (102)	12.7 (323)
ILV-300	3 (76)	No flanges	3.25 (82.6)	3.68 (93)	5.62 (143)	11.04 (280)	4.50 (114)	14.04 (357)
ILV-3002-CF	3 (76)	Rotatable 4.62 CF	3.53 (89.7)	3.68 (93)	5.62 (143)	11.04 (280)	4.50 (114)	14.04 (357)
ILV-3002-ISO	3 (76)	ISO-80-300-OF	3.50 (88.9)	3.68 (93)	5.62 (143)	11.04 (280)	4.50 (114)	14.04 (357)
ILV-3002-ASA	3 (76)	Rotatable ASA-6-300R	3.50 (88.9)	3.68 (93)	5.62 (143)	11.04 (280)	4.50 (114)	14.04 (357)

### SPECIFICATIONS

**Port ODs:** 3/8 to 3 inches (10 to 76mm)

#### Materials

Body: Electropolished 304 stainless steel  
 Bellows: Welded AM-350 stainless steel  
 Bonnet seal: Copper or Viton  
 Poppet seal: Viton  
 Other O-ring compounds available

**Actuation:** Self-lubricating bronze nuts with ACME threads

**Differential pressure:** Maximum 6 psi (0.4 bar) differential across the valve seat

**Maximum temperature with Viton seals**  
 Sustained:  $\leq 150^{\circ}\text{C}$   
 Intermittent:  $\leq 204^{\circ}\text{C}$

#### Vacuum range

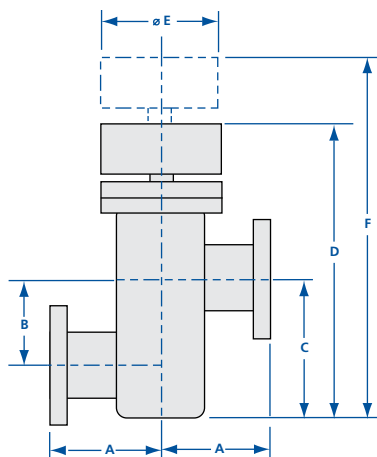
Viton bonnet seal:  $\geq 1 \times 10^{-9}$  mbar - High Vacuum  
 Copper bonnet seal:  $\geq 1 \times 10^{-10}$  mbar - UHV

**Options:** Fittings and O-rings. See page 101

**Thermal:** Heater jackets and controllers available for all valves. See page 127

### Manual Copper Seal Bonnet In-Line Valves

MODEL NUMBER	NOMINAL PORT OD	DESCRIPTION	A	B	C	D	E	F
CILV-038	3/8 (10)	No flanges	1.50 (38.1)	0.94 (24)	1.50 (38)	4.06 (103)	2.73 (69)	4.44 (113)
CILV-0382-CF	3/8 (10)	Rotatable 1.33 CF	1.60 (40.6)	0.94 (24)	1.50 (38)	4.06 (103)	2.73 (69)	4.44 (113)
CILV-050	1/2 (13)	No flanges	1.50 (38.1)	1.00 (25)	1.62 (41)	4.19 (106)	2.73 (69)	4.69 (119)
CILV-0502-CF	1/2 (13)	Rotatable 1.33 CF	1.60 (40.6)	1.00 (25)	1.62 (41)	4.19 (106)	2.73 (69)	4.69 (119)
CILV-075	3/4 (19)	No flanges	2.00 (50.8)	1.12 (28)	1.87 (47)	4.44 (113)	2.73 (69)	5.19 (132)
CILV-0752-CF	3/4 (19)	Rotatable 1.33 CF	2.50 (63.5)	1.12 (28)	1.87 (47)	4.44 (113)	2.73 (69)	5.19 (132)
CILV-100	1 (25)	No flanges	1.88 (47.8)	1.37 (35)	2.25 (57)	4.69 (119)	2.73 (69)	5.69 (145)
CILV-1002-CF	1 (25)	Rotatable 2.12 CF	2.05 (52.1)	1.37 (35)	2.25 (57)	4.69 (119)	2.73 (69)	5.69 (145)
CILV-150	1 1/2 (38)	No flanges	2.25 (57.2)	1.88 (48)	3.12 (79)	6.52 (166)	3.25 (83)	8.02 (204)
CILV-1502-CF	1 1/2 (38)	Rotatable 2.75 CF	2.46 (62.5)	1.88 (48)	3.12 (79)	6.52 (166)	3.25 (83)	8.02 (204)
CILV-200	2 (50)	No flanges	3.25 (82.6)	2.62 (67)	4.12 (105)	8.73 (222)	4.05 (103)	10.73 (273)
CILV-2002-CF	2 (50)	Rotatable 3.38 CF	3.48 (88.4)	2.62 (67)	4.12 (105)	8.73 (222)	4.05 (103)	10.73 (273)
CILV-250	2 1/2 (63)	No flanges	3.00 (76.2)	3.12 (79)	4.93 (125)	10.2 (259)	4.61 (117)	12.7 (323)
CILV-2502-CF	2 1/2 (63)	Rotatable 4.50 CF	3.38 (85.9)	3.12 (79)	4.93 (125)	10.2 (259)	4.61 (117)	12.7 (323)
CILV-300	3 (76)	No flanges	3.25 (82.6)	3.62 (92)	5.55 (141)	11.04 (280)	5.62 (143)	14.04 (357)
CILV-3002-CF	3 (76)	Rotatable 4.62 CF	3.53 (89.7)	3.62 (92)	5.55 (141)	11.04 (280)	5.62 (143)	14.04 (357)



All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.

### CILV O-Ring and Gasket Kits

#### ILV O-Ring Kits

MODEL NUMBER	NOMINAL PORT OD	MODEL NUMBER	NOMINAL PORT OD
ESV-075-95	3/8-1 (10-25)	CSV-075-95	3/8-1 (10-25)
ESV-150-95	1 1/2 (38)	CSV-150-95	1 1/2 (38)
ESV-200-95	2 (50)	CSV-200-95	2 (50)
ESV-250-95	2 1/2 (63)	CSV-250-95	2 1/2 (63)
ESV-300-95	3 (76)	CSV-300-95	3 (76)



### Pneumatic Viton Seal In-Line Valves

MODEL NUMBER	NOMINAL PORT OD	DESCRIPTION	A	B	C	D	E	F
ILVP-038	3/8(10)	No flanges	1.50 (38.1)	0.94 (24)	1.50 (38)	3.62 (92)	2.25 (57)	5.76 (146)
ILVP-0382-CF	3/8(10)	Rotatable 1.33 CF	1.60 (40.6)	0.94 (24)	1.50 (38)	3.62 (92)	2.25 (57)	5.76 (146)
ILVP-0382-NWB	3/8(10)	NW-10B	1.65 (41.9)	0.94 (24)	1.50 (38)	3.62 (92)	2.25 (57)	5.76 (146)
ILVP-050	1/2(12)	No flanges	1.50 (38.1)	1.00 (25)	1.62 (41)	3.75 (95)	2.25 (57)	5.89 (150)
ILVP-0502-CF	1/2(12)	Rotatable 1.33 CF	1.60 (40.6)	1.00 (25)	1.62 (41)	3.75 (95)	2.25 (57)	5.89 (150)
ILVP-0502-NWB	1/2(12)	NW-10B	1.65 (41.9)	1.00 (25)	1.62 (41)	3.75 (95)	2.25 (57)	5.89 (150)
ILVP-075	3/4(19)	No flanges	2.00 (50.8)	1.12 (28)	1.87 (47)	4.00 (102)	2.25 (57)	6.14 (156)
ILVP-0752-CF	3/4(19)	Rotatable 1.33 CF	2.50 (63.5)	1.12 (28)	1.87 (47)	4.00 (102)	2.25 (57)	6.14 (156)
ILVP-0752-NWB	3/4(19)	NW-16B	2.15 (54.6)	1.12 (28)	1.87 (47)	4.00 (102)	2.25 (57)	6.14 (156)
ILVP-100	1 (25)	No flanges	1.88 (47.8)	1.37 (35)	2.25 (57)	4.25 (108)	2.25 (57)	6.39 (162)
ILVP-1002-CF	1 (25)	Rotatable 2.12 CF	2.05 (52.1)	1.37 (35)	2.25 (57)	4.25 (108)	2.25 (57)	6.39 (162)
ILVP-1002-NWB	1 (25)	NW-25B	2.03 (51.6)	1.37 (35)	2.25 (57)	4.25 (108)	2.25 (57)	6.39 (162)
ILVP-150	1 1/2(38)	No flanges	2.25 (57.2)	1.88 (48)	3.12 (79)	5.86 (149)	3.00 (76)	8.45 (215)
ILVP-1502-CF	1 1/2(38)	Rotatable 2.75 CF	2.46 (62.5)	1.88 (48)	3.12 (79)	5.86 (149)	3.00 (76)	8.45 (215)
ILVP-1502-NWB	1 1/2(38)	NW-40B	2.40 (61.0)	1.88 (48)	3.12 (79)	5.86 (149)	3.00 (76)	8.45 (215)
ILVP-200	2 (50)	No flanges	3.25 (82.6)	2.62 (67)	4.12 (105)	7.62 (194)	3.50 (89)	12.11 (308)
ILVP-2002-CF	2 (50)	Rotatable 3.38 CF	3.48 (88.4)	2.62 (67)	4.12 (105)	7.62 (194)	3.50 (89)	12.11 (308)
ILVP-2002-NWB	2 (50)	NW-50B	3.40 (86.4)	2.62 (67)	4.12 (105)	7.62 (194)	3.50 (89)	12.11 (308)
ILVP-2002-ASA	2 (50)	Rotatable ASA-5-200R	3.50 (88.9)	2.62 (67)	4.12 (105)	7.62 (194)	3.50 (89)	12.11 (308)
ILVP-250	2 1/2(63)	No flanges	3.00 (76.2)	3.12 (79)	4.93 (125)	9.11 (231)	4.00 (102)	12.03 (306)
ILVP-2502-CF	2 1/2(63)	Rotatable 4.50 CF	3.38 (85.9)	3.12 (79)	4.93 (125)	9.11 (231)	4.00 (102)	12.03 (306)
ILVP-2502-ISO	2 1/2(63)	ISO-63-250-OF	3.25 (82.6)	3.12 (79)	4.93 (125)	9.11 (231)	4.00 (102)	12.03 (306)
ILVP-2502-ASA	2 1/2(63)	Rotatable ASA-5-250R	3.50 (88.9)	3.12 (79)	4.93 (125)	9.11 (231)	4.00 (102)	12.03 (306)
ILVP-300	3 (76)	No flanges	3.25 (82.6)	3.68 (93)	5.62 (143)	9.98 (253)	4.50 (114)	13.38 (340)
ILVP-3002-CF	3 (76)	Rotatable 4.62 CF	3.53 (89.7)	3.68 (93)	5.62 (143)	9.98 (253)	4.50 (114)	13.38 (340)
ILVP-3002-ISO	3 (76)	ISO-80-300-OF	3.50 (88.9)	3.68 (93)	5.62 (143)	9.98 (253)	4.50 (114)	13.38 (340)
ILVP-3002-ASA	3 (76)	Rotatable ASA-6-300R	3.50 (88.9)	3.68 (93)	5.62 (143)	9.98 (253)	4.50 (114)	13.38 (340)
ILVP-400	4 (100)	No flanges	4.22 (107)	4.88 (124)	7.38 (187)	12.83 (326)	6.50 (165)	18.27 (464)
ILVP-4002-CF	4 (100)	Rotatable 6.00 CF	4.66 (118)	4.88 (124)	7.38 (187)	12.83 (326)	6.50 (165)	18.27 (464)
ILVP-4002-ISO	4 (100)	ISO-100-400-OF	4.47 (114)	4.88 (124)	7.38 (187)	12.83 (326)	6.50 (165)	18.27 (464)
ILVP-4002-ASA	4 (100)	Rotatable ASA-7.5-400R	4.47 (114)	4.88 (124)	7.38 (187)	12.83 (326)	6.50 (165)	18.27 (464)

#### SPECIFICATIONS

**Port ODs:** 3/8 to 4 inches (10 to 100mm)

#### Materials

**Body:** Electropolished 304 stainless steel  
**Bellows:** Welded AM-350 stainless steel  
**Bonnet seal:** Copper or Viton  
**Poppet seal:** Viton  
*Other O-ring compounds available*

#### Actuation:

Normally closed  
 3/8 to 2 inch (9.5-50.8mm) ODs: Air-to-open, spring-to-close  
 2 1/2 to 4 inch (63.5-102mm) ODs: Air-to-open, air-to-close  
*See page 101 for more actuation options*

#### Operating pressure:

60 to 80 psig (4-5.5 bar)  
 differential across the valve seat

#### Maximum temperature with Viton seals

Sustained: ≤150°C  
 Intermittent: ≤204°C

#### Vacuum range

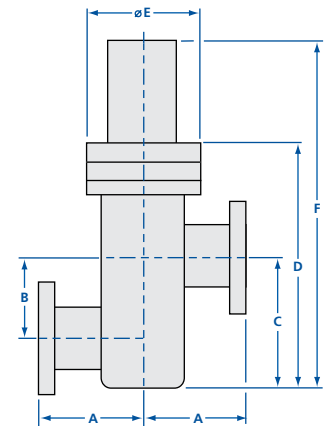
Viton bonnet seal: ≥1x10<sup>-9</sup>mbar - High Vacuum  
 Copper bonnet seal: ≥1x10<sup>-10</sup>mbar - UHV

**Options:** Fittings, O-rings, air solenoids, micro-switches and actuators. *See page 101*

**Thermal:** Heater jackets and controllers available for all valves. *See page 127*

### Pneumatic Copper Seal Bonnet In-Line Valves

MODEL NUMBER	NOMINAL PORT OD	DESCRIPTION	A	B	C	D	E	F
CILVP-038	3/8(10)	No flanges	1.50 (38.1)	0.94 (24)	1.50 (38)	3.74 (95)	2.73 (69)	5.76 (146)
CILVP-0382-CF	3/8(10)	Rotatable 1.33 CF	1.60 (40.6)	0.94 (24)	1.50 (38)	3.74 (95)	2.73 (69)	5.76 (146)
CILVP-050	1/2(12)	No flanges	1.50 (38.1)	1.00 (25)	1.62 (41)	3.88 (99)	2.73 (69)	5.89 (150)
CILVP-0502-CF	1/2(12)	Rotatable 1.33 CF	1.60 (40.6)	1.00 (25)	1.62 (41)	3.88 (99)	2.73 (69)	5.89 (150)
CILVP-075	3/4(19)	No flanges	2.00 (50.8)	1.12 (28)	1.87 (47)	4.12 (105)	2.73 (69)	6.14 (156)
CILVP-0752-CF	3/4(19)	Rotatable 1.33 CF	2.50 (63.5)	1.12 (28)	1.87 (47)	4.12 (105)	2.73 (69)	6.14 (156)
CILVP-100	1 (25)	No flanges	1.88 (47.8)	1.37 (35)	2.25 (57)	4.38 (111)	2.73 (69)	6.39 (162)
CILVP-1002-CF	1 (25)	Rotatable 2.12 CF	2.05 (52.1)	1.37 (35)	2.25 (57)	4.38 (111)	2.73 (69)	6.39 (162)
CILVP-150	1 1/2(38)	No flanges	2.25 (57.2)	1.88 (48)	3.12 (79)	5.86 (149)	3.25 (83)	8.44 (214)
CILVP-1502-CF	1 1/2(38)	Rotatable 2.75 CF	2.46 (62.5)	1.88 (48)	3.12 (79)	5.86 (149)	3.25 (83)	8.44 (214)
CILVP-200	2 (50)	No flanges	3.25 (82.6)	2.62 (67)	4.12 (105)	7.50 (191)	4.05 (103)	12.11 (308)
CILVP-2002-CF	2 (50)	Rotatable 3.38 CF	3.48 (88.4)	2.62 (67)	4.12 (105)	7.50 (191)	4.05 (103)	12.11 (308)
CILVP-250	2 1/2(63)	No flanges	3.00 (76.2)	3.12 (79)	4.93 (125)	9.11 (231)	4.61 (117)	12.03 (306)
CILVP-2502-CF	2 1/2(63)	Rotatable 4.50 CF	3.38 (85.9)	3.12 (79)	4.93 (125)	9.11 (231)	4.61 (117)	12.03 (306)
CILVP-300	3 (76)	No flanges	3.25 (82.6)	3.62 (92)	5.55 (141)	9.98 (253)	5.62 (143)	13.38 (340)
CILVP-3002-CF	3 (76)	Rotatable 4.62 CF	3.53 (89.7)	3.62 (92)	5.55 (141)	9.98 (253)	5.62 (143)	13.38 (340)
CILVP-400	4 (100)	No flanges	4.22 (107)	4.88 (124)	7.38 (187)	12.83 (326)	6.73 (171)	18.27 (464)
CILVP-4002-CF	4 (100)	Rotatable 6.00 CF	4.66 (118)	4.88 (124)	7.38 (187)	12.83 (326)	6.73 (171)	18.27 (464)



### ILVP O-Ring Kits

MODEL NUMBER	NOMINAL PORT OD
ESVP-075-95	3/8-1 (10-25)
ESVP-150-95	1 1/2 (38)
ESVP-200-95	2 (50)
ESVP-250-95	2 1/2 (63)
ESVP-300-95	3 (76)
ESVP-400-95	4 (100)

### CILVP O-Ring & Gasket Kits

MODEL NUMBER	NOMINAL PORT OD
CSVP-075-95	3/8-1 (10-25)
CSVP-150-95	1 1/2 (38)
CSVP-200-95	2 (50)
CSVP-250-95	2 1/2 (63)
CSVP-300-95	3 (76)
CSVP-400-95	4 (100)

*All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.*



# Isolation Valves

## Manual Tee Valves



### Manual Viton Seal Tee Valves

MODEL NUMBER	NOMINAL PORT OD	DESCRIPTION	A	B	C	D
ESV-038T	3/8 (10)	No flanges	1.50 (38.1)	4.06 (103)	4.44 (113)	2.25 (57)
ESV-0383T-CF	3/8 (10)	Rotatable 1.33 CF	1.60 (40.6)	4.16 (106)	4.54 (115)	2.25 (57)
ESV-0383T-NWB	3/8 (10)	NW-10B	1.65 (41.9)	4.21 (107)	4.59 (117)	2.25 (57)
ESV-050T	1/2 (12)	No flanges	1.50 (38.1)	4.06 (103)	4.56 (116)	2.25 (57)
ESV-0503T-CF	1/2 (12)	Rotatable 1.33 CF	1.60 (40.6)	4.16 (106)	4.54 (115)	2.25 (57)
ESV-0503T-NWB	1/2 (12)	NW-10B	1.65 (41.9)	4.21 (107)	4.71 (120)	2.25 (57)
ESV-075T	3/4 (19)	No flanges	2.00 (50.8)	4.56 (116)	5.31 (135)	2.25 (57)
ESV-0753T-CF	3/4 (19)	Rotatable 1.33 CF	2.50 (63.5)	5.06 (129)	5.81 (148)	2.25 (57)
ESV-0753T-NWB	3/4 (19)	NW-16B	2.15 (54.6)	4.71 (120)	5.46 (139)	2.25 (57)
ESV-100T	1 (25)	No flanges	1.88 (47.8)	4.32 (110)	5.32 (135)	2.25 (57)
ESV-1003T-CF	1 (25)	Rotatable 2.12 CF	2.05 (52.1)	4.49 (114)	5.49 (140)	2.25 (57)
ESV-1003T-NWB	1 (25)	NW-25B	2.03 (51.6)	4.47 (114)	5.47 (139)	2.25 (57)
ESV-150T	1 1/2 (38)	No flanges	2.25 (57.2)	5.63 (143)	7.13 (181)	3.00 (76)
ESV-1503T-CF	1 1/2 (38)	Rotatable 2.75 CF	2.46 (62.5)	5.84 (148)	7.34 (186)	3.00 (76)
ESV-1503T-NWB	1 1/2 (38)	NW-40B	2.40 (61.0)	5.78 (147)	7.28 (185)	3.00 (76)
ESV-200T	2 (50)	No flanges	3.25 (82.6)	7.85 (199)	9.85 (250)	3.50 (89)
ESV-2003T-CF	2 (50)	Rotatable 3.38 CF	3.48 (88.4)	8.08 (205)	10.08 (256)	3.50 (89)
ESV-2003T-NWB	2 (50)	NW-50B	3.40 (86.4)	8.00 (203)	10.00 (254)	3.50 (89)
ESV-2003T-ASA	2 (50)	Rotatable ASA-5-200R	3.25 (82.6)	8.10 (206)	10.10 (257)	3.50 (89)
ESV-250T	2 1/2 (63)	No flanges	3.00 (76.2)	8.27 (210)	10.77 (274)	4.00 (100)
ESV-2503T-CF	2 1/2 (63)	Rotatable 4.50 CF	3.38 (85.9)	8.65 (220)	11.15 (283)	4.00 (100)
ESV-2503T-ISO	2 1/2 (63)	ISO-63-250-OF	3.25 (82.6)	8.52 (216)	11.02 (280)	4.00 (100)
ESV-2503T-ASA	2 1/2 (63)	Rotatable ASA-5-250R	3.25 (82.6)	8.52 (216)	11.02 (280)	4.00 (100)
ESV-300T	3 (76)	No flanges	3.25 (82.6)	8.68 (220)	11.68 (297)	4.50 (114)
ESV-3003T-CF	3 (76)	Rotatable 4.62 CF	3.53 (89.7)	8.96 (228)	11.96 (304)	4.50 (114)
ESV-3003T-ISO	3 (76)	ISO-80-300-OF	3.50 (88.9)	8.93 (227)	11.93 (303)	4.50 (114)
ESV-3003T-ASA	3 (76)	Rotatable ASA-6-300R	3.50 (88.9)	8.93 (227)	11.93 (303)	4.50 (114)

#### SPECIFICATIONS

**Port ODs:** 3/8 to 3 inches (10 to 76mm)

#### Materials

Body: Electropolished 304 stainless steel  
 Bellows: Welded AM-350 stainless steel  
 Bonnet seal: Copper or Viton  
 Poppet seal: Viton  
 Other O-ring compounds available

**Actuation:** Self-lubricating bronze nuts with ACME threads

**Differential pressure:** Maximum 6 psi (0.4 bar) differential across the valve seat

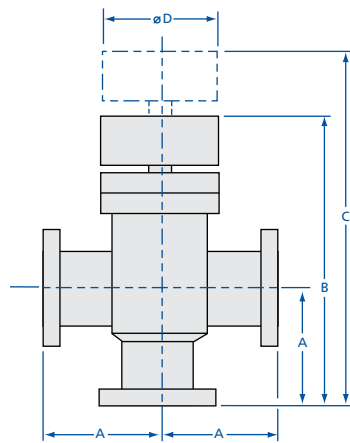
**Maximum temperature with Viton seals**  
 Sustained:  $\leq 150^{\circ}\text{C}$   
 Intermittent:  $\leq 204^{\circ}\text{C}$

#### Vacuum range

Viton bonnet seal:  $\geq 1 \times 10^{-9}$  mbar - High Vacuum  
 Copper bonnet seal:  $\geq 1 \times 10^{-10}$  mbar - UHV

**Options:** Fittings and O-rings. See page 101

**Thermal:** Heater jackets and controllers available for all valves. See page 127



### Manual Copper Seal Bonnet Tee Valves

MODEL NUMBER	NOMINAL PORT OD	DESCRIPTION	A	B	C	D
CSV-038T	3/8 (10)	No flanges	1.50 (38.1)	4.06 (103)	4.44 (113)	2.73 (69)
CSV-0383T-CF	3/8 (10)	Rotatable 1.33 CF	1.60 (40.6)	4.16 (106)	4.54 (115)	2.73 (69)
CSV-050T	1/2 (12)	No flanges	1.50 (38.1)	4.06 (103)	4.56 (116)	2.73 (69)
CSV-0503T-CF	1/2 (12)	Rotatable 1.33 CF	1.60 (40.6)	4.16 (106)	4.66 (118)	2.73 (69)
CSV-075T	3/4 (19)	No flanges	2.00 (50.8)	4.56 (116)	5.31 (135)	2.73 (69)
CSV-0753T-CF	3/4 (19)	Rotatable 1.33 CF	2.50 (63.5)	5.06 (129)	5.81 (148)	2.73 (69)
CSV-100T	1 (25)	No flanges	1.88 (47.8)	4.32 (110)	5.32 (135)	2.73 (69)
CSV-1003T-CF	1 (25)	Rotatable 2.12 CF	2.05 (52.1)	4.49 (114)	5.49 (139)	2.73 (69)
CSV-150T	1 1/2 (38)	No flanges	2.25 (57.2)	5.63 (143)	7.13 (181)	3.25 (83)
CSV-1503T-CF	1 1/2 (38)	Rotatable 2.75 CF	2.46 (62.5)	5.84 (148)	7.34 (186)	3.25 (83)
CSV-200T	2 (50)	No flanges	3.25 (82.6)	7.85 (199)	9.85 (250)	4.05 (103)
CSV-2003T-CF	2 (50)	Rotatable 3.38 CF	3.48 (88.4)	8.08 (205)	10.08 (256)	4.05 (103)
CSV-250T	2 1/2 (63)	No flanges	3.00 (76.2)	8.27 (210)	10.77 (274)	4.61 (117)
CSV-2503T-CF	2 1/2 (63)	Rotatable 3.38 CF	3.38 (85.9)	8.65 (220)	11.15 (283)	4.61 (117)
CSV-300T	3 (76)	No flanges	3.25 (82.6)	8.68 (220)	11.68 (297)	5.62 (143)
CSV-3003T-CF	3 (76)	Rotatable 4.62 CF	3.53 (89.7)	8.96 (228)	11.96 (304)	5.62 (143)

### CSV-T O-Ring & Gasket Kits

#### ESV-T O-Ring Kits

MODEL NUMBER	NOMINAL PORT OD
ESV-075-95	3/8-1 (10-25)
ESV-150-95	1 1/2 (38)
ESV-200-95	2 (50)
ESV-250-95	2 1/2 (63)
ESV-300-95	3 (76)

MODEL NUMBER	NOMINAL PORT OD
CSV-075-95	3/8-1 (10-25)
CSV-150-95	1 1/2 (38)
CSV-200-95	2 (50)
CSV-250-95	2 1/2 (63)
CSV-300-95	3 (76)

All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.

# Isolation Valves

## Pneumatic Tee Valves



### Pneumatic Viton Seal Tee Valves

MODEL NUMBER	NOMINAL PORT OD	DESCRIPTION	A	B	C	D
ESVP-038T	3/8 (10)	No flanges	1.50 (38.1)	3.62 (92)	5.77 (147)	2.25 (57)
ESVP-0383T-CF	3/8 (10)	Rotatable 1.33 CF	1.60 (40.6)	3.67 (93)	5.87 (149)	2.25 (57)
ESVP-0383T-NWB	3/8 (10)	NW-10B	1.65 (41.9)	3.77 (96)	5.92 (150)	2.25 (57)
ESVP-050T	1/2 (12)	No flanges	1.50 (38.1)	3.62 (92)	5.77 (147)	2.25 (57)
ESVP-0503T-CF	1/2 (12)	Rotatable 1.33 CF	1.60 (40.6)	3.67 (93)	5.87 (149)	2.25 (57)
ESVP-0503T-NWB	1/2 (12)	NW-10B	1.65 (41.9)	3.77 (96)	5.92 (150)	2.25 (57)
ESVP-075T	3/4 (19)	No flanges	2.00 (50.8)	4.12 (105)	6.26 (159)	2.25 (57)
ESVP-0753T-CF	3/4 (19)	Rotatable 1.33 CF	2.50 (63.5)	4.62 (117)	6.76 (172)	2.25 (57)
ESVP-0753T-NWB	3/4 (19)	NW-16B	2.15 (54.6)	4.27 (108)	6.41 (163)	2.25 (57)
ESVP-100T	1 (25)	No flanges	1.88 (47.8)	3.88 (99.0)	6.02 (153)	2.25 (57)
ESVP-1003T-CF	1 (25)	Rotatable 2.12 CF	2.05 (52.1)	4.05 (102)	6.19 (157)	2.25 (57)
ESVP-1003T-NWB	1 (25)	NW-25B	2.03 (51.6)	4.03 (102)	6.17 (157)	2.25 (57)
ESVP-150T	1 1/2 (38)	No flanges	2.25 (57.2)	4.98 (126)	7.56 (192)	3.00 (76)
ESVP-1503T-CF	1 1/2 (38)	Rotatable 2.75 CF	2.45 (62.2)	5.19 (132)	7.77 (197)	3.00 (76)
ESVP-1503T-NWB	1 1/2 (38)	NW-40B	2.40 (61.0)	5.13 (130)	7.71 (196)	3.00 (76)
ESVP-200T	2 (50)	No flanges	3.25 (82.6)	6.74 (171)	11.23 (285)	3.50 (89)
ESVP-2003T-CF	2 (50)	Rotatable 3.38 CF	3.48 (88.4)	6.97 (177)	11.46 (291)	3.50 (89)
ESVP-2003T-NWB	2 (50)	NW-50B	3.40 (86.4)	6.89 (175)	11.38 (289)	3.50 (89)
ESVP-2003T-ASA	2 (50)	Rotatable ASA-5-200R	3.50 (88.9)	6.99 (178)	11.48 (292)	3.50 (89)
ESVP-250T	2 1/2 (63)	No flanges	3.00 (76.2)	7.18 (182)	10.10 (257)	4.00 (100)
ESVP-2503T-CF	2 1/2 (63)	Rotatable 4.50 CF	3.38 (85.9)	7.56 (192)	10.48 (266)	4.00 (100)
ESVP-2503T-ISO	2 1/2 (63)	ISO-63-250-OF	3.25 (82.6)	7.43 (189)	10.35 (263)	4.00 (100)
ESVP-2503T-ASA	2 1/2 (63)	Rotatable ASA-5-250R	3.25 (82.6)	7.43 (189)	10.35 (263)	4.00 (100)
ESVP-300T	3 (76)	No flanges	3.25 (82.6)	7.62 (194)	11.00 (279)	4.50 (114)
ESVP-3003T-CF	3 (76)	Rotatable 4.62 CF	3.53 (89.7)	7.90 (201)	11.28 (287)	4.50 (114)
ESVP-3003T-ISO	3 (76)	ISO-80-300-OF	3.50 (88.9)	7.87 (200)	11.25 (286)	4.50 (114)
ESVP-3003T-ASA	3 (76)	Rotatable ASA-6-300R	3.50 (88.9)	7.87 (200)	11.25 (286)	4.50 (114)
ESVP-400T	4 (100)	No flanges	4.22 (107)	9.55 (243)	14.99 (381)	6.50 (165)
ESVP-4003T-CF	4 (100)	Rotatable 6.00 CF	4.66 (118)	9.99 (254)	14.43 (392)	6.50 (165)
ESVP-4003T-ISO	4 (100)	ISO-100-400-OF	4.47 (114)	9.80 (249)	15.24 (387)	6.50 (165)
ESVP-4003T-ASA	4 (100)	Rotatable ASA-7.5-400R	4.47 (114)	9.80 (249)	15.24 (387)	6.50 (165)

### SPECIFICATIONS

**Port ODs:** 3/8 to 4 inches (10 to 100mm)

#### Materials

Body: Electropolished 304 stainless steel  
 Bellows: Welded AM-350 stainless steel  
 Bonnet seal: Copper or Viton  
 Poppet seal: Viton  
 Other O-ring compounds available

#### Actuation:

Normally closed  
 3/8 to 2 inch (9.5-50.8mm) ODs: Air-to-open, spring-to-close  
 2 1/2 to 4 inch (63.5-102mm) ODs: Air-to-open, air-to-close  
 See page 101 for more actuation options

#### Operating pressure:

60 to 80 psig (4-5.5 bar)  
**Differential pressure:** Maximum 6 psi (0.4 bar) differential across the valve seat

#### Maximum temperature with Viton seals

Sustained: ≤150°C  
 Intermittent: ≤204°C

#### Vacuum range

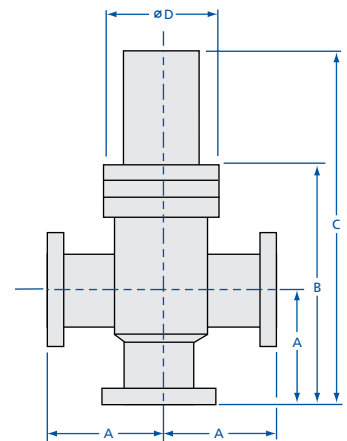
Viton bonnet seal: ≥1x10<sup>-9</sup>mbar - High Vacuum  
 Copper bonnet seal: ≥1x10<sup>-10</sup>mbar - UHV

**Options:** Fittings, O-rings, air solenoids, micro-switches and actuators. See page 101

**Thermal:** Heater jackets and controllers available for all valves. See page 127

### Pneumatic Copper Seal Bonnet Tee Valves

MODEL NUMBER	NOMINAL PORT OD	DESCRIPTION	A	B	C	D
CSVP-038T	3/8 (10)	No flanges	1.50 (38.1)	3.75 (95)	5.77 (147)	2.73 (69)
CSVP-0383T-CF	3/8 (10)	Rotatable 1.33 CF	1.60 (40.6)	3.85 (98)	5.82 (148)	2.73 (69)
CSVP-050T	1/2 (12)	No flanges	1.50 (38.1)	3.75 (95)	5.77 (147)	2.73 (69)
CSVP-0503T-CF	1/2 (12)	Rotatable 1.33 CF	1.60 (40.6)	3.85 (98)	5.82 (148)	2.73 (69)
CSVP-075T	3/4 (19)	No flanges	2.00 (50.8)	4.25 (108)	6.26 (159)	2.73 (69)
CSVP-0753T-CF	3/4 (19)	Rotatable 1.33 CF	2.50 (63.5)	4.75 (121)	6.76 (172)	2.73 (69)
CSVP-100T	1 (25)	No flanges	1.88 (47.8)	4.00 (102)	6.02 (153)	2.73 (69)
CSVP-1003T-CF	1 (25)	Rotatable 2.12 CF	2.05 (52.1)	4.17 (106)	6.19 (157)	2.73 (69)
CSVP-150T	1 1/2 (38)	No flanges	2.25 (57.2)	4.98 (126)	7.56 (192)	3.25 (83)
CSVP-1503T-CF	1 1/2 (38)	Rotatable 2.75 CF	2.46 (62.5)	5.19 (132)	7.77 (197)	3.25 (83)
CSVP-200T	2 (50)	No flanges	3.25 (82.6)	6.62 (168)	11.23 (285)	4.05 (103)
CSVP-2003T-CF	2 (50)	Rotatable 3.38 CF	3.48 (88.4)	6.85 (174)	10.58 (269)	4.05 (103)
CSVP-250T	2 1/2 (63)	No flanges	3.00 (76.2)	7.18 (182)	10.10 (257)	4.61 (117)
CSVP-2503T-CF	2 1/2 (63)	Rotatable 4.50 CF	3.38 (85.9)	7.56 (192)	10.48 (266)	4.61 (117)
CSVP-300T	3 (76)	No flanges	3.25 (82.6)	7.62 (194)	11.00 (279)	5.62 (143)
CSVP-3003T-CF	3 (76)	Rotatable 4.62 CF	3.53 (89.7)	7.90 (201)	11.28 (287)	5.62 (143)
CSVP-400T	4 (100)	No flanges	4.22 (107.2)	9.55 (243)	14.99 (381)	6.73 (171)
CSVP-4003T-CF	4 (100)	Rotatable 6.00 CF	4.66 (118.4)	9.99 (254)	15.43 (392)	6.73 (171)



### ESVP-T O-Ring Kits

MODEL NUMBER	NOMINAL PORT OD
ESVP-075-95	3/8-1 (10-25)
ESVP-150-95	1 1/2 (38)
ESVP-200-95	2 (50)
ESVP-250-95	2 1/2 (63)
ESVP-300-95	3 (76)
ESVP-400-95	4 (100)

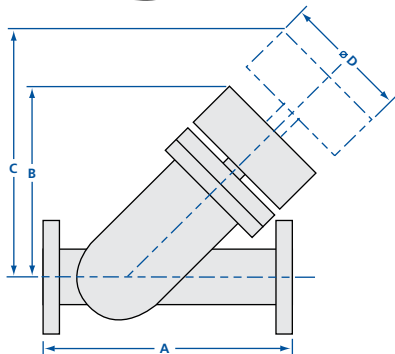
### CSVP-T O-Ring & Gasket Kits

MODEL NUMBER	NOMINAL PORT OD
CSVP-075-95	3/8-1 (10-25)
CSVP-150-95	1 1/2 (38)
CSVP-200-95	2 (50)
CSVP-250-95	2 1/2 (63)
CSVP-300-95	3 (76)
CSVP-400-95	4 (100)

All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.

# Isolation Valves

## Straight-Through Valves



### SPECIFICATIONS

**Port ODs:** 3/4 to 1 1/2 inches (19 to 38mm)

#### Materials

**Body:** Electropolished 304 stainless steel  
**Bellows:** Welded AM-350 stainless steel  
**Bonnet seal:** Copper or Viton  
**Poppet seal:** Viton  
*Other O-ring compounds available*

**Manual actuation:** Self-lubricating bronze nuts with ACME threads

**Pneumatic actuation:** Normally closed  
 3/4 inch (19.05mm) ODs: Air-to-open, spring-to-close  
 1 1/8 to 1 1/2 inch (29-38mm) ODs: Air-to-open, air-to-close  
*See page 99 for more actuation options*

**Operating pressure:** 60 to 80 psig (4-5.5 bar)

**Differential pressure:** Maximum 20psi (1.4bar) differential across the valve seat

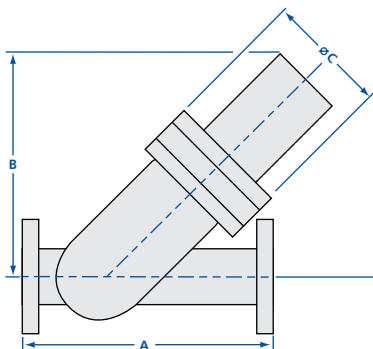
**Maximum temperature with Viton seals**  
 Sustained: <150°C  
 Intermittent: <204°C

#### Vacuum range

Viton bonnet seal: >1x 10<sup>-9</sup> mbar - High Vacuum  
 Copper bonnet seal: >1x 10<sup>-10</sup> mbar - UHV

**Options:** Fittings, O-rings, air solenoids, micro-switches and actuators. *See page 101*

**Thermal:** Heater jackets and controllers available for all valves. *See page 127*



All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.

### Manual Viton Seal Straight-Through Valves

MODEL NUMBER	PORT ID	NOMINAL PORT OD	DESCRIPTION	A	B	C	D
STV-075	0.65 (16.5)	3/4 (19)	No flanges	5.00 (127)	3.30 (84)	4.50 (114)	2.25 (57)
STV-0752-CF	0.65 (16.5)	3/4 (19)	Rotatable 1.33 CF	6.00 (152)	3.30 (84)	4.50 (114)	2.25 (57)
STV-0752-NWB	0.65 (16.5)	3/4 (19)	NW-16B	5.30 (135)	3.30 (84)	4.50 (114)	2.25 (57)
STV-112	1.00 (25.4)	1 1/8 (29)	No flanges	5.50 (140)	3.86 (98)	5.15 (131)	3.00 (76)
STV-1122-CF	1.00 (25.4)	1 1/8 (29)	Rotatable 2.12 CF	5.83 (148)	3.86 (98)	5.15 (131)	3.00 (76)
STV-1122-NWB	1.00 (25.4)	1 1/8 (29)	NW-40B	5.80 (147)	3.86 (98)	5.15 (131)	3.00 (76)
STV-150	1.38 (35.1)	1 1/2 (38)	No flanges	7.00 (178)	5.47 (139)	7.69 (195)	3.50 (89)
STV-1502-CF	1.38 (35.1)	1 1/2 (38)	Rotatable 2.75 CF	7.42 (188)	5.47 (139)	7.69 (195)	3.50 (89)
STV-1502-NWB	1.38 (35.1)	1 1/2 (38)	NW-40B	7.30 (185)	5.47 (139)	7.69 (195)	3.50 (89)

### Manual Copper Seal Bonnet Straight-Through Valves

MODEL NUMBER	PORT ID	NOMINAL PORT OD	DESCRIPTION	A	B	C	D
CSTV-075	0.65 (16.5)	3/4 (19)	No flanges	5.00 (127)	3.51 (89)	4.71 (120)	2.73 (69)
CSTV-0752-CF	0.65 (16.5)	3/4 (19)	Rotatable 1.33 CF	6.00 (152)	3.51 (89)	4.71 (120)	2.73 (69)
CSTV-150	1.38 (35.1)	1 1/2 (38)	No flanges	7.00 (178)	5.47 (139)	7.69 (195)	4.05 (103)
CSTV-1502-CF	1.38 (35.1)	1 1/2 (38)	Rotatable 2.75 CF	7.42 (188)	5.47 (139)	7.69 (195)	4.05 (103)



### STV O-Ring Kits

MODEL NUMBER	NOMINAL PORT OD
ESV-075-95	3/4 (19)
STV-112-95	1 1/8 (29)
STV-150-95	1 1/2 (38)

### CSTV O-Ring & Gasket Kits

MODEL NUMBER	NOMINAL PORT OD
CSV-075-95	3/4 (19)
CSV-150-95	1 1/2 (38)

### Pneumatic Viton Seal Straight-Through Valves

MODEL NUMBER	PORT ID	NOMINAL PORT OD	DESCRIPTION	A	B	C
STVP-075	0.65 (16.5)	3/4 (19)	No flanges	5.00 (127)	3.92 (100)	2.25 (57)
STVP-0752-CF	0.65 (16.5)	3/4 (19)	Rotatable 1.33 CF	6.00 (152)	3.92 (100)	2.25 (57)
STVP-0752-NWB	0.65 (16.5)	3/4 (19)	NW-16B	5.30 (135)	3.92 (100)	2.25 (57)
STVP-112	1.00 (25.4)	1 1/8 (29)	No flanges	5.50 (140)	5.10 (130)	3.00 (76)
STVP-1122-CF	1.00 (25.4)	1 1/8 (29)	Rotatable 2.12 CF	5.83 (148)	5.10 (130)	3.00 (76)
STVP-1122-NWB	1.00 (25.4)	1 1/8 (29)	NW-40B	5.80 (147)	5.10 (130)	3.00 (76)
STVP-150	1.38 (35.1)	1 1/2 (38)	No flanges	7.00 (178)	6.11 (155)	3.50 (89)
STVP-1502-CF	1.38 (35.1)	1 1/2 (38)	Rotatable 2.75 CF	7.42 (188)	6.11 (155)	3.50 (89)
STVP-1502-NWB	1.38 (35.1)	1 1/2 (38)	NW-40B	7.30 (185)	6.11 (155)	3.50 (89)

### Pneumatic Copper Seal Bonnet Straight-Through Valves

MODEL NUMBER	PORT ID	NOMINAL PORT OD	DESCRIPTION	A	B	C
CSTVP-075	0.65 (16.5)	3/4 (19)	No flanges	5.00 (127)	3.92 (100)	2.73 (69)
CSTVP-0752-CF	0.65 (16.5)	3/4 (19)	Rotatable 1.33 CF	6.00 (152)	3.92 (100)	2.73 (69)
CSTVP-150	1.38 (35.0)	1 1/2 (38)	No flanges	7.00 (178)	6.11 (155)	4.05 (103)
CSTVP-1502-CF	1.38 (35.0)	1 1/2 (38)	Rotatable 2.75 CF	7.42 (188)	6.11 (155)	4.05 (103)

### STVP O-Ring Kits

MODEL NUMBER	NOMINAL PORT OD
ESVP-075-95	3/4 (19)
STVP-112-95	1 1/8 (29)
STVP-150-95	1 1/2 (38)

### CSTVP O-Ring & Gasket Kits

MODEL NUMBER	NOMINAL PORT OD
CSV-075-95	3/4 (19)
CSTVP-150-95	1 1/2 (38)

# Isolation Valves

## Replacement Parts & Rebuild Kits



### Complete Valve Rebuild Kits

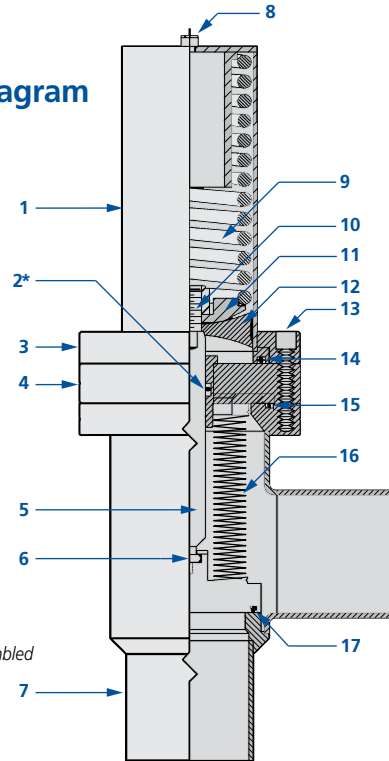
Contains all items except valve body (#7), refer to kit contents diagram at right.

MODEL NUMBER	FOR VALVE MODEL NUMBERS
CSV-075-99	CSV, CILV and CAIV, -038 to -100
CSV-150-99	CSV, CILV and CAIV-150
CSV-200-99	CSV, CILV and CAIV-200
CSV-250-99	CSV, CILV and CAIV-250
CSV-300-99	CSV, CILV and CAIV-300
CSVP-075-99	CSVP, CILVP and CAIVP, -038 to -100
CSVP-150-99	CSVP, CILVP and CAIVP-150
CSVP-200-99	CSVP, CILVP and CAIVP-200
CSVP-250-99	CSVP, CILVP and CAIVP-250
CSVP-300-99	CSVP, CILVP and CAIVP-300
CSVP-400-99	CSVP, CILVP and CAIVP-400
ESV-075-99	ESV, ILV, AIV, STV, -038 to -100
ESV-150-99	ESV, ILV, AIV, STV, -150
ESV-200-99	ESV, ILV and AIV-200
ESV-250-99	ESV, ILV and AIV-250
ESV-300-99	ESV, ILV and AIV-300
ESVP-075-99	ESVP, ILVP, AIVP, STVP, -038 to -100
ESVP-150-99	ESVP, ILVP, AIVP, STVP, -150
ESVP-200-99	ESVP, ILVP and AIVP-200
ESVP-250-99	ESVP, ILVP and AIVP-250
ESVP-300-99	ESVP, ILVP and AIVP-300
ESVP-400-99	ESVP, ILVP and AIVP-400
STV-112-99	STV-112
STVP-112-99	STVP-112
STV-150-99	STV-150
STVP-150-99	STVP-150

### Kit Contents Diagram

1. Air cylinder
2. Stem O-ring\*
3. Retaining plate
4. Center plate
5. Stem shaft
6. Set screw
7. Body
8. Air filter
9. Air cylinder spring
10. Jam nut
11. Spring retainer
12. Piston cup
13. Bonnet screws
14. Air cylinder O-ring
15. Body flange O-ring or gasket
16. Bellows assembly
17. Poppet O-ring

\* 2 inch (50) ID valves are assembled with two stem O-rings.



### O-Ring or Gasket Kits

MODEL NUMBER	KIT CONTENTS (See drawing)	FOR VALVE MODEL NUMBERS
ESV-075-95	2, 14, 15, 17	ESV, AIV, ILV, ESV-T, STV, -038 to -100
ESV-150-95	2, 14, 15, 17	ESV, AIV, ILV, ESV-T, -150
ESV-200-95	2, 14, 15, 17	ESV, AIV, ILV, ESV-T, -200
ESV-250-95	2, 14, 15, 17	ESV, AIV, ILV, ESV-T, -250
ESV-300-95	2, 14, 15, 17	ESV, AIV, ILV, ESV-T, -300
STV-112-95	2, 14, 15, 17	STV-112
STV-150-95	2, 14, 15, 17	STV-150
ESVP-075-95	2, 14, 15, 17	ESVP, AIVP, ILVP, ESVP-T, STVP, -038 to -100
ESVP-150-95	2, 14, 15, 17	ESVP, AIVP, ILVP, ESVP-T, -150
ESVP-200-95	2, 14, 15, 17	ESVP, AIVP, ILVP, ESVP-T, -200
ESVP-250-95	2, 14, 15, 17	ESVP, AIVP, ILVP, ESVP-T, -250
ESVP-300-95	2, 14, 15, 17	ESVP, AIVP, ILVP, ESVP-T, -300
ESVP-400-95	2, 14, 15, 17	ESVP, AIVP, ILVP, ESVP-T, -400
STVP-112-95	2, 14, 15, 17	STVP-112
STVP-150-95	2, 14, 15, 17	STVP-150
CSV-075-95	2, 14, 15, 17	CSV, CAIV, CILV, CSTV, -038 to -100
CSV-150-95	2, 14, 15, 17	CSV, CAIV, CILV, -150
CSV-200-95	2, 14, 15, 17	CSV, CAIV, CILV, -200
CSV-250-95	2, 14, 15, 17	CSV, CAIV, CILV, -250
CSV-300-95	2, 14, 15, 17	CSV, CAIV, CILV, -300
CSTV-150-95	2, 14, 15, 17	CSTV-150
CSVP-075-95	2, 14, 15, 17	CSVP, CAIVP, CILVP, CSTVP, -038 to -100
CSVP-150-95	2, 14, 15, 17	CSVP, CAIVP, CILVP, -150
CSVP-200-95	2, 14, 15, 17	CSVP, CAIVP, CILVP, -200
CSVP-250-95	2, 14, 15, 17	CSVP, CAIVP, CILVP, -250
CSVP-300-95	2, 14, 15, 17	CSVP, CAIVP, CILVP, -300
CSVP-400-95	2, 14, 15, 17	CSVP, CAIVP, CILVP, -400
CSTVP-150-95	2, 14, 15, 17	CSTVP-150

### Bellows Assembly Kits

MODEL NUMBER	CONTENTS (See drawing)	FOR VALVE MODEL NUMBERS
CSV-075-16K	6, 16, 17	CSV, CILV, CAIV, CSTV, manual or pneumatic, -038 to -100
CSV-150-16K	6, 16, 17	CSV, CILV, CAIV, CSTV, manual or pneumatic, -150
CSV-200-16K	6, 16, 17	CSV, CILV, CAIV, manual or pneumatic, -200
CSV-250-16K	6, 16, 17	CSV, CILV, CAIV, manual or pneumatic, -250
CSV-300-16K	6, 16, 17	CSV, CILV, CAIV, manual or pneumatic, -300
CSVP-400-16K	6, 16, 17	CSVP and CILVP-400
ESV-075-16K	6, 16, 17	ESV, ILV and AIV, manual or pneumatic, -038 to -100
ESV-150-16K	6, 16, 17	ESV, ILV and AIV-150, manual or pneumatic
ESV-200-16K	6, 16, 17	ESV, ILV and AIV-200, manual
ESVP-200-16K	6, 16, 17	ESVP, ILVP and AIVP-200, pneumatic
ESV-250-16K	6, 16, 17	ESV, ILV and AIV-250, manual
ESVP-250-16K	6, 16, 17	ESV, ILV and AIV-250, pneumatic
ESV-300-16K	6, 16, 17	ESV, ILV and AIV-300, manual
ESVP-300-16K	6, 16, 17	ESV, ILV and AIV-300, pneumatic
ESVP-400-16K	16, 17	ESV, ILV and AIV-400, manual or pneumatic







# Isolation Valves

## Ball Valves

### SPECIFICATIONS

**Port OD's:** ¾, 1, 1 ½ and 2 inches (19, 25, 38 and 50mm)

**Materials:**

**Body:** 316L stainless steel

**Ball:** 316L stainless steel

**Stem seal:** Viton

(other O-ring compounds available)

**Ball seal:** Teflon

**Actuation:** Manual and pneumatic/spring

**Helium Leak Rates:** <math>1 \times 10^{-9}</math> mbar l/sec to atmosphere, <math>1 \times 10^{-7}</math> mbar l/sec across the seat.

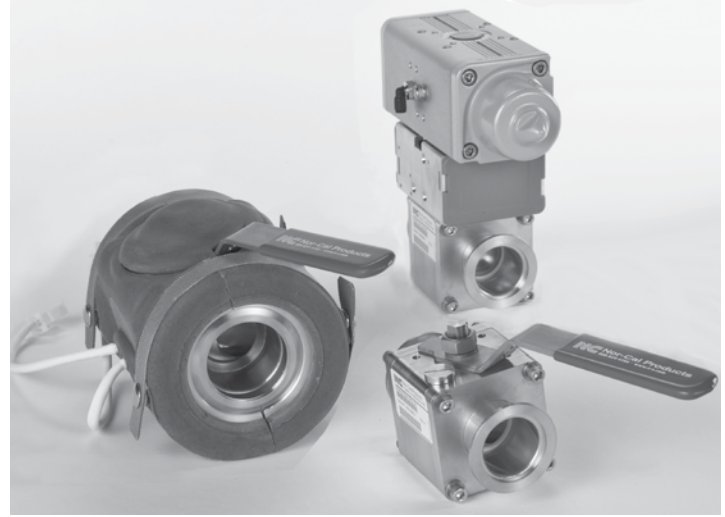
**Operating Temperature:** 150°C Max.

**Supply Pressure** (pneumatic/spring version): 60-100 psig (4-7 bar)

**Vacuum Range:** 1000 to  $1 \times 10^{-4}$  mbar

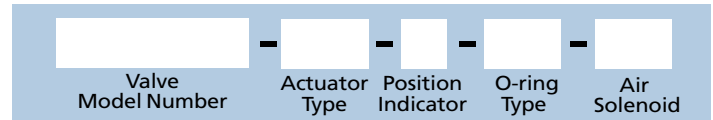
**Options:** Heater jackets and controllers available for all valves.

Ball valves are a low cost, manually or pneumatically operated, straight through isolation device. Their simple, robust design provides high reliability in "dirty" applications. They are commonly used on MOCVD and CVD equipment downstream from the chamber or vacuum pump to isolate traps or abatement tools. A stainless steel body and Teflon seat make these valves ideal for corrosive environments. A quarter turn of the handle quickly switches the valve from open to close. They are available with NW-16 through NW-50 flanges as standards. Heater jackets are available to reduce process by-product accumulation.



### Ball Valve Options

Please use the following part numbering tree to add the appropriate options to a standard ball valve model number. See tables below for option codes.



**Example:** BVP-2004-NW-NPN-S21

Pneumatic ball valve with 1.5 inch (38) ball ID, NW-50 flanges, air-to-open/spring-to-close, position indicators and 24VDC air solenoid.

### O-ring Material Option

CODE	DESCRIPTION
Default (no code)	Viton
-K79	Kalrez 4079
-K85	Kalrez 8085
-K75	Kalrez 8575
-K91	Kalrez 9100
-C38	Chemraz E38
-D19	Dupra 192
-PP7	Perlast G74P

### Actuator Option - BVM

CODE	DESCRIPTION
(Default)	Non-locking handle
-L	Locking handle

### Air Solenoid Option - BVP

CODE	KIT	DESCRIPTION
-S11	BVP-S11-K	120VAC, 50/60 Hz
-S21	BVP-S21-K	24VDC
-S31	BVP-S31-K	240VAC, 50/60 Hz
-S41	BVP-S41-K	24VAC, 50/60 Hz
-S12	BVP-S12-K	120VAC, 50/60 Hz (Use with -A actuator option)
-S22	BVP-S22-K	24VDC (Use with -A actuator option)
-S32	BVP-S32-K	240VAC, 50/60 Hz (Use with -A actuator option)
-S42	BVP-S42-K	24VAC, 50/60 Hz (Use with -A actuator option)

### Actuator Option - BVP

DESCRIPTION	CODE
Air-to-Open/Spring-to-Close (Normally Closed)	(Default)
Spring-to-Open/Air-to-Close (Normally Open)	-SA
Air-to-Open/Air-to-Close	-A

### Position Indicator Option - BVP

Open/closed position indicators detect the valve position. 24 VDC powered.

DESCRIPTION	CODE	KIT
Optical sensor	NPN	B-NPN-K
	PNP	B-PNP-K

All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.

# Isolation Valves

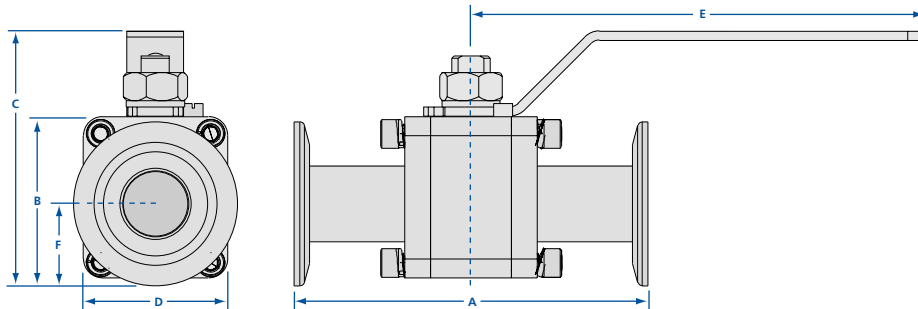
## Ball Valves



### Manual Ball Valve - BVM

MODEL NUMBER	NOMINAL PORT OD	BALL ID	DESCRIPTION	A	B	C	D	E	F
<b>BVM-0751</b>	0.75 (19)	0.56 (14.2)	No Flanges	4.36 (110.7)	1.85 (47)	2.94 (75)	1.85 (47)	5.80 (147)	0.93 (24)
<b>BVM-0751-NW</b>	0.75 (19)	0.56 (14.2)	NW-16	3.47 (88.1)	1.85 (47)	2.94 (75)	1.85 (47)	5.80 (147)	0.93 (24)
<b>BVM-1001-NW</b>	0.75 (19)	0.56 (14.2)	NW-25	3.93 (99.8)	1.85 (47)	2.94 (75)	1.85 (47)	5.80 (147)	0.93 (24)
<b>BVM-1002</b>	1.0 (25)	0.85 (21.6)	No Flanges	4.78 (121.4)	2.13 (54)	3.33 (85)	1.90 (48)	6.20 (157)	0.98 (25)
<b>BVM-1002-NW</b>	1.0 (25)	0.85 (21.6)	NW-25	3.93 (99.8)	2.13 (54)	3.33 (85)	1.90 (48)	6.20 (157)	0.98 (25)
<b>BVM-1502-NW</b>	1.0 (25)	0.85 (21.6)	NW-40	4.66 (118.4)	2.13 (54)	3.33 (85)	1.90 (48)	6.20 (157)	0.98 (25)
<b>BVM-1503</b>	1.5 (38)	1.25 (31.8)	No Flanges	4.59 (142.0)	2.80 (71)	4.04 (103)	2.80 (71)	7.20 (183)	1.40 (36)
<b>BVM-1503-NW</b>	1.5 (38)	1.25 (31.8)	NW-40	4.66 (118.4)	2.80 (71)	4.04 (103)	2.80 (71)	7.20 (183)	1.40 (36)
<b>BVM-2003-NW</b>	1.5 (38)	1.25 (31.8)	NW-50	4.97 (126.2)	2.80 (71)	4.04 (103)	2.80 (71)	7.20 (183)	1.40 (36)
<b>BVM-2004</b>	2.0 (50)	1.50 (38.1)	No Flanges	6.25 (159.0)	3.33 (85)	4.56 (116)	3.33 (85)	7.20 (183)	1.66 (42)
<b>BVM-2004-NW</b>	2.0 (50)	1.50 (38.1)	NW-50	4.97 (126.2)	3.33 (85)	4.56 (116)	3.33 (85)	7.20 (183)	1.66 (42)

Call for information on larger sizes.



### SPECIFICATIONS

**Port OD's:** ¾, 1, 1 ½ and 2 inches (19, 25, 38 and 50mm)

**Materials:**

**Body:** 316L stainless steel

**Ball:** 316L stainless steel

**Stem seal:** Viton

*(other O-ring compounds available)*

**Ball seal:** Teflon

**Actuation:** Manual and pneumatic/spring

**Helium Leak Rates:** <math>1 \times 10^{-9}</math> mbar l/sec to atmosphere, <math>1 \times 10^{-7}</math> mbar l/sec across the seat.

**Operating Temperature:** 150°C Max.

**Supply Pressure (pneumatic/spring version):** 60-100 psig (4-7 bar)

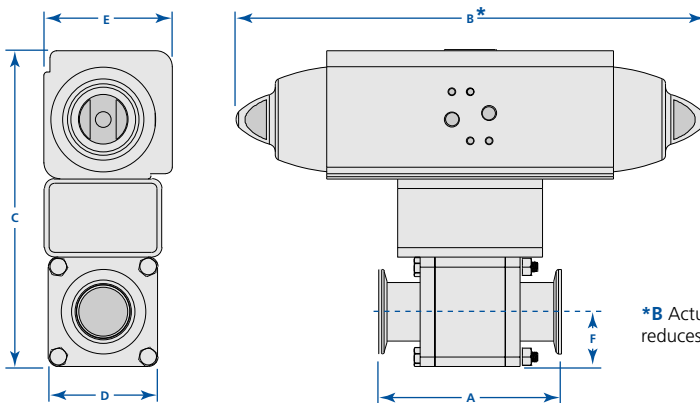
**Vacuum Range:** 1000 to  $1 \times 10^{-4}$  mbar

**Options:** Heater jackets and controllers available for all valves.

### Pneumatic Ball Valve - BVP

MODEL NUMBER	NOMINAL PORT OD	BALL ID	DESCRIPTION	A	B	C	D	E	F
<b>BVP-0751</b>	0.75 (19)	0.56 (14.2)	No Flanges	4.36 (110.7)	10.20 (259)	6.62 (168)	1.85 (47)	2.77 (70)	0.93 (24)
<b>BVP-0751-NW</b>	0.75 (19)	0.56 (14.2)	NW-16	3.47 (88.1)	10.20 (259)	6.62 (168)	1.85 (47)	2.77 (70)	0.93 (24)
<b>BVP-1001-NW</b>	0.75 (19)	0.56 (14.2)	NW-25	3.93 (99.8)	10.20 (259)	6.62 (168)	1.85 (47)	2.77 (70)	0.93 (24)
<b>BVP-1002</b>	1.0 (25)	0.85 (21.6)	No Flanges	4.78 (121.4)	10.20 (259)	6.90 (175)	1.90 (48)	2.77 (70)	0.98 (25)
<b>BVP-1002-NW</b>	1.0 (25)	0.85 (21.6)	NW-25	3.93 (99.8)	10.20 (259)	6.90 (175)	1.90 (48)	2.77 (70)	0.98 (25)
<b>BVP-1502-NW</b>	1.0 (25)	0.85 (21.6)	NW-40	4.66 (118.4)	10.20 (259)	6.90 (175)	1.90 (48)	2.77 (70)	0.98 (25)
<b>BVP-1503</b>	1.5 (38)	1.25 (31.8)	No Flanges	5.59 (142.0)	10.20 (259)	7.57 (192)	2.80 (71)	2.77 (70)	1.40 (36)
<b>BVP-1503-NW</b>	1.5 (38)	1.25 (31.8)	NW-40	4.66 (118.4)	10.20 (259)	7.57 (192)	2.80 (71)	2.77 (70)	1.40 (36)
<b>BVP-2003-NW</b>	1.5 (38)	1.25 (31.8)	NW-50	4.97 (126.2)	10.20 (259)	7.57 (192)	2.80 (71)	2.77 (70)	1.40 (36)
<b>BVP-2004</b>	2.0 (50)	1.50 (38.1)	No Flanges	6.25 (159.0)	10.20 (259)	8.10 (206)	3.33 (85)	2.77 (70)	1.66 (42)
<b>BVP-2004-NW</b>	2.0 (50)	1.50 (38.1)	NW-50	4.97 (126.2)	10.20 (259)	8.10 (206)	3.33 (85)	2.77 (70)	1.66 (42)

Call for information on larger sizes.



\*B Actuator option -A (air-to-open / air-to-close) reduces dimension to 6.76" (172).

### Ball Valve Seal Kit

MODEL NUMBER	DESCRIPTION
<b>BVM-1-95</b>	Teflon seats, Viton Flange Seals
<b>BVM-2-95</b>	Teflon seats, Viton Flange Seals
<b>BVM-3-95</b>	Teflon seats, Viton Flange Seals
<b>BVM-4-95</b>	Teflon seats, Viton Flange Seals

### Ball Valve Rebuild Kit

MODEL NUMBER	DESCRIPTION
<b>BVM-1-99</b>	-95 Seal Kit, SS ball, shaft bushings and seals
<b>BVM-2-99</b>	-95 Seal Kit, SS ball, shaft bushings and seals
<b>BVM-3-99</b>	-95 Seal Kit, SS ball, shaft bushings and seals
<b>BVM-4-99</b>	-95 Seal Kit, SS ball, shaft bushings and seals

All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.





# Isolation Valves

## Genesis Modular Valves

### SPECIFICATIONS

**Port ODs:** 3/4 to 2 inches (19 to 50mm).  
Larger sizes and metric tubing diameters available on request

**Mating flanges:** NW-16 through 50 standard

**Air fittings:** 5/32 inch (4) One-Touch

#### Materials

**Body:** Electroless nickel coated aluminum  
**Bellows:** Welded AM-350 stainless steel  
**O-rings:** Viton standard  
Other compounds available.  
**Air cylinder:** Teflon coated aluminum

**Service interval:** One million cycles

**Actuation:** Air-to-open/spring-to-close

**Operating pressure:** 60 to 80 psig (4-5.5 bar)

**Differential pressure:** Maximum 20psi (1.4bar) differential across the valve seat.

**Helium leak rate:**  $\leq 1 \times 10^{-9}$  mbar l/sec.

#### Operating temperature

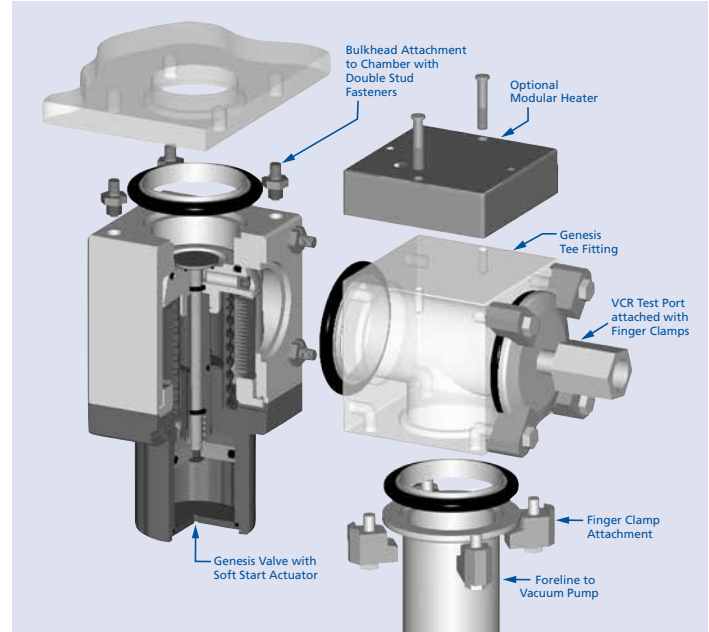
Sustained:  $\leq 150^\circ\text{C}$   
Intermittent:  $\leq 204^\circ\text{C}$

**Options:** Soft Start actuator with or without orifice, position indicators, air solenoids, and various O-ring compounds

**Thermal:** Heaters and insulators available.  
See page 120

The Genesis modular vacuum valve system provides equipment designers with unlimited possibilities for downstream vacuum subassemblies. Nippleless valve bodies and block fittings can be assembled by two attachment methods using universal ISO-KF centering ring/O-ring hardware, providing maximum flexibility and the smallest footprint possible.

Simple and robust, Genesis valves are rated at one million cycles before service. During testing, these valves were cycled millions of times while maintaining vacuum integrity. The welded bellows is AM-350 stainless steel for corrosion resistance, longevity and flexibility. The bellows fully retract from the side port when the valve is open, eliminating buildup of process by-products on the bellows and subsequent particle generation during operation. Valve center plates have been eliminated in order to provide precise alignment between the poppet and valve seat. A composite stem bushing resists wear even at high temperatures. Valve return springs are shot peened in order to provide millions of cycles without loss of force. Teflon coated air cylinders feature a 15 micron air filter to prevent particle migration either into or out of the air cylinder.



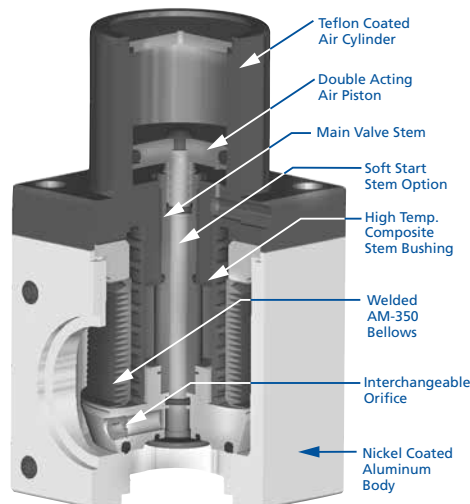
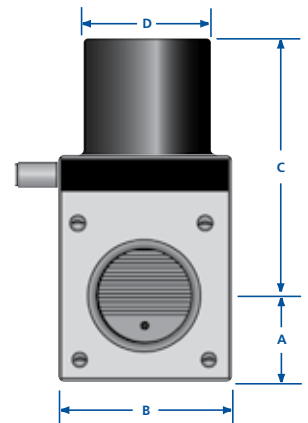
Genesis valves and fittings have a patented nippleless body, which provides the highest conductance and smallest footprint available. Air solenoids, open/closed position indicators, and soft start actuators can be added with no addition to size. All valves are designed for easy O-ring or bellows replacement. Design symmetry allows the air actuator to be oriented at 90° increments for easy access to the air solenoid and visibility of position indicators.

Genesis valve bodies and fittings are electroless nickel coated aluminum for excellent thermal characteristics and corrosion resistance. Components are machined from solid 6061-T6 aluminum to eliminate welds, leak paths and entrapments. All tapped holes are supplied with stainless steel threaded inserts for long term serviceability.

### Genesis Aluminum Modular Valves

MODEL NUMBER	NOMINAL PORT OD	FLANGE	A	B	C	D	THREAD	BOLT CIRCLE
<b>GNV-072</b>	3/4 (19)	NW-16	1.15 (29.2)	2.31 (58.7)	3.04 (77.2)	1.46 (37.1)	12-24	2.031 (51.59)
<b>GNV-102</b>	1 (25)	NW-25	1.06 (26.9)	2.13 (54.1)	3.14 (79.8)	1.46 (37.1)	12-24	2.031 (51.59)
<b>GNV-152</b>	1 1/2 (38)	NW-40	1.25 (31.8)	2.50 (63.5)	3.71 (94.2)	1.88 (47.8)	12-24	2.616 (66.45)
<b>GNV-202</b>	2 (50)	NW-50	1.63 (41.4)	3.25 (82.6)	4.44 (113)	2.25 (57.2)	1/4-20	3.406 (86.51)

**Note:** For option descriptions and how to add options, see next page.



Heaters, insulators, replacement parts and valve rebuild kits are located on Page 120

All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.

### Conductance

The conductance values in the table below have been calculated for air at room temperature using the formulas for tubes and elbows presented in the third edition of Roth's Vacuum Technology:  $C_v = 182(D^4/L')\bar{P}$  for viscous flow or  $C_m = 12(D^3/L')$  for molecular flow, Port lengths without flanges and inner diameters for the valve sizes and configurations were used. This method is an approximation, use values accordingly.

GENESIS VALVE	MOLECULAR FLOW $C_m$ (LITERS/SEC.)	VISCOUS FLOW $C_v$ (LITERS/SEC.)
GNV-10	21	717
GNV-15	59	3115
GNV-20	114	8183

**Note:**  $\bar{P}$ =air at 1 mbar.  $L'$ =Laxial + 1.33(0/180)D for elbows.

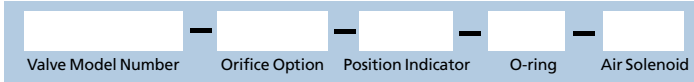
# Isolation Valves

## Genesis Modular Valve Options



Follow this part tree to add one or more options to a Genesis valve.

Add options to the basic valve part number in the order shown. **Example: GNV-152-S2-P10-KT-B21**



### Soft Start Valve Actuator Option

For reduced particle contamination in load locks and process chambers, Genesis valves can be provided with a patented low cost soft start actuator with no increase in valve size. A double-acting air piston, opens a soft start circuit inside the valve when air is supplied to the top of the air cylinder. The soft start by-pass opening can be provided fully open or with a specified orifice, depending on the desired pumpdown. (See diagram.) After the chamber has been pumped from atmosphere to the desired cross over pressure, the main valve circuit is opened by supplying air to the bottom of the air cylinder. Each circuit can be operated independently and is air-to-open, spring-to-close.

### Orifice Option

OPTION	VALVE SIZE	ORIFICE SIZE
-S0	No orifice	
-S1	3/4 - 2 (19-50)	.147 (3.7)
-S2	3/4 - 2 (19-50)	.109 (2.8)
-S3	3/4 - 2 (19-50)	.070 (1.8)

**NOTE:** Refer to diagrams for orifice selection

### Orifice Parts & Kits

MODEL NUMBER	VALVE SIZE	ORIFICE SIZE
GNV-075-S0-1	3/4 - 2 (19-50)	.070 (1.8)
GNV-075-S0-2	3/4 - 2 (19-50)	.109 (2.8)
GNV-075-S0-3	3/4 - 2 (19-50)	.147 (3.7)
GNV-075-S0-K	3/4 - 2 (19-50)	Kit*
GNV-075-S0-T	All	Wrench

\* Kits include all orifice sizes and an installation wrench for the specified valve size

### Position Indicator Option

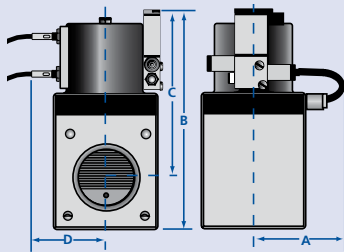
Nor-Cal's CE certified, shielded, open/closed position indicators detect the piston position in the valve's air cylinder. The technician has a visual indication of power to the circuit (12 to 24 VDC) and the valve position, as does the operator watching the panel. With the soft start option only one position indicator can be provided for the fully open position. Operating temperature range is -25°C to 70°C for valves with position indicators. Call for more information on heated valves with position indicators.

OPTION	VALVE ACTUATOR	DESCRIPTION
-P10	Soft Start/Standard	1 position indicator - main valve open only
-P1C	Standard	1 position indicator - main valve closed only
-P2	Standard	2 position indicators - main valve open & closed

Refer to diagram below for dimensions.

### Air Solenoid & Position Indicator Dimensions

SIZE	A	B	C	D
3/4 (19)	2.55 (64.8)	4.82 (122)	3.76 (95.5)	1.66 (42.2)
1 (25)	2.55 (64.8)	4.82 (122)	3.76 (95.5)	1.66 (42.2)
1 1/2 (38)	2.73 (69.3)	5.31 (135)	4.06 (103)	1.82 (46.2)
2 (50)	3.11 (79.0)	6.05 (154)	4.42 (112)	2.03 (51.6)



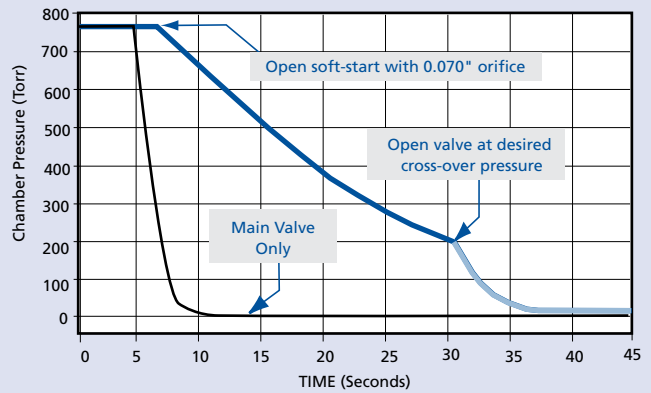
### O-ring Option

Genesis modular valves use chemical resistant Viton O-rings for closure. Viton O-rings should not be heated to above 204°C. Even prolonged exposures of 150°C may degrade the O-rings. High temp Kalrez O-rings allow valve bakeouts to 220°C intermittently or 170°C for extended periods. Silicone O-rings provide adequate sealing performance in thermal cycling from -55°C to 230°C.

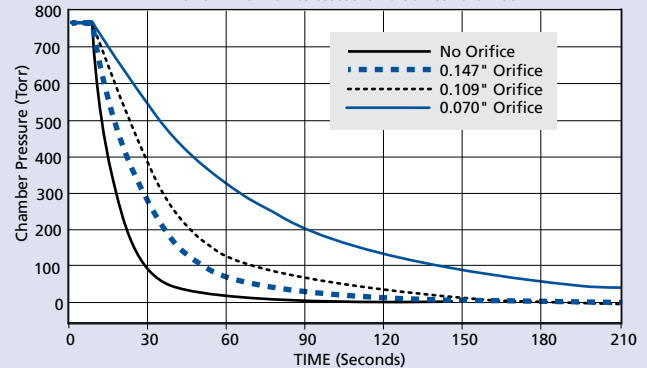
OPTION	COMPOUND	TEMPERATURE MIN.	TEMPERATURE MAX.	DESCRIPTION
Standard	Viton	-29°C	204°C	Industry standard
-KT	Kalrez 4079	-50°C	316°C	High temperatures
-KC	Kalrez 2037	-54°C	220°C	Chemical resistant
-CR	Chemraz 513	-30°C	210°C	Chemical resistant
-S	Silicone	-55°C	232°C	Extreme temps

### Valve/Orifice Pumpdown Curves Charts

Diagram A - TYPICAL PUMP-DOWN WITH SOFT-START  
1 1/2 or 2 inch valve on 30 Liter Chamber



1 1/2 & 2 inch valves tested on a 30 liter chamber



### Air Solenoid Option

Low 1.8 wattage, CE certified air solenoids in several current ratings can be provided on the valve, ready to attach to the house air supply. One three-way air solenoid is required for a standard Genesis valve and two three-way air solenoids are required for a soft start version. This option includes 24 inch (610) quick disconnect electrical leads and 5/32 inch (4) one-touch air fittings. Remote mount required on heated valves. Air solenoids can also be supplied as a kit with assembly hardware and instructions. Kit part numbers are in the second column below.

OPTION	KIT	ACTUATOR	DESCRIPTION	QUANTITY
-A11	A11-K	Standard	120 VAC, 50/60 Hz	1
-A21	A21-K	Standard	24 VDC	1
-A31	A31-K	Standard	240 VAC, 50/60 Hz	1
-A41	A41-K	Standard	24 VAC, 50/60 Hz	1
-B11	B11-K	Soft Start	120 VAC, 50/60 Hz	2
-B21	B21-K	Soft Start	24 VDC	2
-B31	B31-K	Soft Start	240 VAC, 50/60 Hz	2
-B41	B41-K	Soft Start	24 VAC, 50/60 Hz	2

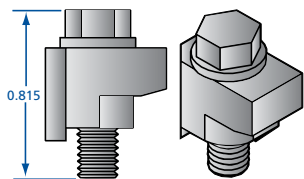
Refer to diagram at left for dimensions.

Valve heaters, insulators, rebuild and replacement part kits are located on page 120



# Isolation Valves

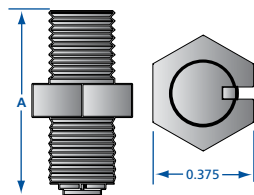
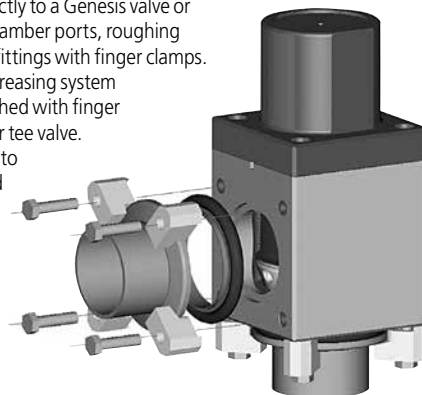
## Genesis Modular Valve Assembly Hardware



### Finger Clamp Component Assembly

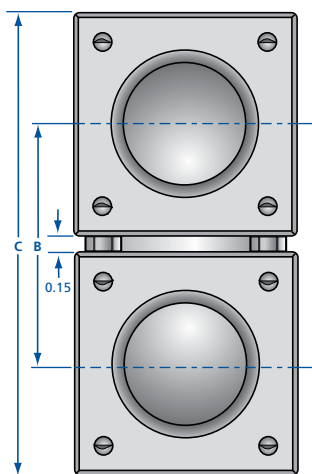
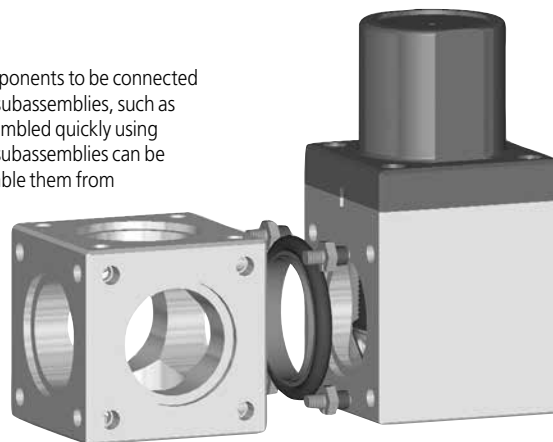
Stainless steel finger clamps allow a standard ISO-KF flange to be attached directly to a Genesis valve or fitting using a standard ISO-KF centering ring and O-ring. Elbows, reducers, chamber ports, roughing lines, or other vacuum components can be attached directly to valve bodies or fittings with finger clamps. Unnecessary valve ports have been eliminated, shortening the gas path and increasing system conductance. For ultimate versatility standard nipples and elbows can be attached with finger clamps in order to make a drop-in replacement valve, such as an angle-in-line or tee valve. Once the finger clamp bolt is loosened it can be pivoted out of the way in order to remove or install the flange and centering ring. The finger clamp does not need to be removed from the valve or fitting. The clamp is self-aligning when tightened, for ease of flange installation. Each kit contains four finger clamps, hex head bolts and washers for one connection.

MODEL NUMBER	VALVE SIZE	BOLT	TORQUE
<b>GNPC-150-S</b>	3/4 to 1 1/2 (19 to 38)	12-24 x 7/8	6.8 Nm.
<b>GNPC-200-S</b>	2 (50)	1/4-20 x 7/8	11.3 Nm.



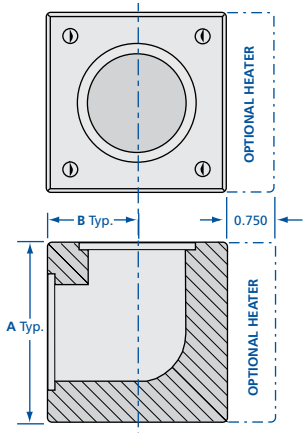
### Block Subassemblies with Double Stud Fasteners

Stainless steel double stud fasteners allow two Genesis components to be connected using a standard ISO-KF centering ring and O-ring. Special subassemblies, such as diverter valves or roughing/high vacuum circuits can be assembled quickly using double stud fasteners with valves and block fittings. These subassemblies can be provided as a unit from Nor-Cal or you may choose to assemble them from individual components. They are ideal for limited space installations, such as on cluster tool frames, and provide highest conductance, while eliminating unnecessary hardware. Double stud fasteners can be used to make a bulkhead attachment from a valve directly to a chamber. Stud fasteners can be installed using a jeweler's screwdriver and a 3/8 inch (9.53) ignition wrench. An installation tool for stud fasteners is provided with each stud fastener kit or assembly, or one can be purchased separately. Each kit contains four double stud fasteners for one connection and an installation tool.



MODEL NUMBER	VALVE SIZE	DESCRIPTION	THREAD	A	B	C
<b>GNSF-150</b>	3/4 to 1 (19 to 25)	(4) double stud fasteners	12-24	0.63 (15.9)	2.3 (57.9)	4.40 (111.8)
<b>GNSF-150</b>	1 1/2 (38)	(4) double stud fasteners	12-24	0.63 (15.9)	2.7 (67.3)	5.15 (130.8)
<b>GNSF-150-K</b>	3/4 to 1 1/2 (19 to 38)	(4) double stud fasteners with install tool	12-24	0.63 (15.9)	-	-
<b>GNSF-200</b>	2 (50)	(4) double stud fasteners	1/4-20	0.73 (18.5)	3.4 (86.4)	6.65 (168.9)
<b>GNSF-200-K</b>	2 (50)	(4) double stud fasteners with install tool	1/4-20	0.73 (18.5)	-	-
<b>GNSF-T</b>	All	Double stud install tool	-	-	-	-

Valve heaters, insulators, rebuild and replacement part kits are located on page 120

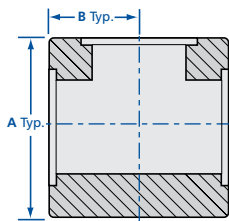


### Genesis Modular Fittings

Genesis fittings provide the most compact, highest conductance, corrosion resistant vacuum connection available when used with Genesis valves, fittings and double stud fasteners. These fittings can also attach with finger clamps to standard ISO-KF components with universal O-rings, which are also available from Nor-Cal Products.

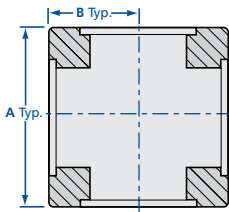
#### 90° Elbow

MODEL NUMBER	VALVE SIZE	A	B	THREAD	BOLT CIRCLE
<b>GNF-102</b>	1 (25)	2.125 (54.0)	1.063 (27.0)	12-24	2.031 (51.6)
<b>GNF-152</b>	1½ (38)	2.500 (63.5)	1.250 (31.8)	12-24	2.616 (66.4)
<b>GNF-202</b>	2 (50)	3.250 (82.6)	1.625 (41.3)	¼-20	3.406 (86.4)



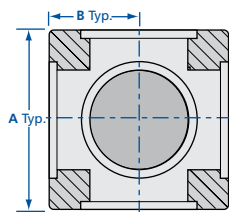
#### Tee

MODEL NUMBER	VALVE SIZE	A	B	THREAD	BOLT CIRCLE
<b>GNF-103</b>	1 (25)	2.125 (54.0)	1.063 (27.0)	12-24	2.031 (51.6)
<b>GNF-153</b>	1½ (38)	2.500 (63.5)	1.250 (31.8)	12-24	2.616 (66.4)
<b>GNF-203</b>	2 (50)	3.250 (82.6)	1.625 (41.3)	¼-20	3.406 (86.4)



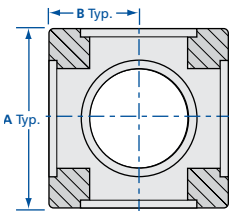
#### 4-Way Cross

MODEL NUMBER	VALVE SIZE	A	B	THREAD	BOLT CIRCLE
<b>GNF-104</b>	1 (25)	2.125 (54.0)	1.063 (27.0)	12-24	2.031 (51.6)
<b>GNF-154</b>	1½ (38)	2.500 (63.5)	1.250 (31.8)	12-24	2.616 (66.4)
<b>GNF-204</b>	2 (50)	3.250 (82.6)	1.625 (41.3)	¼-20	3.406 (86.4)



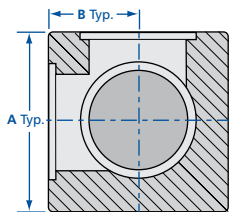
#### 5-Way Cross

MODEL NUMBER	VALVE SIZE	A	B	THREAD	BOLT CIRCLE
<b>GNF-105</b>	1 (25)	2.125 (54.0)	1.063 (27.0)	12-24	2.031 (51.6)
<b>GNF-155</b>	1½ (38)	2.500 (63.5)	1.250 (31.8)	12-24	2.616 (66.4)
<b>GNF-205</b>	2 (50)	3.250 (82.6)	1.625 (41.3)	¼-20	3.406 (86.4)



#### 6-Way Cross

MODEL NUMBER	VALVE SIZE	A	B	THREAD	BOLT CIRCLE
<b>GNF-106</b>	1 (25)	2.125 (54.0)	1.063 (27.0)	12-24	2.031 (51.6)
<b>GNF-156</b>	1½ (38)	2.500 (63.5)	1.250 (31.8)	12-24	2.616 (66.4)
<b>GNF-206</b>	2 (50)	3.250 (82.6)	1.625 (41.3)	¼-20	3.406 (86.4)



#### Tri-Bow

MODEL NUMBER	VALVE SIZE	A	B	THREAD	BOLT CIRCLE
<b>GNF-107</b>	1 (25)	2.125 (54.0)	1.063 (27.0)	12-24	2.031 (51.6)
<b>GNF-157</b>	1½ (38)	2.500 (63.5)	1.250 (31.8)	12-24	2.616 (66.4)
<b>GNF-207</b>	2 (50)	3.250 (82.6)	1.625 (41.3)	¼-20	3.406 (86.4)

#### SPECIFICATIONS

**Port ODs:** 1, 1½ and 2 inches (25, 38 and 50mm). *Other size tubing diameters available*

**Body:** Electroless nickel coated 6061 T-6 aluminum with SS threaded inserts

**O-rings:** Viton standard

#### Assembly

**Fitting to fitting:** Double-stud fasteners  
**Fitting to flange:** Finger clamps

**Helium leak rate:** ≤1x10<sup>-9</sup> mbar l/sec.

#### Operating temperature

Sustained: 150°C  
 Intermittent: 204°C

**Options:** Modular heaters and heater jackets



Heaters and insulators are available on page 120



# Isolation Valves

## Genesis Stainless Steel Valves

Genesis stainless steel poppet valves offer equipment designers the high performance and optimized conductance of Genesis modular valves in Nor-Cal's standard stainless steel poppet valve body. These simple, robust valves are available with standard and soft start air-to-open/spring-to-close actuation in port sizes from 3/4 to 4 inches (19.05-101.6mm). Viton O-ring seals are standard. Other O-ring compounds, open/closed position indicators and air solenoids are available as options. Heater jackets and insulators are also available.

During testing, the valves were cycled millions of times while maintaining vacuum integrity. The welded bellows is AM-350 for corrosion resistance, longevity and flexibility. The bellows fully retracts from the side port when the valve is open, eliminating buildup of process by-products on the bellows and subsequent particle generation during operation. Valve center plates have been eliminated in order to provide precise alignment between the poppet and valve seat. A composite stem bushing resists wear even at high temperatures. Valve return springs are shot peened in order to provide millions of cycles without loss of force. Teflon coated air cylinders feature a 15 micron air filter to prevent particle migration either into or out of the air cylinder. All valves are designed for easy O-ring or bellows replacement. Design symmetry allows the air actuator to be oriented at 90° increments for easy access to the air solenoid and visibility of position indicators.

For reduced particle contamination in load locks and process chambers, Genesis stainless steel valves are offered with a patented low cost soft start actuator with no increase in valve size. A double-acting air piston, opens a soft start circuit inside the valve when air is supplied to the top of the air cylinder. The soft start by-pass opening can be provided fully open or with a specified orifice, depending on the desired pump down. After the chamber has been pumped from atmosphere to the desired cross over pressure, the main valve circuit is opened by supplying air to the bottom of the air cylinder. Each circuit can be operated independently and is air-to-open/spring-to-close. Soft start Genesis stainless steel valves are offered standard with no orifice. Various orifice size options and multiple size orifice kits are available. See next page.

### Conductance

This table has been calculated in liters per second for air at room temperature using the formulas for tubes and elbows presented in the third edition of Roth's Vacuum Technology.

$C_v = 182(D^4/L)P$  for viscous flow or  $C_m = 12(D^3/L')$  for molecular flow

**Note:** Calculations were based on port lengths without flanges and inner diameters for the valve sizes and configurations. P = air at 1 mbar. L' = Laxial + 1.33(θ/180)D for elbows.

NOMINAL PORT OD	ANGLE		ANGLE-IN-LINE	
	VISCOUS	MOLECULAR	VISCOUS	MOLECULAR
1/2 (13)	60	3	-	-
3/4 (19)	135	5	120	4
1 (25)	391	12	285	9
1 1/8 (29)	-	-	-	-
1 1/2 (38)	1925	37	1324	25
2 (50)	4677	65	3459	48
2 1/2 (63)	12332	136	7505	83
3 (76)	23763	217	12558	115
4 (100)	57994	396	-	-



### SPECIFICATIONS

**Port ODs:** 3/4 to 4 inches (19 to 100mm).  
Larger sizes and metric tubing diameters available on request

**Mating flanges:** NW-16 through ISO-100 standard

**Air fittings:** 5/32 inch (4mm) One-Touch

#### Materials

Body: 304 stainless steel  
Bellows: Welded AM-350 stainless steel  
O-rings: Viton standard  
(Other compounds available.)  
Air cylinder: Teflon coated aluminum

**Service interval:** One million cycles

**Actuation:** Normally closed  
Air-to-open/spring-to-close

**Operating pressure:** 60 to 80 psig (4-5.5 bar)

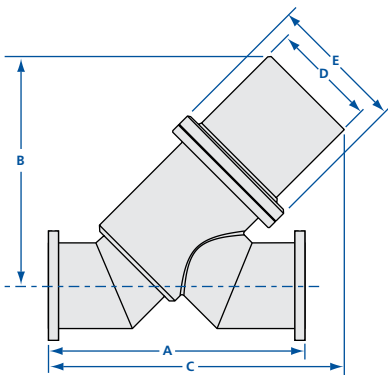
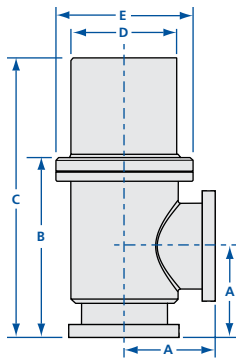
**Differential pressure:** Maximum 20psi (1.4bar) differential across the valve seat

**Helium leak rate:**  $\leq 1 \times 10^{-9}$  mbar l/sec.

#### Operating temperature

Sustained:  $\leq 150^\circ\text{C}$   
Intermittent:  $\leq 204^\circ\text{C}$

**Option:** Air solenoids, open/closed position indicators, soft start with various orifice sizes and various O-ring compounds



Valve rebuild and replacement part kits are available on page 120

### Genesis Stainless Steel Angle Valves

MODEL NUMBER	ACTUATION	FLANGE TYPE	NOMINAL PORT OD	A	B	C	D	E
<b>GNVS-072-NWB</b>	Standard	NW-16	3/4 (19)	1.50 (38.1)	3.40 (86)	4.78 (121)	1.46 (37)	2.13 (54)
<b>GNVS-072-NWB-SO</b>	Soft Start	NW-16	3/4 (19)	1.50 (38.1)	3.40 (86)	4.78 (121)	1.46 (37)	2.13 (54)
<b>GNVS-102-NWB</b>	Standard	NW-25	1 (25)	2.42 (61.47)	4.19 (106)	5.57 (141)	1.46 (37)	2.13 (54)
<b>GNVS-102-NWB-SO</b>	Soft Start	NW-25	1 (25)	2.42 (61.47)	4.19 (106)	5.57 (141)	1.46 (37)	2.13 (54)
<b>GNVS-152-NWB</b>	Standard	NW-40	1 1/2 (38)	2.49 (63.2)	4.51 (115)	6.20 (157)	1.88 (48)	2.50 (63)
<b>GNVS-152-NWB-SO</b>	Soft Start	NW-40	1 1/2 (38)	2.49 (63.2)	4.51 (115)	6.20 (157)	1.88 (48)	2.50 (63)
<b>GNVS-202-NWB</b>	Standard	NW-50	2 (50)	3.22 (81.9)	5.56 (141)	7.66 (195)	2.25 (57)	3.25 (83)
<b>GNVS-202-NWB-SO</b>	Soft Start	NW-50	2 (50)	3.22 (81.9)	5.56 (141)	7.66 (195)	2.25 (57)	3.25 (83)
<b>GNVS-302-ISO</b>	Standard	ISO-80	3 (76)	3.86 (98.0)	7.33 (186)	10.85 (276)	4.13 (105)	5.45 (138)
<b>GNVS-302-ISO-SO</b>	Soft Start	ISO-80	3 (76)	3.86 (98.0)	7.33 (186)	10.85 (276)	4.13 (105)	5.45 (138)
<b>GNVS-402-ISO</b>	Standard	ISO-100	4 (100)	4.25 (108)	8.38 (213)	13.04 (331)	5.00 (127)	6.40 (163)
<b>GNVS-402-ISO-SO</b>	Soft Start	ISO-100	4 (100)	4.25 (108)	8.38 (213)	13.04 (331)	5.00 (127)	6.40 (163)

### Genesis Stainless Steel Angle-In-Line Valves

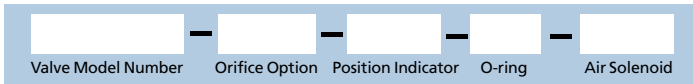
MODEL NUMBER	ACTUATION	FLANGE TYPE	NOMINAL PORT OD	A	B	C	D	E
<b>GNVSAI-072-NWB</b>	Standard	NW-16	3/4 (19)	4.20 (107)	3.76 (95)	4.37 (111)	1.46 (37)	2.13 (54)
<b>GNVSAI-072-NWB-SO</b>	Soft Start	NW-16	3/4 (19)	4.20 (107)	3.76 (95)	4.37 (111)	1.46 (37)	2.13 (54)
<b>GNVSAI-102-NWB</b>	Standard	NW-25	1 (25)	4.00 (102)	3.85 (98)	4.63 (118)	1.46 (37)	2.13 (54)
<b>GNVSAI-102-NWB-SO</b>	Soft Start	NW-25	1 (25)	4.00 (102)	3.85 (98)	4.63 (118)	1.46 (37)	2.13 (54)
<b>GNVSAI-152-NWB</b>	Standard	NW-40	1 1/2 (38)	5.12 (130)	4.47 (114)	5.28 (134)	1.88 (48)	2.50 (63)
<b>GNVSAI-152-NWB-SO</b>	Soft Start	NW-40	1 1/2 (38)	5.12 (130)	4.47 (114)	5.28 (134)	1.88 (48)	2.50 (63)
<b>GNVSAI-202-NWB</b>	Standard	NW-50	2 (50)	7.00 (178)	5.79 (147)	7.00 (178)	2.25 (57)	3.25 (83)
<b>GNVSAI-202-NWB-SO</b>	Soft Start	NW-50	2 (50)	7.00 (178)	5.79 (147)	7.00 (178)	2.25 (57)	3.25 (83)
<b>GNVSAI-302-ISO</b>	Standard	ISO-80	3 (76)	10.55 (268)	8.88 (226)	11.62 (295)	4.13 (105)	5.45 (138)
<b>GNVSAI-302-ISO-SO</b>	Soft Start	ISO-80	3 (76)	10.55 (268)	8.88 (226)	11.62 (295)	4.13 (105)	5.45 (138)
<b>GNVSAI-402-ISO</b>	Standard	ISO-100	4 (100)	12.00 (305)	10.75 (273)	13.81 (351)	5.00 (127)	6.40 (163)
<b>GNVSAI-402-ISO-SO</b>	Soft Start	ISO-100	4 (100)	12.00 (305)	10.75 (273)	13.81 (351)	5.00 (127)	6.40 (163)

# Isolation Valves

## Genesis Stainless Steel Valve Options



Follow this part tree to add one or more options to a Genesis valve. Add options to the basic valve part number in the order shown.



Example: **GNVSAI-302-ISO-P10-KT-A11**

### Orifice Option

Genesis stainless steel valves with Soft Start actuation come standard with no orifice. To order these valves with an orifice replace the "SO" part number suffix with one of the following options. Example: Change standard valve part number **GNVS-072-NWB-S0** to **GNVS-072-NWB-S1**.

ORIFICE OPTION	VALVE SIZE	ORIFICE SIZE	ORIFICE REPLACEMENTS	VALVE SIZE	ORIFICE SIZE
-S0	No orifice		<b>GNV-075-S0-1</b>	3/4 to 2 (19-50)	.070 (1.8)
-S1	3/4 to 2 (19-50)	.147 (3.7)	<b>GNV-075-S0-2</b>	3/4 to 2 (19-50)	.109 (2.8)
-S2	3/4 to 2 (19-50)	.109 (2.8)	<b>GNV-075-S0-3</b>	3/4 to 2 (19-50)	.147 (3.7)
-S3	3/4 to 2 (19-50)	.070 (1.8)	<b>GNV-300-S0-1</b>	3 & 4 (76 & 100)	.055 (1.4)
-S4	3 & 4 (76 & 100)	.055 (1.4)	<b>GNV-300-S0-2</b>	3 & 4 (76 & 100)	.093 (2.4)
-S5	3 & 4 (76 & 100)	.093 (2.4)	<b>GNV-300-S0-3</b>	3 & 4 (76 & 100)	.128 (3.3)
-S6	3 & 4 (76 & 100)	.128 (3.3)	<b>GNV-300-S0-4</b>	3 & 4 (76 & 100)	.201 (5.1)
-S7	3 & 4 (76 & 100)	.201 (5.1)	<b>GNV-075-S0-K</b>	3/4 to 2 (19-50)	Kit*
			<b>GNV-300-S0-K</b>	3 & 4 (76 & 100)	Kit*
			<b>GNV-075-S0-T</b>	3/4 to 4 (76 & 100)	Wrench

NOTE: Refer to diagrams for orifice option selection

\* Kits include all orifice sizes and an installation wrench for the specified valve size

### Open/Closed Position Indicator Option

Nor-Cal's CE certified, shielded, open/closed position indicators detect the piston position in the valve's air cylinder. The technician has a visual indication of power to the circuit (12 to 24 VDC) and the valve position, as does the operator watching the panel. With the soft start option only one position indicator can be provided for the fully open position. Operating temperature range is -25°C to 70°C for valves with position indicators. Call for more information on high temperature position indicators.

OPTION	VALVE ACTUATOR	DESCRIPTION
-P10	Soft Start/Standard	1 position indicator - main valve open only
-P1C	Standard	1 position indicator - main valve closed only
-P2	Standard	2 position indicators - main valve open & closed

### O-ring Option

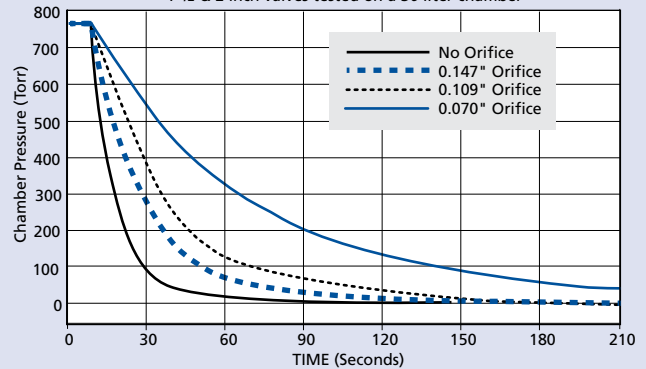
Standard Genesis valves are furnished with Viton O-rings which are resistant to most chemicals, but should not be heated to temperatures in excess 204°C. Even prolonged exposures of 150°C may degrade the O-rings. High temperature Kalrez O-rings allow the valve to be heated to 220°C intermittently or 170°C for prolonged periods.

OPTION	COMPOUND	APPLICATIONS
-KT	4079 Kalrez	High temperature
-KC	2037 Kalrez	Chemical resistant
-CR	513 Chemraz	Chemical resistant
-S	Silicone	Extreme temperatures

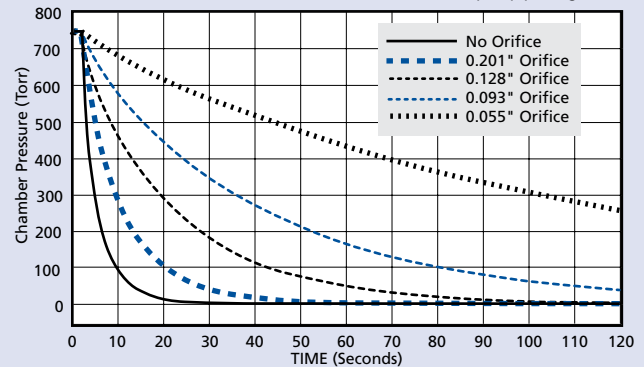


### Valve/Orifice Pumpdown Curves Charts

1 1/2 & 2 inch valves tested on a 30 liter chamber



3 and 4 inch valves tested with various Soft-Start orifices on a 30 liter chamber and 232 CFM Edwards mechanical blower pump package.



### Air Solenoid Option

Low 1.8 wattage, CE certified three-way air solenoids can be provided on the valve in several electrical current ratings, with 24 inch (610mm) quick disconnect electrical leads, and 5/32 inch (3.97mm) one-touch air fittings - ready to attach to the house air supply. One solenoid is required for standard Genesis stainless valves. Two solenoids are required for soft start versions. Remote mount is required on heated valves. Air solenoid kits with assembly hardware and instructions are available. Kit part numbers are in the second column below.

OPTION	KIT	ACTUATOR	DESCRIPTION	QUANTITY
-A11	<b>A11-K</b>	Standard	120 VAC, 50/60 Hz	1
-A21	<b>A21-K</b>	Standard	24 VDC	1
-A31	<b>A31-K</b>	Standard	240 VAC, 50/60 Hz	1
-A41	<b>A41-K</b>	Standard	24 VAC, 50/60 Hz	1
-B11	<b>B11-K</b>	Soft Start	120 VAC, 50/60 Hz	2
-B21	<b>B21-K</b>	Soft Start	24 VDC	2
-B31	<b>B31-K</b>	Soft Start	240 VAC, 50/60 Hz	2
-B41	<b>B41-K</b>	Soft Start	24 VAC, 50/60 Hz	2





# Isolation Valves

## Genesis Heaters & Replacement Kits

### SPECIFICATIONS

**Compatible Valves:** Genesis Modular Valves Heaters and controllers for stainless steel Genesis Valves available. Call for details.

**Insulator Body:** 1/2 inch (13mm) thick, trimable, molded silicone construction. Touch safe exterior

**Heater**  
**Voltage:** 120 or 240 VAC standard  
**Set points:** 120°C or 150°C  
**Manual reset:** 200°C with over temp shutoff  
**Low temperature alert:** standard on 1 1/2 and 2 inch (38-50mm) valves

**Connections**  
**Power cord:** 12 inch (305mm) with AMP 3-pin  
**Alert cords:** Two 12 inch (305mm) with AMP MR connectors standard on 1 1/2 & 2 (38 & 50mm) inch valves

**Certification**  
**Insulators:** UL 94 V-O  
**Heaters:** UL listed. CE certification pending

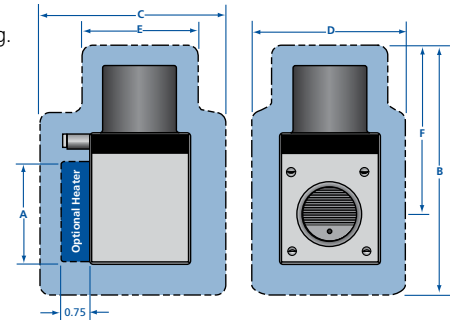
### Genesis Modular Valve Heaters & Insulators

A unique, UL listed modular heater provides 120°C or 150°C internal temperatures in valves or fittings at a fraction of the cost of other heaters. Genesis heaters use thick film technology to provide uniform heat throughout the component. Each heater contains a control set point and a resettable high temperature shut off. The 1 1/2 and 2 inch (38.1 and 50.8mm) sizes also have a low temperature alert that can be connected to a remote alarm. Each thermostat can be replaced without destroying the heater. The same heater can be attached to a valve body or fitting with two screws. A trim-to-fit, molded insulator covers the heated component and mating flanges. These clean room compatible insulators are constructed of 1/2 inch (12.7mm) thick molded silicone. When in use, the exterior surface remains touch-safe. Insulators meet UL 94 V-O requirements. Insulators for other components are available upon request. Heater jackets and controllers for Genesis Stainless Steel Valves are available. Call for information and pricing.

### Heaters

MODEL NUMBER	VALVE SIZE	SET POINT	WATTS	A
HT-GN-100-120-1	3/4 & 1 (19 & 25)	120°C	120	2.13 (54)
HT-GN-100-150-1	3/4 & 1 (19 & 25)	150°C	120	2.13 (54)
HT-GN-150-120-1	1 1/2 (38)	120°C	120	2.50 (63)
HT-GN-150-150-1	1 1/2 (38)	150°C	120	2.50 (63)
HT-GN-200-120-1	2 (50)	120°C	160	3.25 (83)
HT-GN-200-150-1	2 (50)	150°C	160	3.25 (83)

**NOTE:** Replace "-1" with "-2" for 240V heaters.



### Heater Insulators

MODEL NUMBER	VALVE SIZE	B	C	D	E	F
HI-GNV-100	3/4 & 1 (19 & 25)	6.00 (152)	4.50 (114)	3.13 (80)	2.50 (63)	3.64 (92)
HI-GNV-150	1 1/2 (38)	6.63 (168)	5.00 (127)	3.63 (92)	2.88 (73)	4.25 (108)
HI-GNV-200	2 (50)	8.00 (203)	5.88 (149)	4.38 (111)	3.31 (84)	5.00 (127)

### Heater Power Cords

MODEL NUMBER	LENGTH
HT-GN-PCD-6	6 ft.
HT-GN-PCD-12	12 ft.

### Genesis Valve Assembly Kits and Replacement Hardware

The kits below are for use with Genesis modular valves and with Genesis stainless steel valves. First maintenance is recommended at one million cycles, depending on the cleanliness of the process. Typical valve service will require O-ring replacement.



Bellows assembly

### Bellows Assembly Kits

Includes bellows, top flange and poppet weldment assembly. Requires O-ring kit to seal.

KIT NUMBER	VALVE SIZE	ACTUATOR
GNV-100-16	3/4 & 1 (19 & 25)	Standard
GNV-100-16-SO	3/4 & 1 (19 & 25)	Soft Start
GNV-150-16	1 1/2 (38)	Standard
GNV-150-16-SO	1 1/2 (38)	Soft Start
GNV-200-16	2 (50)	Standard
GNV-200-16-SO	2 (50)	Soft Start
GNV-300-16	3 (76)	Standard
GNV-300-16-SO	3 (76)	Soft Start
GNV-400-16	4 (100)	Standard
GNV-400-16-SO	4 (100)	Soft Start

### Viton O-Ring Kits

Includes bellows O-ring and poppet O-ring. Other O-ring compounds are available on request.

KIT NUMBER	VALVE SIZE	ACTUATOR
GNV-100-95	3/4 & 1 (19 & 25)	Standard
GNV-100-95-SO	3/4 & 1 (19 & 25)	Soft Start
GNV-150-95	1 1/2 (38)	Standard
GNV-150-95-SO	1 1/2 (38)	Soft Start
GNV-200-95	2 (50)	Standard
GNV-200-95-SO	2 (50)	Soft Start
GNV-300-95	3 (76)	Standard
GNV-300-95-SO	3 (76)	Soft Start
GNV-400-95	4 (100)	Standard
GNV-400-95-SO	4 (100)	Soft Start

### Valve Rebuild Kits

Includes all standard parts except valve body and position indicator. Your valve's position indicator type must be specified when ordering. Example: GNV-150-99-SO-P10

KIT NUMBER	VALVE SIZE	ACTUATOR
GNV-100-99	3/4 & 1 (19 & 25)	Standard
GNV-100-99-SO	3/4 & 1 (19 & 25)	Soft Start
GNV-150-99	1 1/2 (38)	Standard
GNV-150-99-SO	1 1/2 (38)	Soft Start
GNV-200-99	2 (50)	Standard
GNV-200-99-SO	2 (50)	Soft Start
GNV-300-99	3 (76)	Standard
GNV-300-99-SO	3 (76)	Soft Start
GNV-400-99	4 (100)	Standard
GNV-400-99-SO	4 (100)	Soft Start

All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.



Patented design

Our manual butterfly valves provide a low-cost alternative to bellows sealed gate valves. These valves easily actuate from the fully-closed position to fully open with only a quarter turn of the knob. A patented design allows the sealing disk to center itself when closing, with even pressure around the Viton O-ring seal. This design also helps to lower the amount of scuffing or rolling of the o-ring. Quarter-turn actuation, small footprint and the shortest possible gas path make manual butterfly valves the preferred choice for many applications.

#### SPECIFICATIONS

**Port ODs:** 3/4 to 2 inches (19 to 50mm)

#### Materials

Body: 304 stainless steel  
Knob: Aluminum  
Port seal: Viton

**Actuation:** Manual using knurled knob

#### Maximum temperature with Viton seals

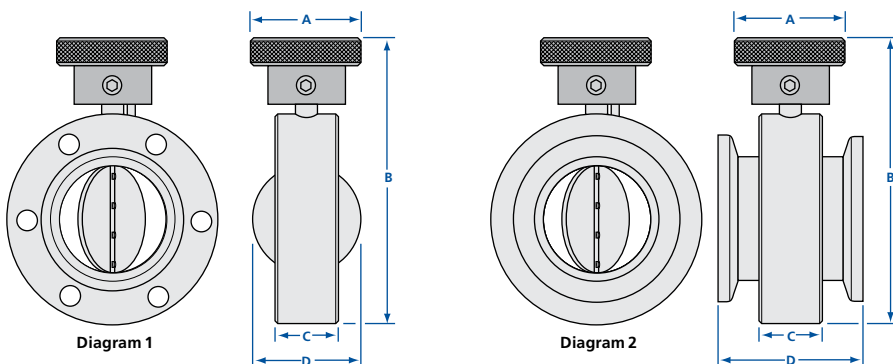
Sustained:  $\leq 150^{\circ}\text{C}$   
Intermittent:  $\leq 204^{\circ}\text{C}$

#### Vacuum range

Viton o-ring:  $\geq 1 \times 10^{-9}$  mbar-High vacuum

## Manual Butterfly Valves

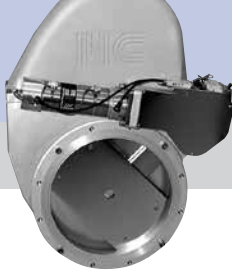
MODEL NUMBER	DIAGRAM	VALVE SIZE	FLANGE TYPE	A	B	C	D
BFV-0752-CF	1	3/4 (19)	1.33 CF	0.75 (19)	2.01 (51)	0.75 (19)	-
BFV-0752-NWB	2	3/4 (19)	NW 16	0.75 (19)	2.01 (51)	0.75 (19)	1.75 (44)
BFV-1002-CF	1	1 (25)	2.12 CF	1.00 (25)	2.75 (70)	1.00 (25)	1.04 (26)
BFV-1002-NWB	2	1 (25)	NW 25	1.00 (25)	2.75 (70)	1.00 (25)	2.00 (50)
BFV-1502-CF	1	1 1/2 (38)	2.75 CF	1.25 (32)	3.71 (94)	0.75 (19)	1.34 (34)
BFV-1502-NWB	2	1 1/2 (38)	NW 40	1.25 (32)	3.71 (94)	1.37 (35)	2.25 (57)
BFV-2002-CF	1	2 (50)	3.38 CF	1.75 (44)	4.90 (124)	1.00 (25)	1.90 (48)
BFV-2002-NWB	2	2 (50)	NW 50	1.75 (44)	4.90 (124)	1.00 (25)	2.25 (57)



## Replacement O-rings

MODEL NUMBER	VALVE SIZE	O-RING COMPOUND
BFV-075-95	3/4 (19.1)	Viton
BFV-100-95	1 (25.4)	Viton
BFV-150-95	1 1/2 (38.1)	Viton
BFV-200-95	2 (50.8)	Viton

All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.



# Isolation Valves

## Isolation Pendulum Valves

### SPECIFICATIONS

**Materials**

Body: Cast aluminum A356.0  
 Valve plate: Aluminum 6061-T6  
 Other parts: A6061, A7075, SS304, SS316, Inconel X-750 and Viton  
 Seals: Viton standard. Kalrez, Chemraz, Perlast and other materials available  
 Body and plate surface treatment  
 Bare aluminum standard.  
 Hard Type III anodizing optional

**Compressed air source**

CDA or equivalent at 65 to 85 psig

**Differential pressure**

With valve fully sealed: 1.02 bar maximum across the valve plate  
 While opening the valve  
 20 mbar (DN160 and DN200)  
 24 mbar (DN250)  
 29 mbar (DN350)

**Operating pressure:**  $3.8 \times 10^{-8}$  to 1000 mbar

**Heating or bakeout capabilities**

Body: 150°C maximum with optional heater kits  
 Actuator: 60°C maximum

**Ambient operating temps:** 0 - 60°C

**Helium Leak rate:**  $\leq 10^{-9}$  mbar l/sec across seat and to atmosphere  
 ( $1 \times 10^{-8}$  mbar l/sec He for hard anodized body or gate)

**Maximum speed:** Customer adjustable depending on size

**Reliability:** 99% confidence level in clean environment  
 O-ring cycle life: 200K cycles open to fully closed  
 MTBF:  $\geq 10,000$  hrs. continuous operation

**Options:** Heater jackets, other O-ring materials and flange configurations available

Nor-Cal Products' pneumatically actuated isolation pendulum valves contain the same patented Penduroll mechanism that is found in the Intellisys throttling pendulum valves. These valves offer the user a highly reliable, compact and low cost alternative to competitive designs. In addition, the smooth actuation results in low particle generation and rapid open-to-close speeds.

In-situ serviceability of the valve is made possible through the incorporation of a removable bonnet cover. The entire gate assembly and sealing O-ring can be accessed without removing the valve from the system, making regular inspections, cleanings and O-ring replacements quick and easy.

The valve body can be heated to 150°C with optional heater jackets. Call for information and pricing.



Heated pendulum valve assembly in our 3000 square foot Class 1000 clean room

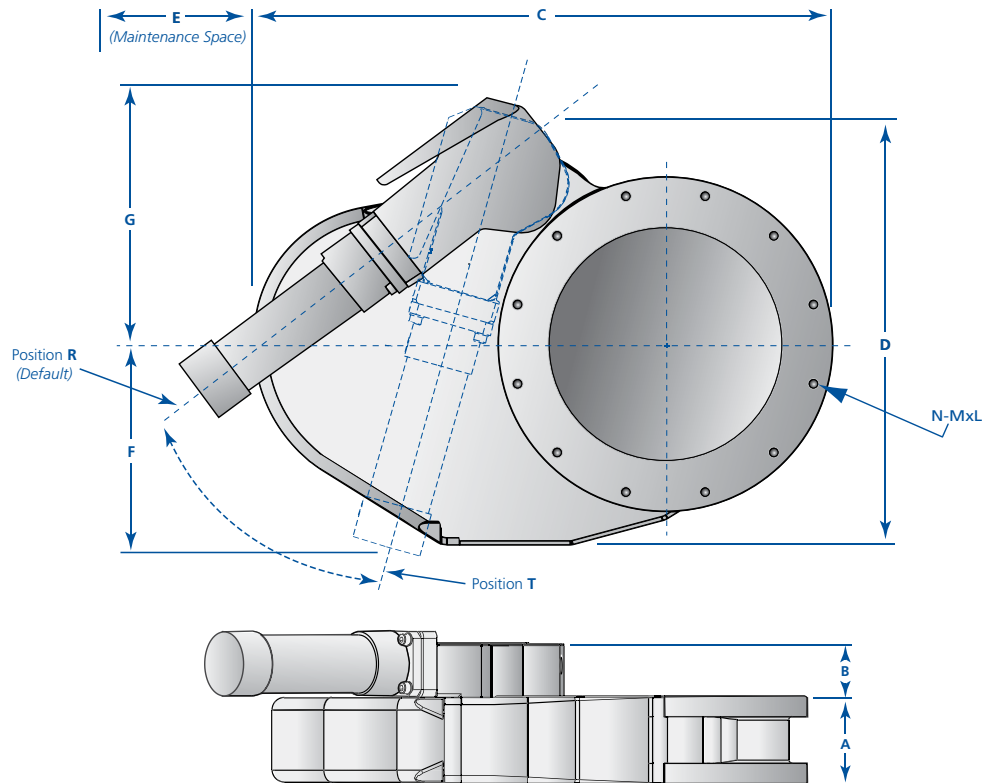
### Isolation Pendulum Valves

MODEL NUMBER	NOMINAL ID	A	B	C	D	E	F	G	WEIGHT IN LBS.
IPV-600-ISO-160	6 (150)	3.15 (80)	3.78 (96)	15.9 (404)	12.2 (310)	5.32 (135)	5.87 (149)	8.5 (216)	40 lbs.
IPV-800-ISO-200	8 (200)	3.46 (88)	3.78 (96)	19.9 (505)	14.4 (366)	6.5 (165)	5.28 (134)	9.29 (236)	49 lbs.
IPV-1000-ISO-250	10 (254)	3.94 (100)	3.78 (96)	23.8 (605)	16.6 (422)	8.46 (215)	5.47 (139)	9.49 (241)	62 lbs.
IPV-1200-ISO-320	12 (300)	4.72 (120)	4.06 (103)	30.2 (767)	22 (559)	10.6 (269)	7.24 (184)	12.8 (325)	123 lbs.
IPV-1400-JIS-350	14 (350)	4.92 (125)	4.06 (103)	32.3 (820)	22 (559)	12.2 (310)	7.64 (194)	12.8 (325)	143 lbs.
IPV-1600-ISO-400	16 (400)	5.91 (150)	5 (127)	36 (914)	24.7 (627)	12.8 (325)	7.83 (199)	15 (381)	231 lbs.

**Note:** Other sizes and flange configurations available. Call for details. See page 141 for bolt hole specifications. N-MxL

### JIS Flange O-Rings

SIZE	O-RINGS
350	OR-JIS-350



All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.

# Isolation Valves

## Gate Valve General Information & Options



Nor-Cal stainless steel gate valves share with our poppet valves the innovative design, highest grade materials and superior workmanship that has made us a major supplier of valves to the vacuum industry. The estimated service interval on these valves is 100,000 cycles, depending on the application.

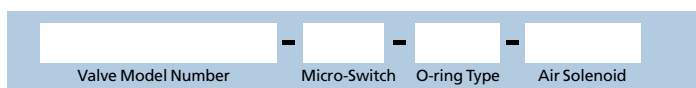
Our gate valves have an ultra-slim profile which makes them perfect for applications where space is limited, and their smaller volume results in lower outgassing and faster pumpdown. Larger sizes have a unique feature in the actuator which dampens the vibration which can arise when the gate is opened. This makes these valves ideal for semiconductor and other vibration sensitive processes. The carriage assembly and actuator can be removed without disassembling the body from the system for easy maintenance. The 304 stainless steel bodies are vacuum furnace brazed to 1100°C at 10-6 mbar before being electropolished inside and out. The welded AM-350 bellows have a short stroke for a longer cycle life.

Nor-Cal gate valves are available with NW (ISO-KF), ISO (clamp and bolt type), CF and ASA flanges in port sizes from 5/8 to 12 inches (16-300mm). Larger sizes are available upon request. Choose from manual or pneumatic actuation and Viton or copper seal bonnet.

Nor-Cal gate valves with Viton seal bonnet and gate and standard Reed-switch position indicators are bakeable to 150°C, as long as the actuator is not baked above 60°C. A gate valve with copper seal bonnet, Viton gate and micro-switch option can be baked to 200°C, except for the actuator. With the air solenoid and position indicators removed, a copper seal bonnet valve with high temperature Kalrez gate O-ring can be baked to 250°C with the gate in the open position. Silicone heater jackets for bakeouts up to 200°C can be provided. Please call for pricing.

### Gate Valve Options

One or more options can be ordered by adding the option suffix to the basic valve model number. Please add the option suffixes in the following order:



**Example:** GVMP-4002-CF-KT-S22

### O-rings

OPTION	COMPOUND	TEMPERATURE		DESCRIPTION
		MIN.	MAX.	
<b>Standard</b>	Viton	-29°C	204°C	Industry standard
<b>-KT</b>	Kalrez 4079	-50°C	316°C	High temperatures
<b>-KC</b>	Kalrez 2037	-54°C	220°C	Chemical resistant.
<b>-CR</b>	Chemraz 513	-30°C	210°C	Chemical resistant
<b>-S</b>	Silicone	-55°C	232°C	Extreme temperatures

### Air Solenoids

OPTION	DESCRIPTION
<b>-S12</b>	4-way, 120V AC, 60 Hz
<b>-S22</b>	4-way, 24V DC
<b>-S32</b>	4-way, 240V AC, 50/60 Hz
<b>-S42</b>	4-way, 24V AC, 50/60 Hz

Air solenoids require 4 watts of power to actuate. Solenoids are mounted on all Viton seal bonnet gate valves with 4 inch (100mm) ID and larger. Solenoids for Viton seal bonnet gate valves with under 4 inch (100mm) ID and all sizes of copper seal gate valves are shipped unmounted with the valve.

### Micro-Switch

**OPTION**  
**-M**  
Micro-switches are available on all pneumatically actuated Nor-Cal valves. One switch closes when the valve is fully open and the other when it is fully closed. These can be connected to control panels with alarms or lights for positive position indication.

*Silicone heater jackets for bakeouts up to 200°C can be provided for all gate valves. (See page 127 for details.)*



### SPECIFICATIONS

<b>General</b>
Nominal IDs: 5/8 to 12 inch (16 to 300mm)
Helium leak rate: $\leq 2 \times 10^{-9}$ mbar l/sec.
<b>Materials</b>
Body: 304 SS vacuum furnace brazed body
Bellows: Welded AM-350
O-ring: Viton (standard)
Other compounds available.
<b>Finish:</b> Electropolished inside and out
<b>Maximum pressure differential</b>
At opening: 20 mbar
Closed: 1000 mbar in either direction
<b>Vacuum range</b>
Viton Seal Bonnet: $\geq 10^{-9}$ mbar
Copper Seal Bonnet: $\geq 10^{-10}$ mbar
<b>Temperature range</b>
Viton Seal Bonnet: $\leq 150^\circ\text{C}$
Copper Seal Bonnet: $\leq 200^\circ\text{C}$ with CF flanges and gate in open position
<b>Pneumatically actuated:</b>
Air-to-Open, Air-to-Close (standard)
80 psig (5.5 bar) max. air pressure
(Higher operating pressures available upon request)
<b>Position indicator:</b>
Reed-switch position indicator, standard on 1.5" (38) and larger valves
<b>Manually actuated</b>
Acme threads for fewer turns
<b>Thermal:</b> Heater jackets and controllers available. Call for information and pricing.
<b>Options:</b>
<ul style="list-style-type: none"> <li>• Air solenoid</li> <li>• Microswitch position indicator</li> <li>• O-ring compounds</li> <li>• Spring-to-Close Option</li> <li>• Million Cycle Option</li> <li>• High pressure air actuator</li> </ul>





# Isolation Valves

## Gate Valves



### Manually Operated Viton Seal Gate Valves

MODEL NUMBER	NOM. ID	FLANGE TYPE	L/SEC (molecular)	A	B	C	D	E	F	G
GV-0622-NW	5/8(16)	NW-16	12	2.39(61)	1.75(44)	2.96(75.2)	1.49(38)	1.80(46)	1.88(48)	1.31(33)
GV-0622-CF	5/8(16)	1.33 CF	12	2.39(61)	1.75(44)	1.56(39.6)	1.49(38)	1.80(46)	1.88(48)	1.31(33)
GV-1502-NW	1 1/2(38)	NW-40	98	4.69(119)	3.40(86)	1.99(50.6)	2.00(50)	3.61(92)	3.31(84)	2.45(62)
GV-1502-CF	1 1/2(38)	2.75 CF	130	4.69(119)	3.40(86)	2.03(51.6)	2.00(50)	3.61(92)	3.31(84)	2.45(62)
GV-2002-NW	2(50)	NW-50	220	5.60(142)	4.12(105)	1.99(50.6)	2.00(50)	3.61(92)	3.81(97)	2.96(75)
GV-2002-CF	2(50)	3.38 CF	300	5.60(142)	4.12(105)	2.28(57.9)	2.00(50)	3.61(92)	3.81(97)	2.96(75)
GV-2502-CF	2 1/2(63)	4.50 CF	520	6.50(165)	4.81(122)	2.40(61.0)	2.00(50)	3.61(92)	4.37(111)	3.52(89)
GV-2502-ASA	2 1/2(63)	ASA-6*	610	6.50(165)	4.81(122)	2.03(51.6)	2.00(50)	3.61(92)	4.37(111)	3.52(89)
GV-2502-ISO	2 1/2(63)	ISO-63	610	6.50(165)	4.81(122)	2.03(51.6)	2.00(50)	3.61(92)	4.37(111)	3.52(89)
GV-2502-ISO-OF	2 1/2(63)	ISO-63-OF	320	6.50(165)	4.81(122)	3.46(87.9)	2.00(50)	3.61(92)	4.37(111)	3.52(89)
GV-3002-CF	3(76)	4.62 CF	840	7.70(196)	5.77(147)	2.53(64.3)	2.00(50)	3.61(92)	4.94(125)	4.28(109)
GV-3002-ASA	3(76)	ASA-7.5*	1,070	7.70(196)	5.77(147)	2.03(51.6)	2.00(50)	3.61(92)	4.94(125)	4.28(109)
GV-3002-ISO	3(76)	ISO-80	1,070	7.70(196)	5.77(147)	1.97(50.0)	2.00(50)	3.61(92)	4.94(125)	4.28(109)
GV-3002-ISO-OF	3(76)	ISO-80-OF	550	7.70(196)	5.77(147)	3.84(97.5)	2.00(50)	3.61(92)	4.94(125)	4.28(109)
GV-4002-CF	4(100)	6.00 CF	1,700	10.76(273)	8.13(207)	2.97(75.4)	3.11(79)	7.90(201)	7.00(178)	5.65(144)
GV-4002-ASA	4(100)	ASA-9*	2,100	10.76(273)	8.13(207)	2.41(61.2)	3.11(79)	7.90(201)	7.00(178)	5.65(144)
GV-4002-ISO	4(100)	ISO-100	2,100	10.76(273)	8.13(207)	2.41(61.2)	3.11(79)	7.90(201)	7.00(178)	5.65(144)
GV-4002-ISO-OF	4(100)	ISO-100-OF	1,400	10.76(273)	8.13(207)	4.25(108)	3.11(79)	7.90(201)	7.00(178)	5.65(144)
GV-6002-CF	6(150)	8.00 CF	5,400	14.07(357)	10.64(270)	3.17(80.5)	3.11(79)	7.90(201)	8.75(222)	7.55(192)
GV-6002-ASA	6(150)	ASA-11*	7,100	14.07(357)	10.64(270)	2.41(61.2)	3.11(79)	7.90(201)	8.75(222)	7.55(192)
GV-6002-ISO	6(150)	ISO-160	7,100	14.07(357)	10.64(270)	2.36(59.9)	3.11(79)	7.90(201)	8.75(222)	7.55(192)
GV-6002-ISO-OF	6(150)	ISO-160-OF	4,000	14.07(357)	10.64(270)	4.25(108)	3.11(79)	7.90(201)	8.75(222)	7.55(192)
GV-8002-CF	8(200)	10.00 CF	12,200	18.42(468)	13.93(354)	3.35(85.1)	3.11(79)	7.90(201)	11.25(286)	10.02(255)
GV-8002-ASA	8(200)	ASA-11*	14,500	18.42(468)	13.93(354)	2.76(70.1)	3.11(79)	7.90(201)	11.25(286)	10.02(255)
GV-8002-ISO	8(200)	ISO-200	15,200	18.42(468)	13.93(354)	2.66(67.5)	3.11(79)	7.90(201)	11.25(286)	10.02(255)
GV-8002-ISO-OF	8(200)	ISO-200-OF	9,500	18.42(468)	13.93(354)	4.25(108)	3.11(79)	7.90(201)	11.25(286)	10.02(255)
GV-10002-CF	10(254)	12.00 CF	24,900	24.04(611)	18.30(465)	3.65(92.7)	8.98(228)	12.00(305)	13.44(341)	11.99(305)
GV-10002-ASA	10(254)	ASA-16*	24,800	24.04(611)	18.30(465)	3.15(80.0)	8.98(228)	12.00(305)	13.44(341)	11.99(305)
GV-10002-ISO	10(254)	ISO-250	26,900	24.04(611)	18.30(465)	3.15(80.0)	8.98(228)	12.00(305)	13.44(341)	11.99(305)
GV-10002-ISO-OF	10(254)	ISO-250-OF	15,400	24.04(611)	18.30(465)	5.51(140)	8.98(228)	12.00(305)	13.44(341)	11.99(305)
GV-12002-CF	12(300)	14.00 CF	34,600	28.89(734)	22.03(560)	3.89(98.8)	8.98(228)	12.00(305)	15.9(404)	14.28(363)
GV-12002-ASA	12(300)	ASA-16*	42,800	28.89(734)	22.03(560)	3.15(80.0)	8.98(228)	12.00(305)	15.9(404)	14.28(363)
GV-12002-ISO	12(300)	ISO-320	42,800	28.89(734)	22.03(560)	3.15(80.0)	8.98(228)	12.00(305)	15.9(404)	14.28(363)

\*Note: All ASA flanged valves are provided without O-ring grooves. Grooves can be provided on request.

#### SPECIFICATIONS

**General**  
 Nominal IDs: 5/8 to 12 inch (16 to 300mm)  
 Helium leak rate:  $\leq 2 \times 10^{-9}$  mbar l/sec.

**Materials**  
 Body: 304 SS vacuum furnace brazed body  
 Bellows: Welded AM-350  
 O-ring: Viton (standard)  
 Other compounds available.

**Finish:** Electropolished inside and out

**Maximum pressure differential**  
 At opening: 20 mbar  
 Closed: 1000 mbar in either direction

**Vacuum range**  
 Viton seal bonnet:  $\geq 10^{-9}$  mbar  
 Copper seal bonnet:  $\geq 10^{-10}$  mbar

**Temperature range**  
 Viton Seal Bonnet:  $\leq 150^\circ\text{C}$   
 Copper Seal Bonnet:  $\leq 200^\circ\text{C}$  with CF flanges and gate in open position

**Manually actuated**  
 Acme threads for fewer turns

**Options:**

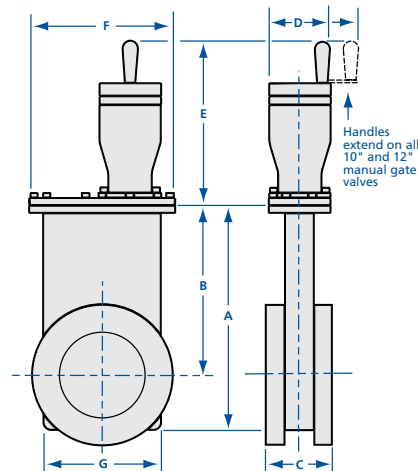
- O-ring compounds
- Spring-to-Close Option
- Million Cycle Option
- Heater Jackets

### Manually Operated Copper Seal Bonnet Gate Valves

MODEL NUMBER	NOM. ID	FLANGE TYPE	L/SEC (molecular)	A	B	C	D	E	F	G
GVM-0622-CF	5/8(16)	1.33 CF	12	2.39(61)	1.75(44)	1.56(39.6)	1.49(38)	1.80(46)	1.88(47.8)	1.31(33)
GVM-1502-CF	1 1/2(38)	2.75 CF	130	4.69(119)	3.40(86)	2.03(51.6)	2.00(50)	3.57(91)	3.31(84.1)	2.45(62)
GVM-2002-CF	2(50)	3.38 CF	300	5.60(142)	4.12(105)	2.28(57.9)	2.00(50)	3.61(92)	3.81(96.8)	2.96(75)
GVM-2502-CF	2 1/2(63)	4.50 CF	520	6.50(165)	4.81(122)	2.40(61.0)	2.00(50)	3.61(92)	4.37(111)	3.52(89)
GVM-3002-CF	3(76)	4.62 CF	840	7.70(196)	5.77(147)	2.53(64.3)	2.00(50)	3.61(92)	5.24(133)	4.28(109)
GVM-4002-CF	4(100)	6.00 CF	1,700	10.76(273)	8.13(207)	2.97(75.4)	3.11(79)	7.90(201)	7.00(178)	5.65(144)
GVM-6002-CF	6(150)	8.00 CF	5,400	14.07(357)	10.64(270)	3.17(80.5)	3.11(79)	7.90(201)	8.75(222)	7.55(192)
GVM-8002-CF	8(200)	10.00 CF	12,200	18.42(468)	13.93(354)	3.35(85.1)	3.11(79)	7.90(201)	11.25(286)	10.02(255)
GVM-10002-CF	10(254)	12.00 CF	24,900	24.04(611)	18.30(465)	3.65(92.7)	8.98(228)	12.12(308)	13.44(341)	11.99(305)
GVM-12002-CF	12(300)	14.00 CF	34,600	28.89(734)	22.03(560)	3.89(98.8)	8.98(228)	12.12(308)	15.90(404)	14.28(363)

All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.

To order gate valve replacement O-rings, pin and bearing kits or O-ring/gasket kits, you must provide us with your valve's serial number.



### Pneumatically Actuated Viton Seal Gate Valves

MODEL NUMBER	NOM. ID	FLANGE TYPE	L/SEC (molecular)	A	B	C	D	E	F	G
GVP-0622-NW	5/8 (16)	NW-16	12	2.39 (61)	1.75 (44)	2.96 (75.2)	1.00 (25)	2.55 (65)	1.88 (48)	1.31 (33)
GVP-0622-CF	5/8 (16)	1.33 CF	12	2.39 (61)	1.75 (44)	1.56 (39.6)	1.00 (25)	2.55 (65)	1.55 (39)	1.31 (33)
GVP-1502-NW	1 1/2 (38)	NW-40	98	4.69 (119)	3.40 (86)	1.99 (50.6)	2.00 (50)	5.29 (134)	3.31 (84)	2.45 (62)
GVP-1502-CF	1 1/2 (38)	2.75 CF	130	4.69 (119)	3.40 (86)	2.03 (51.6)	2.00 (50)	5.29 (134)	3.31 (84)	2.45 (62)
GVP-2002-NW	2 (50)	NW-50	220	5.60 (142)	4.12 (105)	1.99 (50.6)	2.00 (50)	5.29 (134)	3.81 (97)	2.96 (75)
GVP-2002-CF	2 (50)	3.38 CF	300	5.60 (142)	4.12 (105)	2.28 (57.9)	2.00 (50)	5.29 (134)	3.81 (97)	2.96 (75)
GVP-2502-CF	2 1/2 (63)	4.50 CF	520	6.50 (165)	4.81 (122)	2.40 (61.0)	2.45 (62)	5.29 (134)	4.37 (111)	3.52 (89)
GVP-2502-ASA	2 1/2 (63)	ASA-6*	610	6.50 (165)	4.81 (122)	2.03 (51.6)	2.45 (62)	5.29 (134)	4.37 (111)	3.52 (89)
GVP-2502-ISO	2 1/2 (63)	ISO-63	610	6.50 (165)	4.81 (122)	2.03 (51.6)	2.45 (62)	5.29 (134)	4.37 (111)	3.52 (89)
GVP-2502-ISO-OF	2 1/2 (63)	ISO-63-OF	320	6.50 (165)	4.81 (122)	3.46 (87.9)	2.45 (62)	5.29 (134)	4.37 (111)	3.52 (89)
GVP-3002-CF	3 (76)	4.62 CF	840	7.7 (196)	5.77 (147)	2.53 (64.3)	2.45 (62)	5.29 (134)	4.94 (125)	4.28 (109)
GVP-3002-ASA	3 (76)	ASA-7.5*	1,070	7.7 (196)	5.77 (147)	2.03 (51.6)	2.45 (62)	5.29 (134)	4.94 (125)	4.28 (109)
GVP-3002-ISO	3 (76)	ISO-80	1,070	7.7 (196)	5.77 (147)	1.97 (50.0)	2.45 (62)	5.29 (134)	4.94 (125)	4.28 (109)
GVP-3002-ISO-OF	3 (76)	ISO-80-OF	550	7.7 (196)	5.77 (147)	3.84 (97.5)	2.45 (62)	5.29 (134)	4.94 (125)	4.28 (109)
GVP-4002-CF	4 (100)	6.00 CF	1,700	10.76 (273)	8.13 (207)	2.97 (75.4)	2.97 (75)	6.95 (177)	7.00 (178)	5.65 (144)
GVP-4002-ASA	4 (100)	ASA-9*	2,100	10.76 (273)	8.13 (207)	2.41 (61.2)	2.97 (75)	6.95 (177)	7.00 (178)	5.65 (144)
GVP-4002-ISO	4 (100)	ISO-100	2,100	10.76 (273)	8.13 (207)	2.41 (61.2)	2.97 (75)	6.95 (177)	7.00 (178)	5.65 (144)
GVP-4002-ISO-OF	4 (100)	ISO-100-OF	1,400	10.76 (273)	8.13 (207)	4.25 (108)	2.97 (75)	6.95 (177)	7.00 (178)	5.65 (144)
GVP-6002-CF	6 (150)	8.00 CF	5,400	14.07 (357)	10.64 (270)	3.17 (80.5)	2.97 (75)	6.95 (177)	8.75 (222)	7.55 (192)
GVP-6002-ASA	6 (150)	ASA-11*	7,100	14.07 (357)	10.64 (270)	2.41 (61.2)	2.97 (75)	6.95 (177)	8.75 (222)	7.55 (192)
GVP-6002-ISO	6 (150)	ISO-160	7,100	14.07 (357)	10.64 (270)	2.36 (59.9)	2.97 (75)	6.95 (177)	8.75 (222)	7.55 (192)
GVP-6002-ISO-OF	6 (150)	ISO-160-OF	4,000	14.07 (357)	10.64 (270)	4.25 (108)	2.97 (75)	6.95 (177)	8.75 (222)	7.55 (192)
GVP-8002-CF	8 (200)	10.00 CF	12,200	18.42 (468)	13.93 (354)	3.35 (85.1)	2.97 (75)	6.95 (177)	11.25 (286)	10.02 (255)
GVP-8002-ASA	8 (200)	ASA-11*	14,500	18.42 (468)	13.93 (354)	2.76 (70.1)	2.97 (75)	6.95 (177)	11.25 (286)	10.02 (255)
GVP-8002-ISO	8 (200)	ISO-200	15,200	18.42 (468)	13.93 (354)	2.66 (67.6)	2.97 (75)	6.95 (177)	11.25 (286)	10.02 (255)
GVP-8002-ISO-OF	8 (200)	ISO-200-OF	9,500	18.42 (468)	13.93 (354)	4.25 (108)	2.97 (75)	6.95 (177)	11.25 (286)	10.02 (255)
GVP-10002-CF	10 (254)	12.00 CF	24,900	24.04 (611)	18.30 (465)	3.65 (92.7)	4.75 (121)	9.47 (241)	13.44 (341)	11.9 (305)
GVP-10002-ASA	10 (254)	ASA-16*	24,800	24.04 (611)	18.30 (465)	3.15 (80.0)	4.75 (121)	9.47 (241)	13.44 (341)	11.9 (305)
GVP-10002-ISO	10 (254)	ISO-250	26,900	24.04 (611)	18.30 (465)	3.15 (80.0)	4.75 (121)	9.47 (241)	13.44 (341)	11.9 (305)
GVP-10002-ISO-OF	10 (254)	ISO-250-OF	15,400	24.04 (611)	18.30 (465)	5.51 (140)	4.75 (121)	9.47 (241)	13.44 (341)	11.9 (305)
GVP-12002-CF	12 (300)	14.00 CF	34,600	28.89 (734)	22.03 (560)	3.89 (98.8)	4.75 (121)	9.47 (241)	15.90 (404)	14.28 (363)
GVP-12002-ASA	12 (300)	ASA-16*	42,800	28.89 (734)	22.03 (560)	3.15 (80.0)	4.75 (121)	9.47 (241)	15.90 (404)	14.28 (363)
GVP-12002-ISO	12 (300)	ISO-320	42,800	28.89 (734)	22.03 (560)	3.15 (80.0)	4.75 (121)	9.47 (241)	15.90 (404)	14.28 (363)

\*Note: All ASA flanged valves are provided without O-ring grooves. Grooves can be provided on request



#### SPECIFICATIONS

**General**  
Nominal IDs: 5/8 to 12 inch (16 to 300mm)  
Helium leak rate:  $\leq 2 \times 10^{-9}$  mbar l/sec.

**Materials**  
Body: 304 SS vacuum furnace brazed body  
Bells: Welded AM-350  
O-ring: Viton (standard)  
Other compounds available.

**Finish:** Electropolished inside and out

**Maximum pressure differential**  
At opening: 20 mbar  
Closed: 1000 mbar in either direction

**Vacuum range**  
Viton seal bonnet:  $\geq 10^{-9}$  mbar  
Copper seal bonnet:  $\geq 10^{-10}$  mbar

**Temperature range**  
Viton seal bonnet:  $\leq 150^\circ\text{C}$   
Copper seal bonnet:  $\leq 200^\circ\text{C}$  with CF flanges and gate in open position

**Pneumatically actuated:**  
Air-to-Open, Air-to-Close (standard)  
80 psig (5.5 bar) max. air pressure  
(Higher operating pressures available upon request)

**Position indicator:**  
Reed-switch position indicator, standard on 1.5" (38) and larger valves

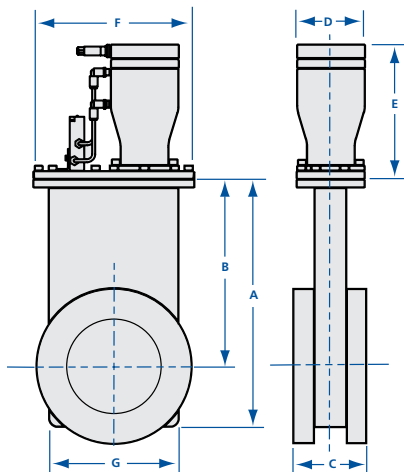
- Options:**
- Air solenoid
  - Microswitch position indicator
  - O-ring compounds
  - Spring-to-Close Option
  - Million Cycle Option
  - High pressure air actuator
  - Heater Jackets

All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.

To order gate valve replacement O-rings, pin and bearing kits or O-ring/gasket kits, you must provide us with your valve's serial number.

### Pneumatically Actuated Copper Seal Bonnet Gate Valves

MODEL NUMBER	NOM. ID	FLANGE TYPE	L/SEC (molecular)	A	B	C	D	E	F	G
GVMP-0622-CF	5/8 (16)	1.33 CF	12	2.39 (61)	1.75 (44)	1.56 (39.6)	1.00 (25)	2.55 (65)	1.88 (48)	1.31 (33)
GVMP-1502-CF	1 1/2 (38)	2.75 CF	130	4.69 (119)	3.4 (86)	2.03 (51.6)	2.00 (50)	5.29 (134)	3.31 (84)	2.45 (62)
GVMP-2002-CF	2 (50)	3.38 CF	300	5.6 (142)	4.12 (105)	2.28 (57.9)	2.00 (50)	5.29 (134)	3.81 (97)	2.96 (75)
GVMP-2502-CF	2 1/2 (63)	4.50 CF	520	6.5 (165)	4.81 (122)	2.4 (61.0)	2.00 (50)	5.29 (134)	4.37 (111)	3.52 (89.4)
GVMP-3002-CF	3 (76)	4.62 CF	840	7.7 (196)	5.77 (147)	2.53 (64.3)	2.00 (50)	5.29 (134)	5.24 (133)	4.28 (109)
GVMP-4002-CF	4 (100)	6.00 CF	1,700	10.76 (273)	8.13 (207)	2.97 (75.4)	2.97 (75)	6.95 (177)	7.00 (178)	5.65 (144)
GVMP-6002-CF	6 (150)	8.00 CF	5,400	14.07 (357)	10.64 (270)	3.17 (80.5)	2.97 (75)	6.95 (177)	8.75 (222)	7.55 (192)
GVMP-8002-CF	8 (200)	10.00 CF	12,200	18.42 (468)	13.93 (354)	3.35 (85.1)	2.97 (75)	6.95 (177)	11.25 (286)	10.02 (255)
GVMP-10002-CF	10 (254)	12.00 CF	24,900	24.04 (611)	18.3 (465)	3.65 (92.7)	4.75 (121)	9.47 (241)	13.44 (341)	11.99 (305)
GVMP-12002-CF	12 (300)	14.00 CF	34,600	28.89 (734)	22.03 (560)	3.89 (98.8)	4.75 (121)	9.47 (241)	15.9 (404)	14.28 (363)



# Isolation Valves

## Bellowless Poppet Valves & Leak Valves



### Pneumatic Bellowless Angle Valves

Right angle bellowless poppet valves are now available in sizes from  $\frac{3}{8}$  thru  $1\frac{1}{2}$  inches (9.53-38.1mm). These valves are typically used for applications with large differential pressures, extremely high cycle rates or "dirty" processes that cause frequent bellows failures. Poppet shafts are sealed with double O-rings. Heater jackets and other port and flange configurations are available on request.

MODEL NUMBER	NOMINAL PORT OD	FLANGE TYPE	L/SEC (molecular)	A	B	C	D
ESVP-0382-NWB-5	$\frac{3}{8}$ (10)	NW-10B	0.66	1.65 (41.9)	3.77 (96)	5.92 (150)	2.25 (57)
ESVP-0752-NWB-5	$\frac{3}{4}$ (19)	NW-16B	5.00	2.15 (54.6)	4.27 (108)	6.41 (163)	2.25 (57)
ESVP-1002-NWB-5	1 (25)	NW-25B	12.00	2.03 (51.6)	4.03 (102)	6.17 (157)	2.25 (57)
ESVP-1502-NWB-5	$1\frac{1}{2}$ (38)	NW-40B	128.00	2.40 (61.0)	5.13 (130)	7.71 (196)	3.00(76)

#### SPECIFICATIONS

**Nominal Port ODs:**  $\frac{3}{8}$  to  $1\frac{1}{2}$  inches (10 to 38mm)

#### Materials

Body: Electropolished 304 stainless steel  
Bonnet seal: Viton  
Poppet seal: Viton  
Other O-ring compounds available

#### Actuation:

Normally closed  
 $\frac{3}{8}$  to  $1\frac{1}{2}$  inch (10 to 38mm) ODs: Air-to-open, spring-to-close  
See page 101 for actuation options

#### Operating pressure:

60 to 80 psig (4-5.5 bar)

#### Differential pressure

Port side: Maximum 100 psig (7 bar)  
Poppet: Maximum 6psi (0.4 bar) differential across the valve seat.

#### Maximum temperature with Viton seals

Sustained:  $\leq 150^{\circ}\text{C}$   
Intermittent:  $\leq 204^{\circ}\text{C}$

#### Vacuum range:

$\geq 1 \times 10^{-9}$  mbar - High Vacuum

#### Options:

Fittings, O-rings, air solenoids, micro-switches and actuators. See page 101

#### SPECIFICATIONS

#### Materials

Body: Electropolished 304 stainless steel

#### Flanges

Inlet: 1.33 CF, rotatable, clearance bolt holes  
Outlet: 2.75 CF, nonrotatable, clearance bolt holes

Poppet: Sapphire  
Poppet seat: Copper

#### Actuation:

Manual, adjustable set point

#### Maximum temperature

Sustained:  $\leq 250^{\circ}\text{C}$   
Intermittent:  $\leq 450^{\circ}\text{C}$

#### Vacuum range:

$\geq 1 \times 10^{-11}$  mbar - UHV

#### Minimum leak rate

Normal:  $1 \times 10^{-10}$  mbar l/sec.  
Non-condensable gas:  $1 \times 10^{-8}$  mbar l/sec.

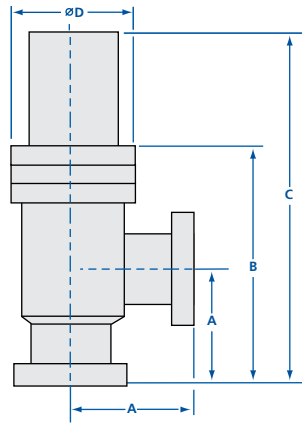
#### Inlet gas pressure:

maximum 500 psig (34 bar)

#### Poppet seat life

Unbaked: 250 to 300 closures  
 $\leq 250^{\circ}\text{C}$ : 80 to 100 closures  
 $\leq 450^{\circ}\text{C}$ : 20 to 30 closures

All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.



### Replacement O-Ring & Valve Rebuild Kits

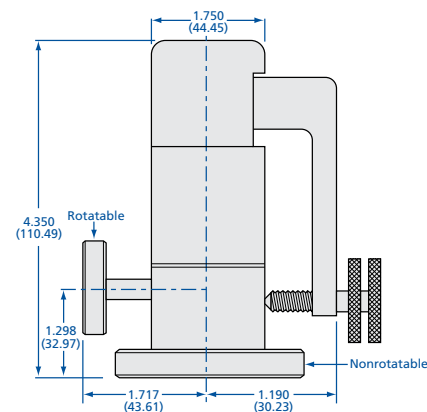
MODEL NUMBER	NOMINAL PORT OD	DESCRIPTION
ESVP-075-95-5	$\frac{3}{8}$ -1 (10-25)	O-ring kit
ESVP-150-95-5	$1\frac{1}{2}$ (38)	O-ring kit
ESVP-075-99-5	$\frac{3}{8}$ -1 (10-25)	Complete rebuild kit, includes all valve parts except valve body
ESVP-150-99-5	$1\frac{1}{2}$ (38)	Complete rebuild kit, includes all valve parts except valve body

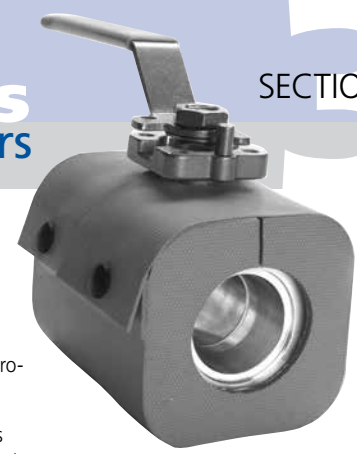
### Leak Valves

Leak valves are used for controlling gas introduction into high- and ultra-high vacuum systems. They utilize an optically flat sapphire poppet and a metal seal seat, allowing bakeout temperatures to  $450^{\circ}\text{C}$ . These valves are manually actuated by a cantilever arm with precision adjustment threads. The adjustment knobs can be set to allow controlled leak rates as small as  $1 \times 10^{-10}$  mbar l/sec. Replacement sapphire and gasket assemblies are available. Call for pricing.

#### MODEL NUMBER

LL-275-133





### Poppet Valve, Ball Valve and Gate Valve Heaters

Many semiconductor processes are carried out in vacuum chambers with internal temperatures of several hundred degrees Celsius. Process by-products exit the chamber in vapor phase, but sublimate in the foreline and vacuum pump exhaust when gas temperatures drop sufficiently for them to form solids. The resultant buildup can increase wafer defects from particle backstreaming, reduce throughput of vacuum lines, impede the function of throttle valves and isolation valves, damage some dry

pumps and reduce the efficiency of the scrubber. This buildup can be reduced or eliminated by heating vacuum lines and associated components from the chamber to the scrubber, or by using a combination of heaters and foreline traps, which collect the by-products preventing them from continuing downstream.

Heater jackets with a UL recognized electronic thermostat for fixed set-point applications is available for temperatures up to 150°C. For fully adjustable

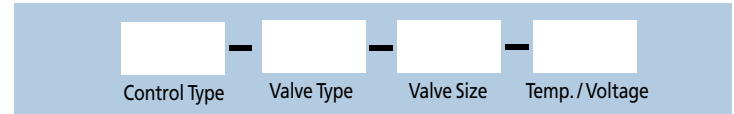
temperature set-points up to 200 °C, a UR/CE certified heater with a Type K thermocouple and PID controller can provide precise temperature control.

Standard ½” insulation add-on heaters are available for all poppet valves and gate valves. (Aluminum Genesis valves have their own integrated heater.) These can be purchased and installed separately provided that the valve is fitted with the proper high temperature seals and other thermally compatible components.

### Heater Jacket Part Number and Ordering Information

Please use the following part numbering tree to specify the heater jacket to fit your poppet valve or gate valve.

**Note:** All part number combinations may not be valid or available. Contact Nor-Cal Products for the latest pricing, availability and other options.



#### Control Type

CONTROL TYPE	CODE
PID control*	<b>HC</b>
Electronic thermostat	<b>HTE</b>

\* Requires separate PID controller. (See controllers Section 6.)

#### Valve Type

VALVE TYPE	CODE
Angle-in-line	<b>AIV</b>
Manual Ball valve	<b>BVM</b>
Pneumatic Ball Valve	<b>BVP</b>
Angle valve	<b>ESV</b>
SS Genesis (stainless steel)	<b>GNVS</b>
SS Genesis angle-in-line	<b>GNVSAI</b>
Gate valve with CF flange	<b>GVC</b>
Gate valve with ISO flange	<b>GVI</b>
In-line valve	<b>ILV</b>
N-Series angle	<b>NAP</b>
N-Series angle-in-line	<b>NAIP</b>

#### Valve Size

VALVE SIZE	CODE
0.38 (10)	<b>038</b>
0.50 (13)	<b>050</b>
0.75 (19)	<b>075</b>
1.00 (25)	<b>100</b>
1.50 (38)	<b>150</b>
2.00 (50)	<b>200</b>
2.50 (63)	<b>250</b>
3.00 (76)	<b>300</b>
4.00 (100)	<b>400</b>
6.00 (150)	<b>600</b>
8.00 (200)	<b>800</b>
10.00 (254)	<b>1000</b>

#### Temperature/Voltage

TEMPERATURE & VOLTAGE	CODE
HC type, 120 VAC	<b>201</b>
HC Type, 208 VAC	<b>202</b>
HTE type, 90°C, 120 VAC	<b>091</b>
HTE type, 90°C, 208 VAC	<b>092</b>
HTE type, 120°C, 120 VAC	<b>121</b>
HTE type, 120°C, 208 VAC	<b>122</b>
HTE type, 150°C, 120 VAC	<b>151</b>
HTE type, 150°C, 208 VAC	<b>152</b>

**Example:** **HTE-NAP-150-091**

Electronic thermostatically controlled heater jacket for 1.5 inch (38mm) N-Series angle valve, 90°C, 120VAC.



# Isolation Valves

## Bakeable All Metal Valves



Nor-Cal's metal seal angle valves are intended for use in UHV or cryogenic applications where temperature extremes preclude the use of our elastomer seal valves. Approved for use in beamline facilities, these valves have a temperature operating range from -250°C to 400°C. Heater jackets and controllers are available on request.

The pulled-port method is used for the fabrication of the stainless steel bodies resulting in higher conductance and better cleanliness. Heater jackets and controllers are available on request.

The life of the copper poppet seal is dependent upon the temperature at which the valve is used. Maximum temperature bakeouts may require copper poppet seal replacement after 50 cycles, while hundreds of cycles are possible with moderate bakeouts. As many as 10,000 cycles have been obtained from the same seal during testing.

A dial indicator at the top of the valve indicates the proper torque for closure and also when the seal should be replaced. The copper poppet seal is easily replaced by opening the valve with a slotted screw driver. The seal is removed through the side port and a new one replaced in a like manner. After seal replacement the valve must be torqued to a higher value than during normal operation to make it seat. Do not exceed the maximum torque



specifications. (See torque specifications table.) After closing the valve to its normal torque value loosen the set screw below the closure nut, rotate the indicator to the furthest counter-clockwise line on top of the valve and retighten the set

screw. The valve may be closed to this mark indefinitely. Periodic checks with a torque wrench will indicate seat wear and the proper mark to use for alignment. When the indicator has reached the last mark we recommend seal replacement.

### SPECIFICATIONS

**Port ODs:** 3/4 and 1 1/2 inch (19 to 38mm)

**Finish:** Electropolished

**Assembly:** Clean room

#### Materials

Pulled port body: 304 stainless steel  
Bellows: Formed 321 stainless steel  
Poppet seal: OFHC Copper

**Actuation:** Manual using self-lubricating bronze nuts with ACME threads

**Operating temperature:** -250°C to 400°C

#### Maximum bakeout temperature

Open: 400°C  
Closed: 300°C

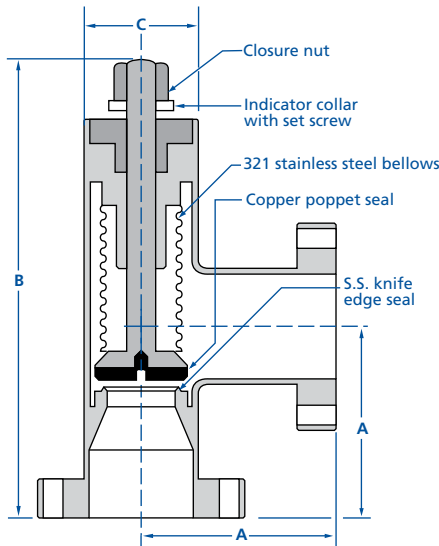
**Vacuum rated:**  $\geq 1 \times 10^{-10}$  mbar - UHV

**Helium leak rate:**  $\leq 10^{-10}$  mbar l/sec.

**Options:** Heater jackets and controllers

MODEL NUMBER	NOMINAL PORT OD	FLANGE TYPE	CONDUCTANCE (L/sec)		A	(OPEN)	
			MOLECULAR	VISCOUS		B	C
AMV-0752-CF	3/4 (19)	Rotatable 1.33 CF	3	56	1.50 (38)	5.40 (137)	1.50 (38)
AMV-1502-CF	1 1/2 (38)	Rotatable 2.75 CF	10	356	2.45 (62)	6.87 (175)	1.50 (38)

**NOTE:** Port lengths that match other manufacturers' products are available upon request.



All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.

### Replacement Seals

MODEL NUMBER	NOMINAL PORT OD
AMV-075-95	0.75 (19)
AMV-150-95	1.50 (38)

### Torque Specifications

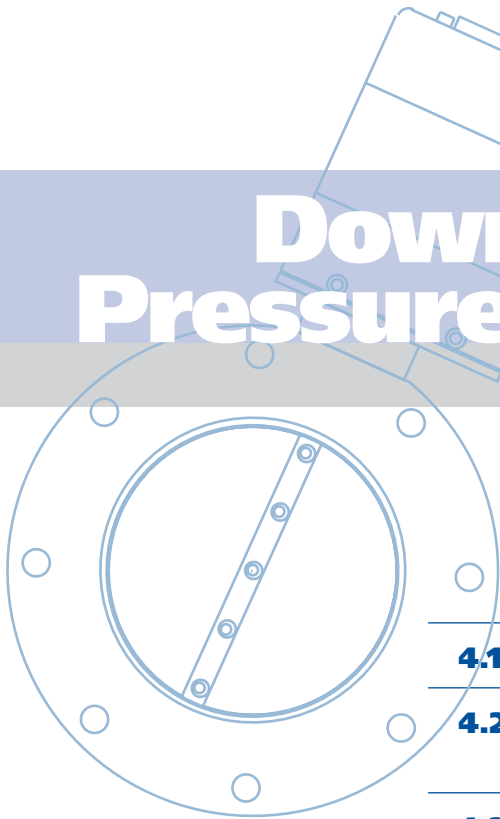
MODEL NUMBER	SEATING NORMAL MAXIMUM		
	Nm	Nm	Nm
AMV-075-CF	6.8	5.6	13.6
AMV-150-CF	13.6	11.3	22.6

# Downstream Pressure Control

## Section Four



# 4



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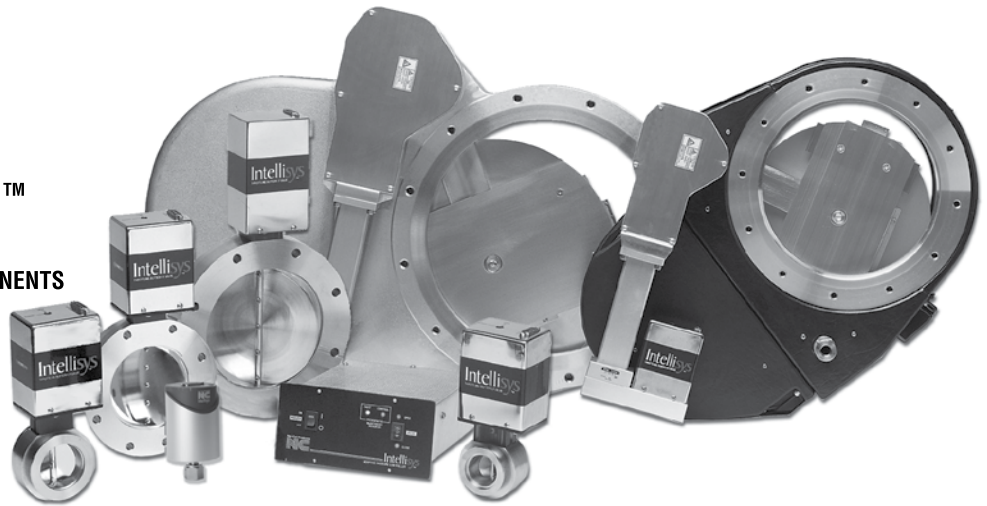
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# Intellisys™

ADAPTIVE PRESSURE CONTROL COMPONENTS



### New Products

#### Intellisys Next Generation IQ+ Controller

Responding to emerging industry requirements, Nor-Cal now has a fully RoHS compliant and DeviceNet certified adaptive pressure controller called the IQ+. It is similar in function and appearance to the earlier line of IQ-controllers, but features a much advanced pressure control algorithm for improved control during difficult conditions. The IQ+ on-board controller can be used with most throttle valves and it offers a popular fail safe battery backup option and add-on gauge power.



#### Capacitance Diaphragm Gauges

Nor-Cal proudly announces the availability of ultra stable ceramic sensor gauges featuring digital circuitry, one push button zero and a convenient service port. The gauges exhibit second-to-none short and long term stability, shorter warm-up times and excellent recovery from atmospheric bursts.



## Intellisys - The Fastest, Most Precise Pressure Control System

Nor-Cal Products offers unequalled performance with the Intellisys downstream pressure control products, providing measurable process benefits through higher resolution, speed and reliability. These benefits are the direct result of two core functions embedded in all Intellisys control systems.

**First**, a unique patented closed-loop motor control technology, which is a combination of electronics hardware and software, resides in every Intellisys controller. This allows Intellisys control valves to be operated at high rates of speed and with extremely fine positional resolution, while using standard off-the-shelf stepper motors.

**Second**, capitalizing on the high motor speed and fine resolution is an adaptive pressure control algorithm that yields near flawless pressure control performance over a wide range of system conditions without the need to "tune" or "learn" PID parameters.

Adding to the pressure control system benefits is a host of valve functions and features aimed at optimizing control performance and reliability. These include the selection of direct driven valves that eliminate the use of costly and unreliable gear heads or belt drives. Furthermore, none of the Intellisys control valves rely on mechanical or optical switches to determine the valve stroke end-points. Instead, bulletproof hard stops that are sensed by the closed-loop motor position feedback signals serve as the open and closed indicators. Last, all Intellisys control valves, regardless of type, have been designed with controllability and conductance in mind.

Optimally designed throttle plates and actuation mechanisms therefore provide an essential contribution to the overall behavior and performance of the downstream pressure control system.

### Products

Every complete downstream pressure control system design incorporates three components including a throttle valve, valve controller and pressure (vacuum) gauge. Nor-Cal Products has products available in all of these categories.

The selection of throttle valves includes families of butterfly, pendulum, and gate valves. The choice of valve depends on the intended application, but each is available in a wide range of sizes and flange types with many optional functions and features, and all of them feature the closed-loop motor control capability that results in high speed and ultra-fine resolution. In addition, Nor-Cal offers the Universal Valve Drive (UVD) – a motor drive product that can be tailored to fit most other manufacturers' valves. Doing so can greatly improve pressure control performance characteristics of existing valves at a reduced cost.

Adaptive pressure controllers are available for each type of valve or valve drive, and generally come in two styles. The stand-alone buried box controllers are ideal for applications where expanded communications or user interfaces are desired. For installations where installation space is of concern, the on-valve IQ-series controllers may be a preferred choice. Regardless of type, all Intellisys controllers are powered by Digital Signal Processors (DSP) and have many available host communications

interfaces such as RS-232, RS-485, DeviceNet, and Analog/TTL.

Nor-Cal capacitance diaphragm gauges (CDG) feature an ultra-stable ceramic diaphragm and advanced digital circuitry in all unheated and heated models. The gauges are available in all common ranges and can be supplied with most popular pipe fittings and connector types.

### Intellisys Technology

Many users want to know more about the underlying closed-loop control technology that forms the backbone of Intellisys control systems. Whereas the finer details of this technology are, for obvious reasons, closely guarded, Nor-Cal is still happy to provide educational material for the sake of eliminating some of the "mystique" surrounding the technology or simply satisfying anyone's curious mind. To this end, the following page contains excerpts from a feature article that was written for and published by Semiconductor International magazine. Also, please visit us on the web at [www.n-c.com](http://www.n-c.com) or give our Intellisys technical support staff a call at **800-824-4166**.



## Increase Vacuum Processing Throughput and Yield Using Advanced Downstream Pressure Control Methods

Vacuum process tool throughput and yield rates can be significantly affected by the performance level of chamber pressure control. Faster step transitions and more precise pressure control are often desired or needed to enhance tool productivity or increase production yields.

The Intellisys technology revolves around a new method of operating a variety of stepper motor driven downstream control valves (such as butterfly, poppet, gate and pendulum). In essence, it combines closed loop stepper motor control with an advanced pressure control algorithm allowing such valves to be controlled in ways never before possible. As a result of the exceptionally fast valve actuation and ultra-high position resolution, throughput increases up to 15% coupled with significant yield improvements and 100-fold scrap reduction have been realized saving vacuum processors millions of dollars per year.

### Throttle Valves & Control Systems

One common method of controlling pressure in vacuum chambers is downstream pressure control. Downstream pressure control generally works well over a wide range of conditions, but its effectiveness can be challenged by "external" factors such as the sudden changing of inlet gas flowrates or the turning on or off of plasma events. Furthermore, certain flow- and pressure combinations can force the throttle valve to operate in a position at or beyond the limit of its intended control range. In such instances neither accurate nor repeatable pressure control may be feasible. Alternatively, pressure control may be feasible but not in a fast and efficient manner. As a result semiconductor wafer yield and throughput suffer.

**Existing Technology** – At present, throttle valves are available from a host of manufacturers and tool OEMs. As different as the various valves may be, almost all possess one common characteristic – that they are driven by stepper motors. Conventional motor drive technology involves sequencing the stepper motor through a prescribed combination of motor winding currents designed to guide the motor to move in a given direction using the desired number of steps. Referring to Table 1, we can see a typical sequence for a bipolar full step moving sequence.

From any given position (step), the motor can be moved to an adjacent position by changing the current going to the four respective drive phases (A, A', B and B'). Knowledge about the actual position is in these cases done by incrementing a step- or pulse-counter. This is referred to as open-loop motor control. Unfortunately, the speed and resultant position accuracy with which conventional open-loop stepping can be done is negatively influenced by non-linear effects from the valve and the motor drive assembly. Examples of such effects include inertia, friction, and backlash. As a result (and in comparison to what it could be) open-loop motor operation and positioning is by design sluggish.

**Table 1: Bipolar Full Step Phase Sequencing**

STEP	A	A'	B	B'
1	+	-	-	+
2	-	+	-	+
3	-	+	+	-
4	+	-	+	-
1	+	-	-	+

**Improved Method** – Motor control performance can be greatly improved by employing some means of true position feedback. By accurately tracking position, the user is no longer forced to be as conservative with respect to the acceleration or speed used in operating the motor. In addition to using the position feedback signal to determine the actual position, a position error term (target position less observed position) can easily be calculated, monitored and used to alter the amount of current delivered to the motor so as to overcome variations in external inertia and friction. This is what is referred to as closed-loop motor control, and it enables the motor to be driven to its full torque-speed potential. Since the knowledge of position can only be as accurate and timely as is the means by which the

true position is obtained, it is important to use a feedback sensor with a high enough resolution and accuracy. It is also imperative to synchronize the reading of position with the commanded position, lest the position error term cannot be accurately calculated. It is because of the challenges associated with the achievable resolution and synchronization that Nor-Cal Products' Intellisys line of valves and controllers employ the back EMF generated by the motor itself as a means of determining its position.

### Effects on Pressure Control

The enhancements in the motor and valve drive technology as have been discussed up to this point would have little importance if they could not be tied to quantifiable improvements in pressure control. A live test was designed and conducted in order to illustrate and quantify any possible benefits of using higher speed and higher position resolution valve drive technology, such as in the case with a direct drive butterfly valve using back EMF position sensing. A multi-step wafer recipe was executed in a 35 liter chamber outfitted with throttling valve in the downstream position.

**The Benefits of Speed** – As can be seen in Figure 1 the first notable event occurs in the pressure transition step in which the pressure set-point is suddenly increased. As each of the three controllers drives their respective valves completely closed, the chamber pressure rises accordingly. The Intellisys valve closes completely in 0.125 seconds, as compared to 1.7 and 2.0 seconds of System 1 and 2, respectively. The result is an immediate onset of pressure rise allowing the set point to be reached that much faster.

Further contributing to the slower time to set point is System 2's gradual ramp toward set-point. The valve's relatively low speed necessitates a slow approach

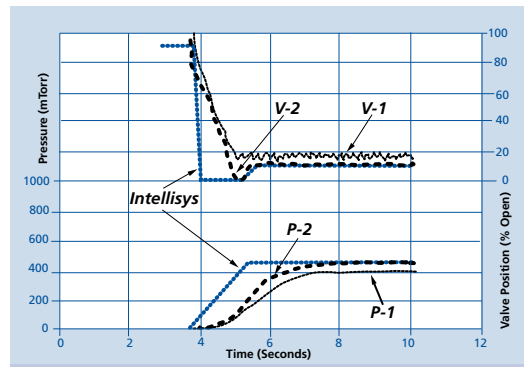
to set-point, lest significant pressure over-shooting would occur.

**The Benefits of Resolution** – Ultrafine step resolution, such as that which can be achieved through back EMF position sensing, can play a very important role in the ability to control pressure at all. This benefit is especially noticeable in large valves that are also sealing valves – such as throttling gate and pendulum valves.

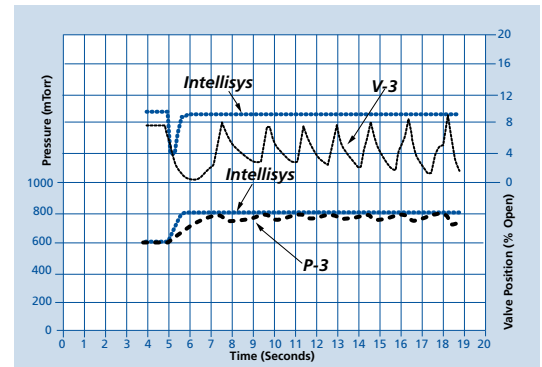
Figure 2 shows a comparison between two ISO-200 sealing throttling pendulum valves. In this diagram, the Intellisys system uses back EMF as the position sensing mechanism. System 3 uses standard open-loop type motor control. As is illustrated by the chart, almost indistinguishable moves by the Intellisys valve plate result in smooth pressure control at 1000 mbar. In contrast, a significant amount of "hunting" is evidenced by the System 3 valve, which in this case translates in to 50 to 60 mbar pressure swings. When occurring in critical processes or at sensitive times within a process, pressure swings such as these can have a dramatic and detrimental effect on the uniformity and yield of the wafer.

It has been shown how open-loop motor control differs from closed-loop motor control, and specifically how back EMF can be used to provide an unparalleled method for motor position feedback. Because of the high precision and resolution of such feedback mechanisms, ordinary stepper motors can be employed in ways not possible by conventional means. The advancements in motor control capabilities were then substantiated by demonstrating how cluster tool throughput and wafer yield can positively be impacted by the resultant improvements in pressure control.

**Figure 1: Pressure Transition Using 100 mm Butterfly Valves**



**Figure 2: Pressure Control Stability Using 200 mm Pendulum Valve**





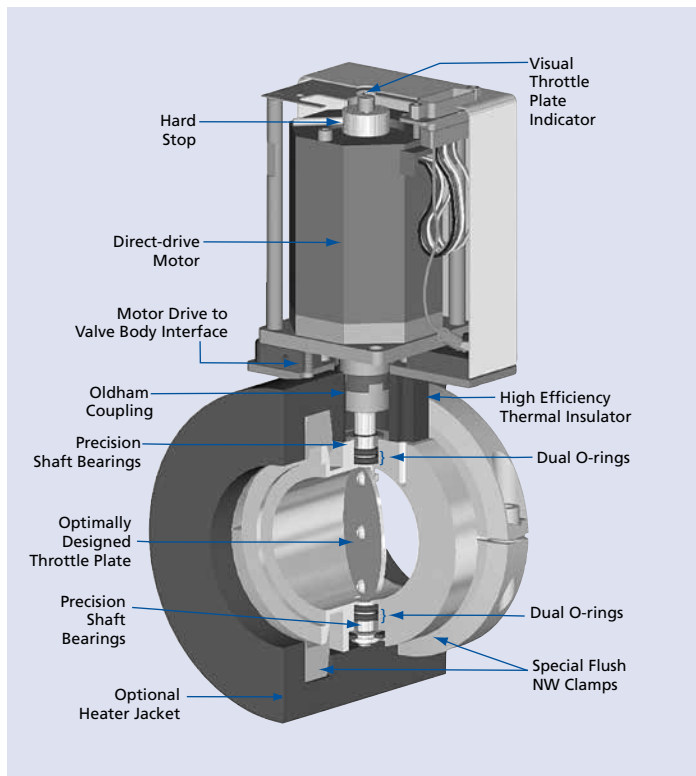
# Downstream Pressure Control Throttling Butterfly Valves



## High actuation speed and ultra-fine position resolution

The Intellisys throttling butterfly valves (TBV) are available in a wide range of sizes and flange types and come standard with compact and low cost direct drives. More powerful geared drives are available as an option. Both styles use long time proven and reliable off-the-shelf stepper motors that deliver smooth operation, high actuation speed and ultra-fine position resolution. Intellisys TBVs are non-sealing and are therefore not suitable as isolation valves.

When combined with an Intellisys controller, the fast response Nor-Cal TBVs enable vacuum systems to reach process pressures sooner, reducing cycle time and increasing throughput. Furthermore, the high precision valve movement assures pressure control accuracy at 0.25% of set point, and often well within. Available controllers for TBVs include the buried box APC-family and, in most cases, the on-valve IQ and IQ+ series.



## Features and Benefits

- Higher system throughput
- Optimally designed throttle plate for improved controllability
- Smallest footprint available
- Direct drive motor for more compact and reliable design
- Fully serviceable valve motor subassembly
- 316 stainless steel and Viton seals on all wetted parts. Other seal materials are available.
- High open conductance
- Low closed conductance

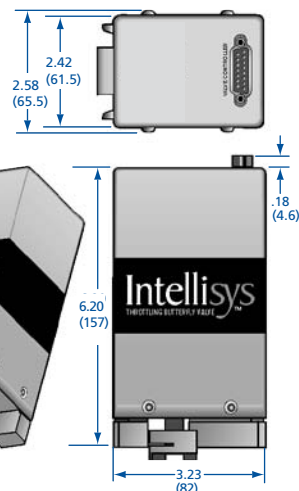


## Universal Valve Drive (UVD)

Universal Valve Drives (UVD) can be used to retrofit and upgrade other manufacturers' valves, including butterfly, vane, flapper and other ¼- or ½-turn valve types. The resulting performance often comes close of that of a standard Intellisys system but at a fraction of the cost. Drive-to-valve adapters for most manufacturers have already been designed, and others can be easily made upon request. The UVD is currently only available with a geared drive.

### UVD90-G— Specific Mating Valve Details

Please call with mating valve information such as: manufacturer, shaft diameter, adapter configuration, etc.



All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.

# Downstream Pressure Control Throttling Butterfly Valves



## Direct Drive Throttling Butterfly Valves

MODEL NUMBER	NOMINAL ID	FLANGE TYPE	A	B	C	D	WEIGHT
TBVP-D-100-NW-25	1 (25)	NW-25	2.25 (57.1)	2.75 (69.8)	6.68 (169.7)	6.99 (177.6)	5.5 (2.5)
TBVP-D-150-NW-40	1.5 (38)	NW-40	2.25 (57.1)	2.75 (69.8)	6.68 (169.7)	1.39 (35.3)	5.3 (2.4)
TBVP-D-200-NW-50	2 (50)	NW-50	2.00 (50.8)	3.36 (85.3)	6.99 (177.5)	1.98 (50.3)	5.5 (2.5)
TBVP-D-250-ISO-63	2.5 (63)	ISO-63	1.00 (25.4)	5.12 (130.0)	7.44 (189.0)	2.44 (62.0)	7.5 (3.4)
TBVP-D-300-ISO-80	3 (76)	ISO-80	1.00 (25.4)	5.71 (145.0)	7.76 (197.1)	2.94 (74.7)	8.8 (4.0)
TBVP-D-400-ISO-100	4 (100)	ISO-100	1.00 (25.4)	6.50 (165.1)	8.19 (208.0)	3.85 (97.8)	9.5 (4.3)

## Gear Drive Throttling Butterfly Valves

MODEL NUMBER	NOMINAL ID	FLANGE TYPE	A	B	C	D	WEIGHT
TBVP-G-600-ISO-160	6 (150)	ISO-160	1.62 (41.1)	8.90 (226.1)	10.5 (266.7)	5.67 (144.0)	21.8 (9.9)
TBVP-G-800-ISO-200	8 (200)	ISO-200	1.62 (41.1)	11.2 (284.5)	12.5 (317.5)	7.87 (199.9)	28.5 (12.9)
TBVP-G-1000-ISO-250	10 (250)	ISO-250	1.62 (41.1)	13.2 (335.3)	13.5 (342.9)	9.88 (250.9)	38.0 (17.3)

### SPECIFICATIONS

#### General

**Compatible Controllers:**  
**Direct drive:** 200-series  
**Gear drive:** 100-series buried box  
**Valve position:** Visual indicator

#### Construction

**Wetted materials:** 316 stainless steel, seal material (see below)  
**Seals:** Viton standard. Kalrez, Chemraz, Perlast and other materials available on request.

#### Operation

**Motor power input:** Supplied by BQC controller.  
**Differential pressure:** 1.1 bar maximum across the valve plate  
**Forced heating capabilities:** Valves may be heated up to 200°C with optional external heaters, provided seal and coupling material is specified to handle such temperatures.  
**Process gas temperature capabilities:** For process gas temperatures in excess of 100°C, please consult with Nor-Cal Intellisys technical support for proper selection of seal materials and other design considerations.  
**Ambient operating conditions:** 0 - 60°C @ 0 - 95% humidity  
**Leak rate:** 1 x 10<sup>-9</sup> mbar-liter/sec He

#### Inherent performance

**Maximum speed:** Open to closed in 125 msec (*direct*), 250 msec (*geared*)  
**Control resolution:** 3.2 arc second (*direct*), 0.2 arc second (*geared*)  
**Maximum torque:** 280 in-oz (*direct*), 2100 in-oz (*geared*)

#### Pressure Control Performance (when used with an Intellisys controller)

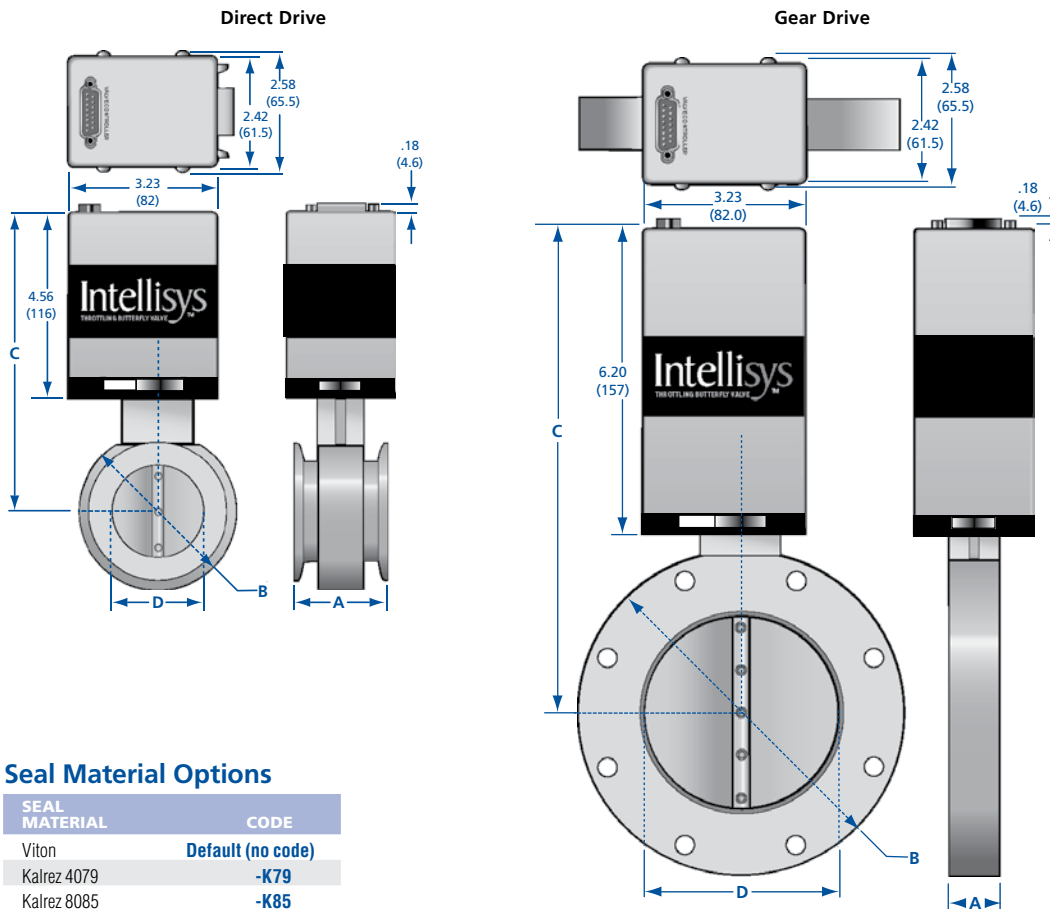
**Accuracy:** The greater of 5 mV or 0.25% of reading  
**Repeatability:** Within 2.5 mV or 0.12% of reading  
**Control range:** 0.5% - 100% of the vacuum gauge range

#### Reliability

(99% confidence level, in clean environment)  
**O-ring cycle life:** 5 million open-close cycles  
**MTBF:** >50,000 hrs. continuous operation

#### Approvals

CE (EMC and machinery directives)



## Seal Material Options

SEAL MATERIAL	CODE
Viton	Default (no code)
Kalrez 4079	-K79
Kalrez 8085	-K85
Kalrez 8575	-K75
Kalrez 9100	-K91
Chemraz E38	-C38
Dupra 192	-D19
Perlast G74P	-PP7

**Example:** TBVP-G-600-ISO-160-K75  
 Gear drive TBV with 6 inch bore, ISO 160 flanges and Kalrez 8575 O-rings.

All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.

# Downstream Pressure Control Throttling Butterfly Valves



## IQ Throttling Butterfly Valves

MODEL NUMBER	NOM. ID	FLANGE TYPE	A	B	C	D	WEIGHT
<b>TBV-IQA-100-NW-25</b>	1 (25)	NW-25	2.25 (57.1)	2.75 (69.8)	8.34 (211.8)	0.87 (22.1)	5.5 (2.5)
<b>TBV-IQA-150-NW-40</b>	1.5 (38)	NW-40	2.25 (57.1)	2.75 (69.8)	8.34 (211.8)	1.39 (35.31)	5.3 (2.4)
<b>TBV-IQA-200-NW-50</b>	2 (50)	NW-50	2.00 (50.8)	3.36 (85.3)	8.65 (219.7)	1.98 (50.3)	5.5 (2.5)
<b>TBV-IQA-250-ISO-63</b>	2.5 (63)	ISO-63	1.00 (25.4)	5.12 (130.0)	9.10 (231.1)	2.44 (62.0)	7.5 (3.4)
<b>TBV-IQA-300-ISO-80</b>	3 (76)	ISO-80	1.00 (25.4)	5.71 (145.0)	9.42 (239.3)	2.94 (74.7)	8.8 (4.0)
<b>TBV-IQA-400-ISO-100</b>	4 (100)	ISO-100	1.00 (25.4)	6.50 (165.1)	9.85 (250.2)	3.85 (97.8)	9.5 (4.3)
<b>TBV-IQA-600-ISO-160</b>	6 (150)	ISO-160	1.62 (41.1)	8.90 (226.1)	10.4 (264.2)	5.87 (149.1)	21.8 (9.9)
<b>TBV-IQA-800-ISO-200</b>	8 (200)	ISO-200	1.62 (41.1)	11.2 (284.5)	12.4 (315.0)	7.87 (199.9)	28.5 (12.9)
<b>TBV-IQA-1000-ISO-250</b>	10 (250)	ISO-250	1.62 (41.1)	13.2 (335.3)	13.3 (337.8)	9.88 (250.9)	38.0 (17.3)
<b>TBV-IQA-1200-ISO-320</b>	12 (300)	ISO-320	1.62(41.1)	16.73 (424.9)	15.35 (389.9)	12.31(312.7)	51 (23.2)

**Note:** IQA can be replaced with IQD, IQD2, IQE, and IQR

### SPECIFICATIONS

#### General

##### Controller Options:

- IQA: Analog/TTL/RS232 interface
- IQD: DeviceNet/RS232 interface
- IQD2: DeviceNet/RS232 interface, no power via DN connector
- IQE: Ethernet/RS232 interface
- IQR: RS485 interface

**Value position:** Visual indicator

#### Construction

**Wetted materials:** 316 stainless steel, seal material (see below)

**Seals:** Viton standard. Kalrez, Chemraz, Perlast and other materials available on request (see below)

#### Operation

**Power input:** +24 VDC

##### Differential pressure:

1.1 bar maximum across valve plate

##### Forced heating capabilities:

Valves may be heated up to 150°C with optional external heaters.

##### Process gas temperature capabilities:

For process gas temperatures in excess of 100°C, please consult with Nor-Cal Intellisys technical support for proper design considerations.

##### Ambient operating conditions:

0 - 60°C @ 0 - 95% humidity  
**Leak rate:** 1 × 10<sup>-9</sup> mbar-liter/sec He

#### Inherent performance

**Open to close speed:** 125 msec

**Control resolution:** 3.2 arc second

**Maximum torque:** 1 in - 4 in : 280 in-oz

**Maximum torque:** 6 in - 10 in : 700 in-oz

#### Pressure control performance

**Accuracy:** The greater of 5mV or 0.25% of reading

**Repeatability:** Within 2.5mV or 0.12% of reading Control range: 0.5% - 100% of the vacuum gauge range

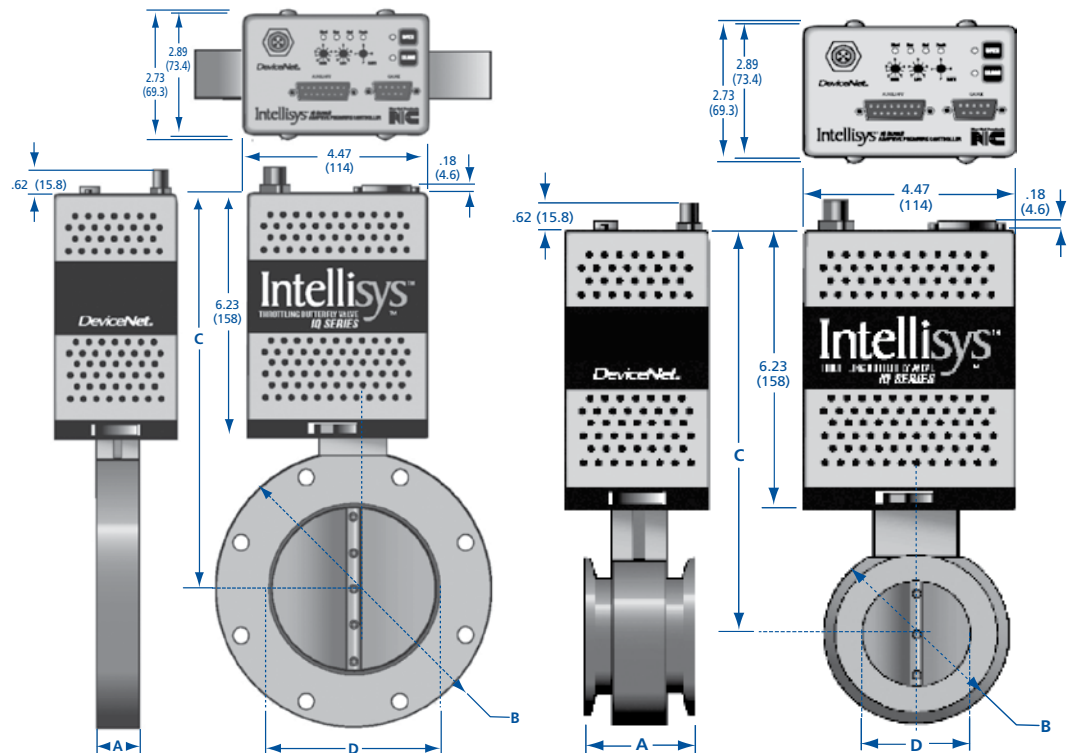
#### Reliability (99% confidence level, in clean environment)

**O-ring cycle life:** 5 million open-close cycles

**MTBF:** >50,000 hours continuous operation

#### Approvals

CE (EMC and machinery directives)



All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.

### Seal Material Options

SEAL MATERIAL	CODE
Viton	Default (no code)
Kalrez 4079	-K79
Kalrez 8085	-K85
Kalrez 8575	-K75
Kalrez 9100	-K91
Chemraz E38	-C38
Dupra 192	-D19
Perlast G74P	-PP7

**Example:** TBV-IQD-400-ISO-100-C38  
 IQD TBV with 4 inch bore, ISO 100 flanges and Chemraz E38 O-rings.

# Downstream Pressure Control Throttling Butterfly Valves



## IQ+ Throttling Butterfly Valves

Nor-Cal's new IQ+ controller is available on the complete line of regular and sealing Throttling Butterfly Valves (TBV and TBVS) turning what is very good performance into best-in-class process control. The IQ+ controller is an on-valve integral control & drive unit that is fully RoHS compliant with 100% lead-free circuit board content. User interfaces include an ODVA certified DeviceNet protocol and physical layer, as well as standard RS-232 communications. Gauge power capabilities have been upgraded to a full 1500 mA at

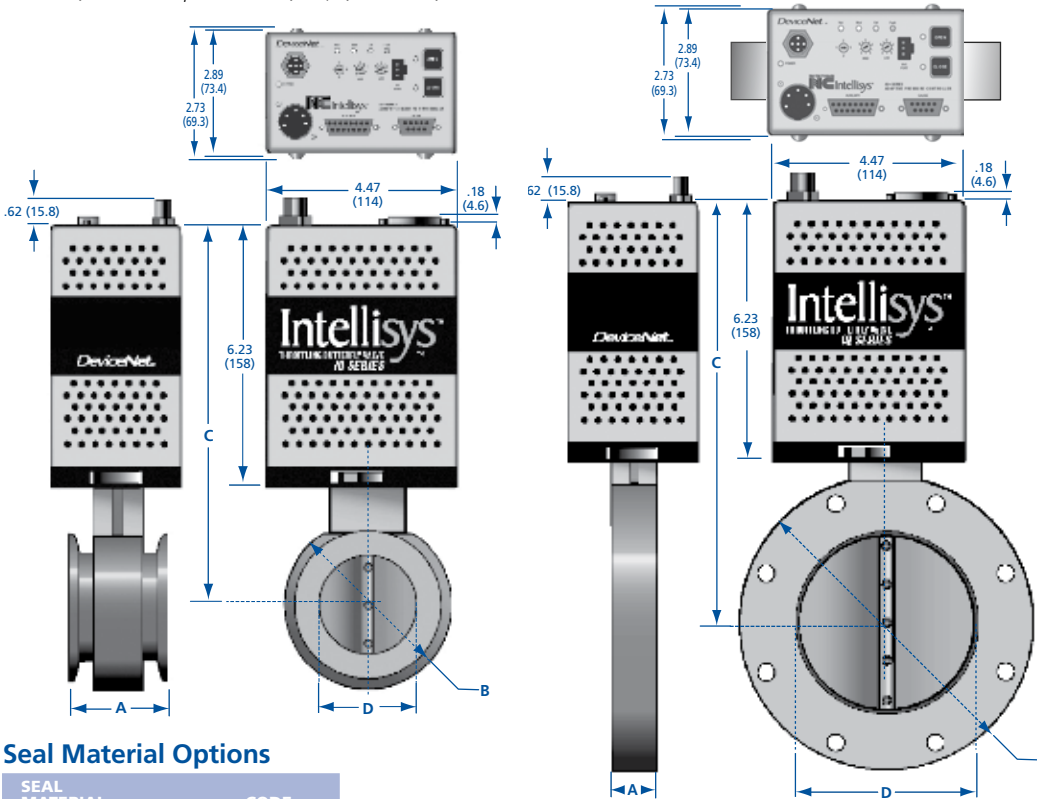
+/- 15 VDC in order to power two heated CDG's directly from the IQ+ unit. In addition, a battery backup feature is available that can be used to bring the valve to a fail-closed or fail-open safe position in the event of system power loss. Last, the IQ+ adaptive pressure control algorithm has been significantly improved to better deal with difficult control situations, in particular at conditions that typically occur at low pressures and low flows.

For larger system pressure control requiring multiple pumps and forelines, such as

on flat panel, industrial coating or photovoltaic tools, it is easily possible to gang up to ten valves together. Multi-valve Master/Slave system control like this is facilitated via the Nor-Cal-Net intervalve communications system. One IQ+ operated valve serves as the master with communications to the host tool, gauge input and has direct command over the control position of the remaining slave valves. The IQ+ controlled butterfly valves are the right answer to any new or challenging pressure control application.

MODEL NUMBER	NOM. ID	FLANGE TYPE	A	B	C	D	WEIGHT
TBV-QPD-NW-25	1 (25)	NW-25	2.25 (57.1)	2.75 (69.8)	8.34 (211.8)	0.87 (22.1)	5.5 (2.5)
TBV-QPD-NW-40	1.5 (38)	NW-40	2.25 (57.1)	2.75 (69.8)	8.34 (211.8)	1.39 (35.3)	5.3 (2.4)
TBV-QPD-NW-50	2 (50)	NW-50	2.00 (50.8)	3.36 (85.3)	8.65 (219.7)	1.98 (50.3)	5.5 (2.5)
TBV-QPD-ISO-63	2.5 (63)	ISO-63	1.00 (25.4)	5.12 (130.0)	9.10 (231.1)	2.44 (62.0)	7.5 (3.4)
TBV-QPD-ISO-80	3 (76)	ISO-80	1.00 (25.4)	5.71 (145.0)	9.42 (239.3)	2.94 (74.7)	8.8 (4.0)
TBV-QPD-ISO-100	4 (100)	ISO-100	1.00 (25.4)	6.50 (165.1)	9.85 (250.2)	3.85 (97.8)	9.5 (4.3)
TBV-QPD-ISO-160	6 (150)	ISO-160	1.62 (41.1)	8.90 (226.1)	10.4 (264.2)	5.87 (149.1)	21.8 (9.9)
TBV-QPD-ISO-200	8 (200)	ISO-200	1.62 (41.1)	11.2 (284.5)	12.4 (315.0)	7.87 (199.9)	28.5 (12.9)
TBV-QPD-ISO-250	10 (250)	ISO-250	1.62 (41.1)	13.2 (335.3)	13.3 (337.8)	9.88 (250.9)	38.0 (17.3)
TBV-QPD-ISO-320	12 (300)	ISO-320	1.62 (41.1)	16.73 (424.9)	15.35 (389.9)	12.31 (312.7)	51 (23.2)

Note: QPD can be replaced with QPDB, QPDG and QPDBG



## Seal Material Options

SEAL MATERIAL	CODE
Viton	Default (no code)
Kalrez 4079	-K79
Kalrez 8085	-K85
Kalrez 8575	-K75
Kalrez 9100	-K91
Chemraz E38	-C38
Dupra 192	-D19
Perlast G74P	-PP7

Example: **TBV-QPDBG-400-ISO-100-C38**  
 IQ+ TBV with DeviceNet, battery backup, gauge power, 4 inch bore, ISO 100 flanges and Chemraz E38 O-rings.

## SPECIFICATIONS

### General

- Controller Options:**  
**QPD:** DeviceNet / RS232 interface  
**QPDB:** DeviceNet / RS232 interface, with battery back-up  
**QPDG:** DeviceNet / RS232 interface, with gauge power  
**QPDBG:** DeviceNet / RS232 interface, with battery back-up and gauge power  
 Contact the factory for other interfaces such as Analog, TTL, RS-485 and Ethernet.  
**Valve position:** Visual indicator

### Construction

- Wetted materials:** 316 stainless steel, seal material (see below)  
**Seals:** Viton standard. Kalrez, Chemraz, Perlast and other materials available on request.

### Operation

- Power input:** +24 VDC  
**Differential pressure:** 1.1 bar maximum across the valve plate  
**Forced heating capabilities:** Valves may be heated up to 150°C with optional external heaters.  
**Process gas temperature capabilities:** For process gas temperatures in excess of 100°C, please consult with Nor-Cal Intellisys technical support for proper selection of seal materials and other design considerations.  
**Ambient operating conditions:** 0 - 60°C @ 0 - 95% humidity  
**Leak rate:** 1 x 10<sup>-9</sup> mbar-liter/sec He

### Inherent performance

- Open to close speed:** 125 msec  
**Control resolution:** 0.4 arc second  
**Maximum torque:**  
 1" - 4": 280 in-oz  
 6" - 10": 700 in-oz

### Pressure Control Performance

- (when used with an Intellisys controller)  
**Algorithm:** Improved for better stability and faster transitions  
**Accuracy:** The greater of 5 mV or 0.25% of reading  
**Repeatability:** Within 2.5mV or 0.12% of reading  
**Control range:** 0.5% - 100% of the vacuum gauge range

### Reliability

- (99% confidence level, in clean environment)  
**O-ring cycle life:** 5 million open-close cycles  
**MTBF:** >50,000 hrs. continuous

### Approvals

- RoHS compliant  
 ODVA certified DeviceNet  
 CE (EMC and machinery directives)

All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.





## SPECIFICATIONS

### General

#### Controller Options:

- QP:** RS232 interface
- QPA:** Analog/TTL/RS232 interface
- QPD:** DeviceNet/RS232 interface
- QPM:** EtherCAT interface
- QPR:** RS485 Interface
- QPS:** Slave controller (used for master/slave systems)

**Valve position:** Visual indicator

### Construction

**Body materials:** 6061 Aluminum, hard anodized aluminum or 316 stainless steel,  
**Seals:** Viton standard. Kalrez, Chemraz, Perlast and other materials available on request.

### Operation

**Power input:** +24 VDC

**Differential pressure:** 1.2 bar maximum across the valve plate

**Valve bakeout capabilities:** Valves may be heated up to 150°C with optional external heaters.

#### Process gas temperature capabilities:

For process gas temperatures in excess of 100°C, please consult with Nor-Cal Intellisys technical support for proper design considerations.

#### Ambient operating conditions:

0-45°C @ 0-95% humidity

**Shaft Leak rate:**  $1 \times 10^{-9}$  mbarl/sec He (SS, AL)  
 $1 \times 10^{-6}$  mbarl/sec He (HA)

**Plate Leak rate:**  $1 \times 10^{-8}$  mbarl/sec He (SS, AL)  
 $1 \times 10^{-5}$  mbarl/sec He (HA)

### Inherent performance

**Open to close speed:** 0.5–0.8 seconds

**Control resolution:** 0.5 arc second

**Maximum torque:** 2100 in-oz

### Pressure Control Performance

**Accuracy:** The greater of 5 mV or 0.25% of reading

**Repeatability:** Within 2.5mV or 0.12% of reading

**Control range:** 0.5% - 100% of the vacuum gauge range

### Reliability

(99% confidence level, in clean environment)

**MTBF:** >10,000 hrs. continuous

### Approvals

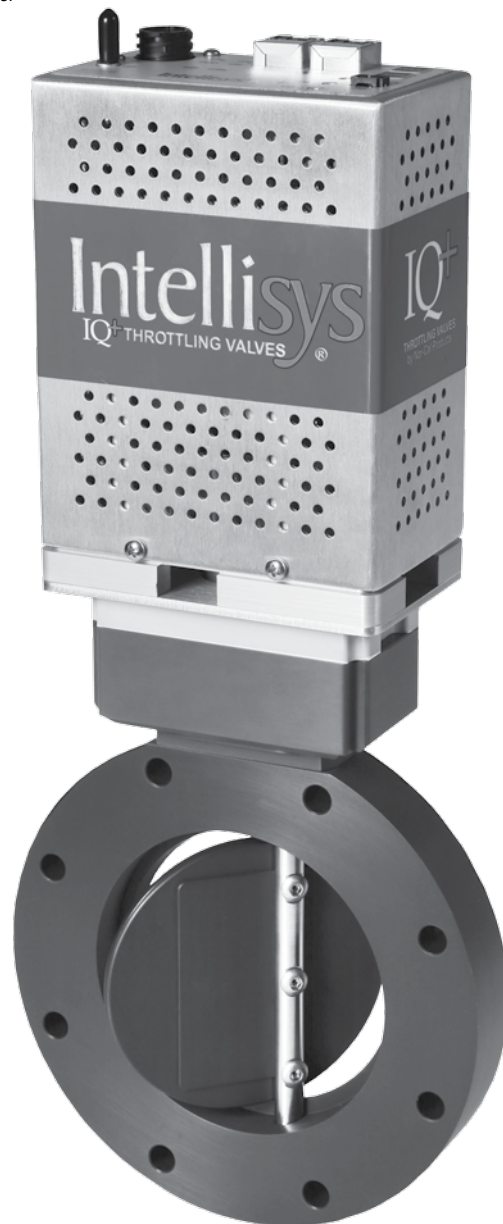
CE (EMC and machinery directives)

## Intellisys™ Combination Butterfly Valve with Maximum Dynamic Range

Nor-Cal has upgraded its sealing butterfly valve technology to provide a broader and more robust product line. Available in either stainless steel or aluminum, the STBV-product is a dual function valve capable of acting both as foreline isolation- and down-stream pressure control valve. The isolation function is rated up to  $1 \times 10^{-9}$  mbar · l / sec depending on the choice of seal and body material, and is actuated through a dual cam self-locking linkage arrangement. The new valve ranges in sizes from 1 ½ to 4 inch (38-100mm) nominal ID's.

The dynamic range, or controllable conductance, of these valves spans from 0.01 liters/sec at closed for the 40mm size up to 600 liters/sec using the 100mm size valve in the full open position. When combined with the Intellisys™ on-board IQ+ controller, the STBV valves can be used to control chamber pressures up to 1 bar and beyond, even with very low gas flow rates. The ultra-fine motor resolution of the IQ+ controller enables extremely precise valve plate movement resulting in very smooth and stable system pressures.

Process by-product mitigation is accomplished by heating the valve body, either by use of heater jackets or integral cartridge heaters. The STBV valves can be baked out to 120°C as long as precautions are taken to ensure the IQ+ controller does not exceed 45°C.



## Seal Material Options

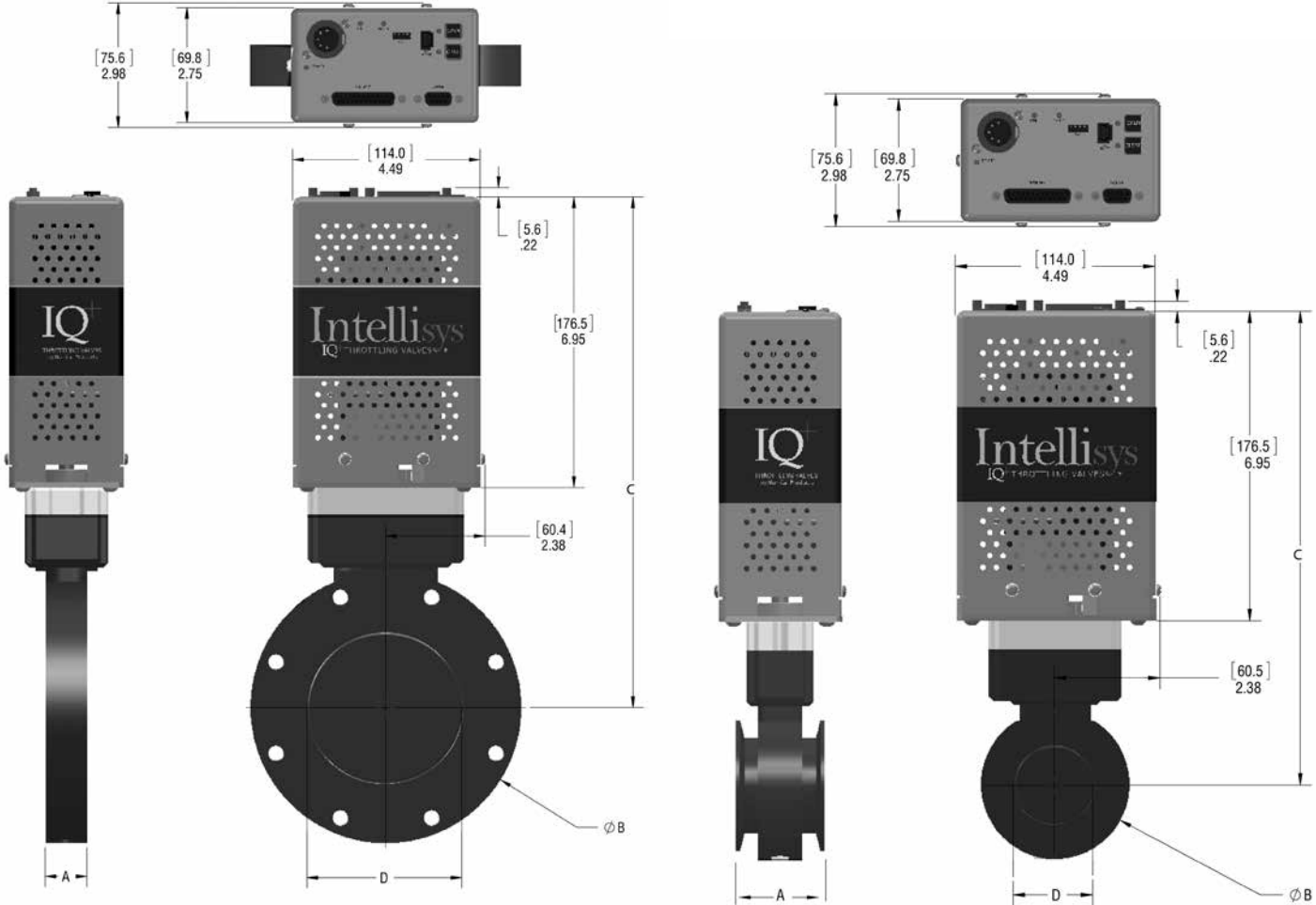
SEAL MATERIAL	CODE
Viton	Default (no code)
Kalrez 8085	-K85
Kalrez 8575	-K75
Kalrez 9100	-K91
Chemraz E38	-C38
Dupra 192	-D19
Perlast G74P	-PP7

## Flapper O-ring Sizes

FLANGE SIZE	CODE
NW-40	OR-2-213
NW-50	OR-2-223
ISO-63	OR-2-228
ISO-80	OR-2-232
ISO-100	OR-2-237

# Downstream Pressure Control

## Sealing Throttling Butterfly Valves



MODEL NUMBER	NOM. ID	FLANGE TYPE	A	B	C	D	WEIGHT (AL & HA)	WEIGHT (SS)
STBV-QPA-NW-40-xx	1.5	NW-40	2.25 (57.2)	2.75 (69.9)	10.33 (262.4)	1.21 (30.7)	6.7 (3.0)	7.7 (3.5)
STBV-QPA-NW-50-xx	2	NW-50	2.00 (50.8)	3.36 (85.3)	10.64 (270.3)	1.77 (45.0)	6.9 (3.1)	8.3 (3.8)
STBV-QPA-ISO-63-xx	2.5	ISO-63	1.00 (25.4)	5.12 (130.0)	11.44 (290.6)	2.49 (63.2)	8.0 (3.6)	10.8 (4.9)
STBV-QPA-ISO-80-xx	3	ISO-80	1.00 (25.4)	5.71 (145.0)	11.77 (299.0)	2.95 (74.9)	8.3 (3.8)	11.6 (5.3)
STBV-QPA-ISO-100-xx	4	ISO-100	1.00 (25.4)	6.50 (165.0)	12.21 (310.1)	3.62 (91.9)	9.3 (4.2)	13.0 (5.9)

**Note:** QPA can be replaced with QP, QPD, QPM, QPR or QPS

**Note:** "xx" designates the body material, AL for aluminum, HA for hard anodized aluminum and SS for stainless steel

**Example:** STBV-QPDBG-ISO-100-C38

IQ+ STBV with DeviceNet, battery backup, gauge power, 4 inch bore, ISO 100 flanges and Chemraz E38 O-rings.

All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.

# Downstream Pressure Control

## Throttle Valve Heaters



### Throttle Valve Heaters

Many semiconductor processes are carried out in vacuum chambers with internal temperatures of several hundred degrees Celsius. Process by-products exit the chamber in vapor phase, but sublimate in the foreline and vacuum pump exhaust when gas temperatures drop sufficiently for them to form solids. The resultant buildup can increase wafer defects from particle backstreaming, reduce throughput of vacuum lines, impede the function of throttle valves and isolation valves, damage some dry pumps and reduce the efficiency of the scrubber. This buildup can be reduced or eliminated by heating vacuum lines and associated components from the chamber to the scrubber, or by using a combination of heaters and foreline traps, which collect the by-products preventing them from continuing downstream.

Heater jackets with a UL recognized electronic thermostat for fixed set-point

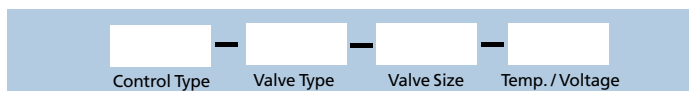
applications is available for temperatures up to 150°C. For fully adjustable temperature set-points up to 200 °C, a UR/CE certified heater with a Type K thermocouple and PID controller can provide precise temperature control. Standard heaters cover the entire valve body, and in the case of butterfly valves also the mating flanges. As such, heaters for NW-flanged TBV's are provided with special aluminum clamps.

Standard ½ inch (12.7mm) insulation add-on heaters are available for all Throttling Butterfly and SoftShut Gate Valves. These can be purchased and installed separately provided that the valve is fitted with the proper high temperature seals and other thermally compatible components. Heaters for Throttling Pendulum Valves are integral to the valve, and must be ordered together. Field retrofit of a heater on to a TPV is not possible. Special heater solutions or higher temperature control for all valves may be available. Call for details.



### Heater Jacket Part Number and Ordering Information

Please use the following part numbering tree to specify the heater jacket to fit your throttling butterfly or SoftShut valve. **Note:** All part number combinations may not be valid or available. Contact Nor-Cal Products for the latest pricing, availability and other options.



#### Control Type

CONTROL TYPE	CODE
PID control*	<b>HC</b>
Electronic thermostat	<b>HTE</b>

\* Requires separate PID controller. (See controllers Section 6.)

#### Valve Type

VALVE TYPE	CODE
Throttling butterfly	<b>TBV</b>
Sealing throttling butterfly	<b>TBVS</b>
Throttling SoftShut - ISO	<b>TSSI</b>
Throttling SoftShut - CF	<b>TSSC</b>

#### Valve Size

VALVE SIZE	CODE
1.00*	<b>100</b>
1.50*	<b>150</b>
2.00*	<b>200</b>
2.50	<b>250</b>
3.00	<b>300</b>
4.00	<b>400</b>
6.00	<b>600</b>
8.00	<b>800</b>
10.00	<b>1000</b>

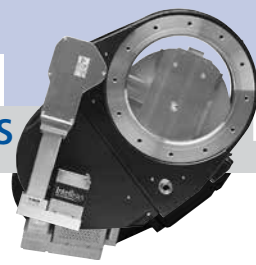
\* Includes two special NW clamps

#### Temperature/Voltage

TEMPERATURE & VOLTAGE	CODE
HC type, 120 VAC	<b>201</b>
HC Type, 208 VAC	<b>202</b>
HTE type, 90°C, 120 VAC	<b>091</b>
HTE type, 90°C, 208 VAC	<b>092</b>
HTE type, 120°C, 120 VAC	<b>121</b>
HTE type, 120°C, 208 VAC	<b>122</b>
HTE type, 150°C, 120 VAC	<b>151</b>
HTE type, 150°C, 208 VAC	<b>152</b>

**Example 1:** **HC-TBV-250-201** PID controlled jacket for 2.5 inch ID TBV. 120 VAC.

**Example 2:** **HTE-TSSC-600-122** Electronic thermostat controlled jacket for 6 inch ID, CF flanged TSS. 120 °C and 208 VAC operation.



## Unmatched Pressure Control Performance and Low Particle Generation

Nor-Cal's line of Intellisys pendulum valves provides equipment manufacturers with unmatched pressure control performance and low particle generation. Other pendulum valves use one actuation method to move the gate and another method to seal, creating an "out of control" area near the closed position. To compensate for this, system designers often add secondary bypass lines with costly throttling butterfly valves for high pressure, high flow regimes, such as NF<sub>3</sub> cleans. Intellisys pendulum valves utilize the same exclusive closed loop motor technology as other Nor-Cal control valves, but also feature a patented Penduroll actuator mechanism to move the sealing gate rapidly across the valve bore and transition to the axial direction. The result is precise pressure control over the entire valve stroke, most notably near the closed position. The Intellisys control system is the only choice for demanding 300mm Etch and CVD applications which require fast, accurate pressure control across the entire range of critical process flows and chamber pressures.

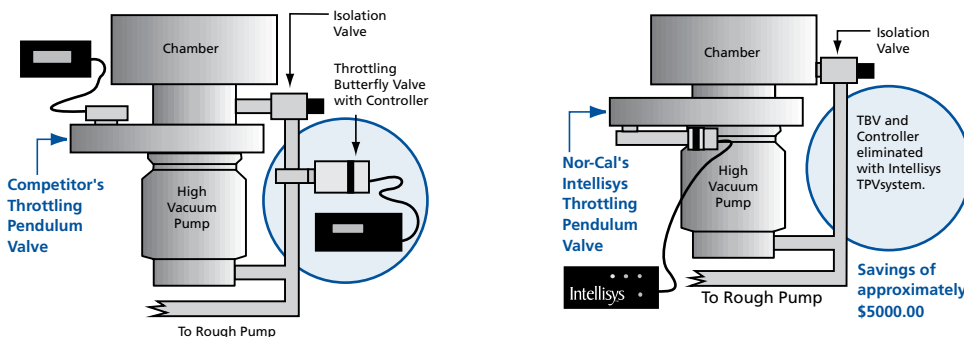
The Intellisys closed loop motor control monitors and controls the exact position of the valve's gate mechanism. When combined with an Intellisys adaptive pressure controller, the pendulum valves provide up to 160 million steps of positional resolution to position the gate exactly where it needs to be to control pressure or to seal. In addition, the Nor-Cal control system's speed of actuation is unequalled in providing optimal transient response, pressure set-point stability and overall process improvement. The APC's adaptive algorithm outperforms "learn modes" by optimizing phase and gain settings in real time during varying chamber pressure and flow conditions.

In-situ serviceability of the valve is made possible through the incorporation of a removable bonnet cover. The entire gate assembly and sealing O-ring can be accessed without removing the valve from the system, making regular inspections, cleanings and O-ring replacements quick and easy.

Nor-Cal Products also offers pneumatically actuated isolation pendulum valves that contain the same patented Penduroll mechanism that is found in the throttling valves. For more information about these valves, please refer to the Isolation Valves section of this catalog.

## Features and Benefits

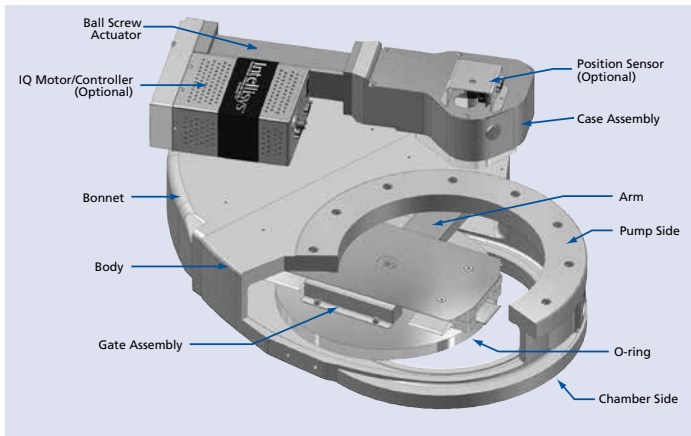
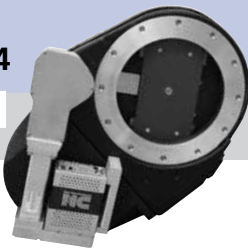
- Space saving, low cost design
- Low particle generation
- High reliability
- Easy maintenance, split body allows O-ring replacement without removing valve from system
- Body can be heated up to 150°C with optional heater jackets
- Available in ISO and JIS flange styles





# Downstream Pressure Control

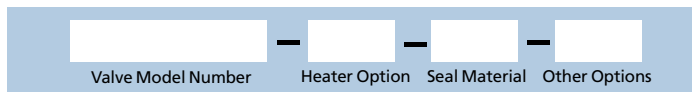
## Throttling Pendulum Valves



### TPV Part Number and Ordering Information

Please use the following part numbering tree to add the appropriate options for a TPV to fit your application.

**Note:** All part number combinations may not be valid. Contact Nor-Cal Products for the latest pricing, availability and other options.



#### Heater Options

HEATER OPTIONS	OPERATION	CODE
None		<i>Leave blank</i>
90°C thermostat	120 VAC	<b>HT091</b>
120°C thermostat	120 VAC	<b>HT121</b>
150°C thermostat	120 VAC	<b>HT151</b>
90°C thermostat	208 VAC	<b>HT092</b>
120°C thermostat	208 VAC	<b>HT122</b>
150°C thermostat	208 VAC	<b>HT152</b>

#### Seal Material Options

SEAL MATERIAL	CODE
Viton	<i>Leave blank</i>
Kalrez 4079	<b>-K79</b>
Kalrez 8085	<b>-K85</b>
Kalrez 8575	<b>-K75</b>
Kalrez 9100	<b>-K91</b>
Chemraz E38	<b>-C38</b>
Dupra 192	<b>-D19</b>
Perlast G74P	<b>-PP7</b>

#### Other Options

OTHER OPTIONS	CODE
Motor actuator position R* (default)	<i>Leave blank</i>
Motor actuator position T*	<b>T</b>
Pump-out port (NW-16 size on DN160 and DN200 NW-40 size on DN250, DN320 and DN35)	<b>U</b>
Open / closed position indicators (Optical with indicating LEDs)	<b>W</b>
Mirror image body configuration	<b>Z</b>

\*See dimension diagram on facing page

#### Example 1: TPV-800-ISO-200-MB-HT122-K79-T

TPV with 8 inch ISO flanges, bright dipped aluminum, heated to 120°C with thermostat control, 208 VAC operation, Kalrez 4079 compound O-ring material and motor actuator in T position

#### Example 2: TPV-QPDB-ISO-250-C38

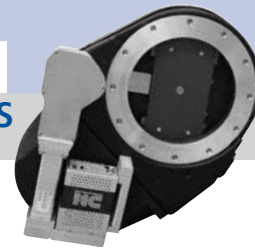
IQ+ TPV with DeviceNet and battery backup, 10 inch ISO flanges and E38 Chemraz O-ring material.

#### Body Materials Available

Standard TPV bodies are cast aluminum that have been either bright dipped or hard anodized. Some sizes are machined and either bright dipped or hard anodized. The model number denotes the body material and surface treatment used for each size. **Note:** Some sizes are not available in both machined and cast bodies.

BODY MATERIAL	CODE
Cast bright dipped aluminum	<i>Default</i>
Cast Type III hard anodize	<b>HA</b>
Machined bright dipped aluminum	<b>MB</b>
Machined Type III hard anodize	<b>HM</b>

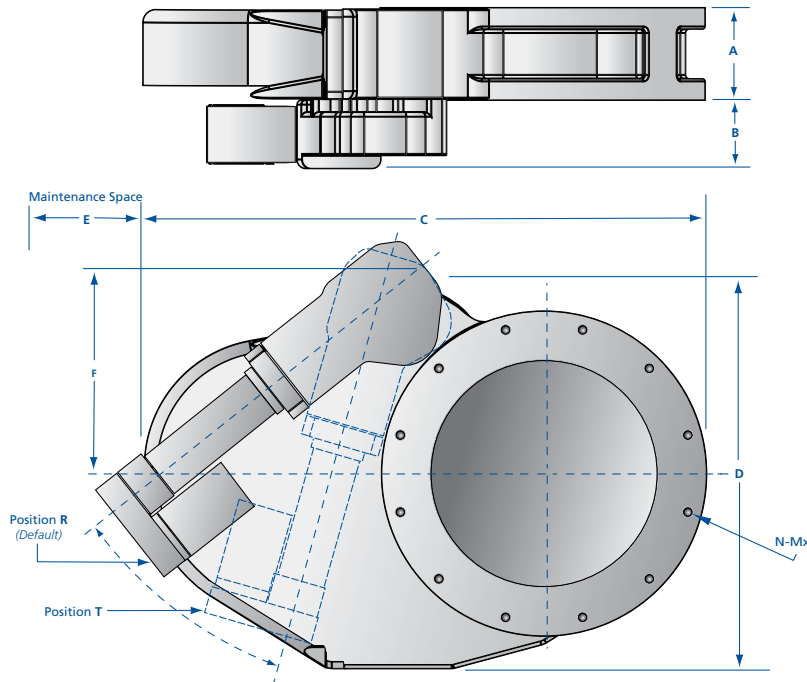
All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.



### Throttling Pendulum Valves

MODEL NUMBER	NOM. ID	FLANGE TYPE	A	B	C	D	E	F	N	M	L	WEIGHT
TPVP-600-ISO-160	6	ISO-160	3.15 (80.0)	3.78 (96.0)	15.9 (403)	12.2 (310)	5.31 (135)	8.50 (216)	8	M10	(10)	40 (18.0)
TPVP-600-ISO-160-HA	6	ISO-160	3.15 (80.0)	3.78 (96.0)	15.9 (403)	12.2 (310)	5.31 (135)	8.50 (216)	8	M10	(10)	40 (18.0)
TPVP-800-ISO-200-MB	8	ISO-200	3.46 (87.9)	3.78 (96.0)	19.9 (506)	14.4 (266)	6.50 (165)	9.29 (236)	12	M10	(10)	49 (22.2)
TPVP-800-ISO-200-HM	8	ISO-200	3.46 (87.9)	3.78 (96.0)	19.9 (506)	14.4 (266)	6.50 (165)	9.29 (236)	12	M10	(10)	49 (22.2)
TPVP-1000-ISO-250	10	ISO-250	3.94 (100)	3.78 (96.0)	23.8 (605)	16.6 (422)	8.46 (215)	9.49 (241)	12	M10	(10)	62 (28.1)
TPVP-1000-ISO-250-HA	10	ISO-250	3.94 (100)	3.78 (96.0)	23.8 (605)	16.6 (422)	8.46 (215)	9.49 (241)	12	M10	(10)	62 (28.1)
TPVP-1200-ISO-320	12	ISO-320	4.72 (120)	4.06 (103)	30.2 (767)	22.0 (559)	10.6 (269)	12.8 (325)	12	M12	(18)	123 (55.8)
TPVP-1200-ISO-320-HA	12	ISO-320	4.72 (120)	4.06 (103)	30.2 (767)	22.0 (559)	10.6 (269)	12.8 (325)	12	M12	(18)	123 (55.8)
TPVP-600-JIS-150	6	JIS-150	3.15 (80.0)	3.78 (96.0)	15.9 (403)	12.2 (310)	5.31 (135)	8.50 (216)	8	M10	(10)	40 (18.0)
TPVP-600-JIS-150-HA	6	JIS-150	3.15 (80.0)	3.78 (96.0)	15.9 (403)	12.2 (310)	5.31 (135)	8.50 (216)	8	M10	(10)	40 (18.0)
TPVP-800-JIS-200-MB	8	JIS-200	3.46 (87.9)	3.78 (96.0)	19.9 (506)	14.4 (266)	6.50 (165)	9.29 (236)	8	M12	(12)	49 (22.2)
TPVP-800-JIS-200-HM	6	JIS-200	3.46 (87.9)	3.78 (96.0)	19.9 (506)	14.4 (266)	6.50 (165)	9.29S (236)	8	M12	(12)	49 (22.2)
TPVP-1000-JIS-250	10	JIS-250	3.94 (100)	3.78 (96.0)	23.8 (605)	16.6 (422)	8.46 (215)	9.49 (241)	12	M12	(12)	62 (28.1)
TPVP-1000-JIS-250-HA	10	JIS-250	3.94 (100)	3.78 (96.0)	23.8 (605)	16.6 (422)	8.46 (215)	9.49 (241)	12	M12	(12)	62 (28.1)
TPVP-1200-JIS-300	12	JIS-300	4.72 (120)	4.06 (103)	30.2 (767)	22.0 (559)	10.6 (269)	12.8 (325)	12	M12	(18)	123 (55.8)
TPVP-1200-JIS-300-HA	12	JIS-300	4.72 (120)	4.06 (103)	30.2 (767)	22.0 (559)	10.6 (269)	12.8 (325)	12	M12	(18)	123 (55.8)
TPVP-1400-JIS-350	4	JIS-350	4.92 (125)	4.06 (103)	32.3 (820)	22.0 (559)	12.2 (310)	12.8 (325)	12	M12	(18)	143 (64.9)
TPVP-1400-JIS-350-HA	14	JIS-350	4.92 (125)	4.06 (103)	32.3 (820)	22.0 (559)	12.2 (310)	12.8 (325)	12	M12	(18)	143 (64.9)

Note: N=Number bolt holes M=Thread bolt diameter L=Thread depth



### SPECIFICATIONS

#### General

**Compatible controllers:** 800-series APC buried box controllers

#### Construction

##### Wetted materials

Body: Cast aluminum A356.0 (machined billet aluminum 6061-T6 in 8" size)

Valve plate: Aluminum 6061-T6

Other parts: A6061, A7075, SS304, SS316,

Inconel X-750 and Viton

Seals: Viton standard, Kalrez, Chemraz,

Perlast and other materials available

Body and plate surface treatment: Bare aluminum standard, hard Type III anodizing optional

#### Operation

**Motor power input:** Supplied by BQC controller. Refer to APC section.

##### Differential pressure:

With valve fully sealed: 1.1 bar maximum across the valve plate

##### While opening the valve

27 mbar (DN160 and DN200)

32 mbar (DN250)

39 mbar (DN320 & DN350)

**Operating pressure:**  $3.8 \times 10^{-8}$  to 1 bar

##### Heating or bakeout capabilities:

Body: 150°C maximum with optional heater kits

Actuator: 60°C maximum

##### Ambient operating conditions:

0 - 60°C @ 0 - 95% humidity, noncondensing

**Leak rate:**  $1 \times 10^{-9}$  mbar-liter/sec He with Viton seals across seat and to atmosphere

( $1 \times 10^{-6}$  mbar-liter/sec He for hard anodized body or gate)

Derated with some perfluoro-elastomers

#### Inherent performance

**Maximum speed:** Open to closed in 2 to 5 seconds, depending on size

**Control resolution:** 16 to 40 million steps, open to closed, depending on size

#### Pressure control performance

(when used with an Intellisys controller)

**Accuracy:** The greater of 5 mV or 0.25% of reading

**Repeatability:** Within 2.5 mV or 0.12% of reading

**Control range:** 0.5% - 100% of the vacuum gauge range

#### Reliability

(99% confidence level, in clean environment)

**O-ring cycle life:** 1 million cycles open to control closed. 200K cycles open to fully closed.

**MTBF:** >10,000 hrs. continuous operation

#### Approvals

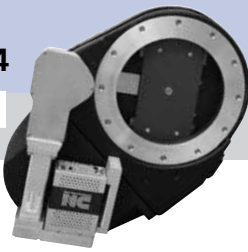
CE (EMC and machinery directives)

#### Options

Body & seal material, drive & heater (see options page this section)

### JIS Flange O-Rings

SIZE	O-RINGS
150	OR-JIS-150
200	OR-JIS-200
250	OR-JIS-250
320	OR-JIS-320
350	OR-JIS-350



### IQ Throttling Pendulum Valves

MODEL NUMBER	NOM. ID	FLANGE TYPE	A	B	C	D	E	F	N	M	L	WEIGHT
TPV-IQA-600-ISO-160	6	ISO-160	3.15 (80.0)	3.78 (96.0)	15.9 (403)	12.2 (310)	5.31 (135)	8.50 (216)	8	M10	(10)	40 (18.0)
TPV-IQA-600-ISO-160-HA	6	ISO-160	3.15 (80.0)	3.78 (96.0)	15.9 (403)	12.2 (310)	5.31 (135)	8.50 (216)	8	M10	(10)	40 (18.0)
TPV-IQA-800-ISO-200-MB	8	ISO-200	3.46 (87.9)	3.78 (96.0)	19.9 (506)	14.4 (266)	6.50 (165)	9.29 (236)	12	M10	(10)	49 (22.2)
TPV-IQA-800-ISO-200-HM	8	ISO-200	3.46 (87.9)	3.78 (96.0)	19.9 (506)	14.4 (266)	6.50 (165)	9.29 (236)	12	M10	(10)	49 (22.2)
TPV-IQA-1000-ISO-250	10	ISO-250	3.94 (100)	3.78 (96.0)	23.8 (605)	16.6 (422)	8.46 (215)	9.49 (241)	12	M10	(10)	62 (28.1)
TPV-IQA-1000-ISO-250-HA	10	ISO-250	3.94 (100)	3.78 (96.0)	23.8 (605)	16.6 (422)	8.46 (215)	9.49 (241)	12	M10	(10)	62 (28.1)
TPV-IQA-1200-ISO-320	12	ISO-320	4.72 (120)	4.06 (103)	30.2 (767)	22.0 (559)	10.6 (269)	12.8 (325)	12	M12	(18)	123 (55.8)
TPV-IQA-1200-ISO-320-HA	12	ISO-320	4.72 (120)	4.06 (103)	30.2 (767)	22.0 (559)	10.6 (269)	12.8 (325)	12	M12	(18)	123 (55.8)
TPV-IQA-600-JIS-150	6	JIS-150	3.15 (80.0)	3.78 (96.0)	15.9 (403)	12.2 (310)	5.31 (135)	8.50 (216)	8	M10	(10)	40 (18.0)
TPV-IQA-600-JIS-150-HA	6	JIS-150	3.15 (80.0)	3.78 (96.0)	15.9 (403)	12.2 (310)	5.31 (135)	8.50 (216)	8	M10	(10)	40 (18.0)
TPV-IQA-800-JIS-200-MB	8	JIS-200	3.46 (87.9)	3.78 (96.0)	19.9 (506)	14.4 (266)	6.50 (165)	9.29 (236)	8	M12	(12)	49 (22.2)
TPV-IQA-800-JIS-200-HM	8	JIS-200	3.46 (87.9)	3.78 (96.0)	19.9 (506)	14.4 (266)	6.50 (165)	9.29 (236)	8	M12	(12)	49 (22.2)
TPV-IQA-1000-JIS-250	10	JIS-250	3.94 (100)	3.78 (96.0)	23.8 (605)	16.6 (422)	8.46 (215)	9.49 (241)	12	M12	(12)	62 (28.1)
TPV-IQA-1000-JIS-250-HA	10	JIS-250	3.94 (100)	3.78 (96.0)	23.8 (605)	16.6 (422)	8.46 (215)	9.49 (241)	12	M12	(12)	62 (28.1)
TPV-IQA-1200-JIS-300	12	JIS-300	4.72 (120)	4.06 (103)	30.2 (767)	22.0 (559)	10.6 (269)	12.8 (325)	12	M12	(18)	123 (55.8)
TPV-IQA-1200-JIS-300-HA	12	JIS-300	4.72 (120)	4.06 (103)	30.2 (767)	22.0 (559)	10.6 (269)	12.8 (325)	12	M12	(18)	123 (55.8)
TPV-IQA-1400-JIS-350	14	JIS-350	4.92 (125)	4.06 (103)	32.3 (820)	22.0 (559)	12.2 (310)	12.8 (325)	12	M12	(18)	143 (64.9)
TPV-IQA-1400-JIS-350-HA	14	JIS-350	4.92 (125)	4.06 (103)	32.3 (820)	22.0 (559)	12.2 (310)	12.8 (325)	12	M12	(18)	143 (64.9)

NOTE: IQA can be replaced with IQD, IQD2, IQE and IQR N=Number bolt holes M=Thread bolt diameter L=Thread depth

#### SPECIFICATIONS

##### General

###### Controller Options:

- IQA: Analog / TTL / RS232 interface
- IQD: DeviceNet / RS232 interface
- IQD2: DeviceNet / RS232 interface, no power via DN connector
- IQE: Ethernet / RS232 interface
- IQR: RS485 interface

##### Construction

###### Wetted materials:

- Body: Cast aluminum A356.0 (machined billet aluminum 6061-T6 in 8" size)
- Valve plate: Aluminum 6061-T6
- Other parts: A6061, A7075, SS304, SS316, Inconel X-750 and Viton
- Seals: Viton standard. Kalrez, Chemraz, Perlast and other materials available
- Body and plate surface treatment: Bare aluminum standard, hard Type III anodizing optional

##### Operation

- IQ controller power input: +24 VDC, +/- 10%
- Differential pressure: With valve fully sealed: 1.1 bar maximum cross the valve plate  
While opening the valve: 27 mbar (DN160 & DN200); 32 mbar (DN250); 29 mbar (DN320 & DN350)
- Operating pressure:  $3.8 \times 10^{-8}$  to 1 bar
- Heating or bakeout capabilities: Body: 150°C maximum with optional heater kits  
Actuator: 60°C maximum
- Ambient operating conditions: 0 - 45°C @ 0 - 95% humidity, non-condensing
- Leak rate:  $1 \times 10^{-9}$  mbar-liter sec<sup>-1</sup> He Viton seals across seat and to atmosphere ( $1 \times 10^{-6}$  mbar-liter sec<sup>-1</sup> He for hard anodized body or gate). Derated with some perfluoro-elastomers.

##### Inherent performance

- Maximum speed: Open to closed in 2 to 5 seconds, depending on size
- Control resolution: 16 to 40 million steps, open to closed, depending on size

##### Pressure control performance

(when used with an Intellisys controller)

- Accuracy: The greater of 5mV or 0.25% of reading
- Repeatability: Within 2.5mV or 0.12% of reading
- Control range: 0.5% - 100% of the vacuum gauge range

##### Reliability (99% confidence level, in clean environment)

- O-ring cycle life: 1 million cycles open to control closed. 200K cycles open to fully closed.
- MTBF: >10,000 hrs. continuous operation

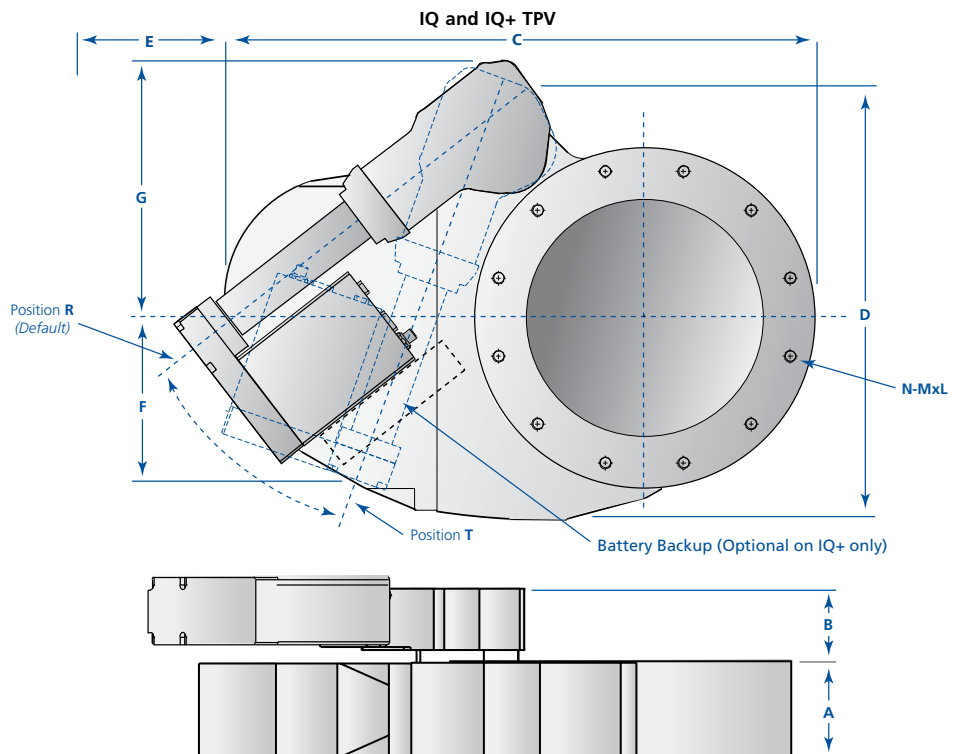
##### Approvals

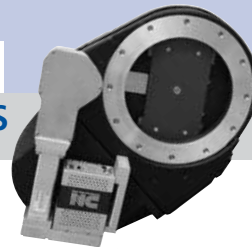
CE (EMC and machinery directives)

##### Options

- Body & seal material, drive & heater (see options page this section)

All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.





### IQ+ Throttling Pendulum Valves



Nor-Cal's new IQ+ controller is available on the complete line of Throttling Pendulum Valves (TPV) turning what is very good performance into best-in-class

process control. The IQ+ controller is an on-valve integral control & drive unit that is fully RoHS compliant with 100% lead-free circuit board content. User interfaces include an ODVA certified DeviceNet protocol and physical layer, as well as standard RS-232 communications. Gauge power capabilities have been upgraded to a full 1500 mA at +/- 15 VDC in order to power two heated CDG's directly from the IQ+ unit. In addition, a battery back-up feature is available that can be used to bring the valve to a fail-closed or fail-open safe position in the event of system power loss. Last, the IQ+ adaptive pressure control algorithm has been significantly improved to better deal with difficult control situations, in particular at conditions that typically occur at low pressures and low flows.

For larger system pressure control requiring multiple pumps and forelines, such as on flat panel, industrial coating or photovoltaic tools, it is easily possible to gang up to ten valves together. Multi-valve Master/ Slave system control like this is facilitated via the Nor-Cal-Net inter-valve communications system. One IQ+ operated valve serves as the master with communications to the host tool, gauge input and has direct command over the control position of the remaining slave valves. The IQ+ controlled pendulum valves are the right answer to any new or challenging pressure control application.

### SPECIFICATIONS

#### General

##### Controller Options:

- QPD:** DeviceNet/RS232 interface
  - QPDB:** DeviceNet/RS232 interface, with battery backup
  - QPDG:** DeviceNet/RS232 interface, with gauge power
  - QPDBG:** DeviceNet/RS232 interface, with battery backup and gauge power
- Contact the factory for other interfaces, such as Analog, TTL, RS-485 and Ethernet.

#### Construction

##### Wetted materials

- Body:** Cast aluminum A356.0 (machined billet aluminum 6061-T6 in 8 inch size)
- Valve plate:** Aluminum 6061-T6
- Other parts:** A6061, A7075, SS304, SS316, Inconel X-750 and Viton
- Seals:** Viton standard. Kalrez, Chemraz, Perlast and other materials available
- Body and plate surface treatment:** Bare aluminum standard, hard Type III anodizing optional

#### Operation

- Power input:** +24 VDC
- Differential pressure:** With valve fully sealed: 1.1 bar maximum across the valve plate
- While opening the valve:** 27 mbar (DN160 and DN200) 32 mbar (DN250) 39 mbar (DN320 & DN350)
- Operating pressure:**  $3.8 \times 10^{-8}$  to 1 bar
- Heating or bakeout capabilities:** Body: 150°C maximum with optional heater kits Actuator: 60°C maximum
- Ambient operating conditions:** 0 - 45°C @ 0 - 95% humidity, non-condensing
- Leak rate:**  $1 \times 10^{-9}$  mbar-liter/sec He with Viton seals across seat and to atmosphere ( $1 \times 10^{-6}$  mbar-liter/sec He for hard anodized body or gate)
- Derated with some perfluoro-elastomers

#### Inherent performance

- Maximum speed:** Open to closed in 2 to 5 seconds, depending on size
- Control resolution:** 64 to 160 million steps, open to closed, depending on size

#### Pressure control performance

(when used with an Intellisys controller)

- Accuracy:** The greater of 5 mV or 0.25% of reading
- Repeatability:** Within 2.5 mV or 0.12% of reading
- Control range:** 0.5% - 100% of the vacuum gauge range

#### Reliability

(99% confidence level, in clean environment)

- O-ring cycle life:** 1 million cycles open to control closed. 200K cycles open to fully closed.
- MTBF:** >10,000 hrs. continuous operation

#### Approvals

- RoHS compliant
- ODVA certified DeviceNet
- CE (EMC and machinery directives)

#### Options

Body & seal material, drive & heater (see options page this section)

MODEL NUMBER	NOM. ID	FLANGE TYPE	A	B	C	D	E	F	N	M	L	WEIGHT
TPV-QPD-ISO-160	6	ISO-160	3.15 (80.0)	3.78 (96.0)	15.9 (403)	12.2 (310)	5.31 (135)	8.50 (216)	8	M10	(10)	40 (18.0)
TPV-QPD-ISO-160-HA	6	ISO-160	3.15 (80.0)	3.78 (96.0)	15.9 (403)	12.2 (310)	5.31 (135)	8.50 (216)	8	M10	(10)	40 (18.0)
TPV-QPD-ISO-200-MB	8	ISO-200	3.46 (87.9)	3.78 (96.0)	19.9 (506)	14.4 (266)	6.50 (165)	9.29 (236)	12	M10	(10)	49 (22.2)
TPV-QPD-ISO-200-HM	8	ISO-200	3.46 (87.9)	3.78 (96.0)	19.9 (506)	14.4 (266)	6.50 (165)	9.29 (236)	12	M10	(10)	49 (22.2)
TPV-QPD-ISO-250	10	ISO-250	3.94 (100)	3.78 (96.0)	23.8 (605)	16.6 (422)	8.46 (215)	9.49 (241)	12	M10	(10)	62 (28.1)
TPV-QPD-ISO-250-HA	10	ISO-250	3.94 (100)	3.78 (96.0)	23.8 (605)	16.6 (422)	8.46 (215)	9.49 (241)	12	M10	(10)	62 (28.1)
TPV-QPD-ISO-320	12	ISO-320	4.72 (120)	4.06 (103)	30.2 (767)	22.0 (559)	10.6 (269)	12.8 (325)	12	M12	(18)	123 (55.8)
TPV-QPD-ISO-320-HA	12	ISO-320	4.72 (120)	4.06 (103)	30.2 (767)	22.0 (559)	10.6 (269)	12.8 (325)	12	M12	(18)	123 (55.8)
TPV-QPD-JFF-150	6	JIS-150	3.15 (80.0)	3.78 (96.0)	15.9 (403)	12.2 (310)	5.31 (135)	8.50 (216)	8	M10	(10)	40 (18.0)
TPV-QPD-JFF-150-HA	6	JIS-150	3.15 (80.0)	3.78 (96.0)	15.9 (403)	12.2 (310)	5.31 (135)	8.50 (216)	8	M10	(10)	40 (18.0)
TPV-QPD-JFF-200-MB	8	JIS-200	3.46 (87.9)	3.78 (96.0)	19.9 (506)	14.4 (266)	6.50 (165)	9.29 (236)	8	M12	(12)	49 (22.2)
TPV-QPD-JFF-200-HM	8	JIS-200	3.46 (87.9)	3.78 (96.0)	19.9 (506)	14.4 (266)	6.50 (165)	9.29 (236)	8	M12	(12)	49 (22.2)
TPV-QPD-JFF-250	10	JIS-250	3.94 (100)	3.78 (96.0)	23.8 (605)	16.6 (422)	8.46 (215)	9.49 (241)	12	M12	(12)	62 (28.1)
TPV-QPD-JFF-250-HA	10	JIS-250	3.94 (100)	3.78 (96.0)	23.8 (605)	16.6 (422)	8.46 (215)	9.49 (241)	12	M12	(12)	62 (28.1)
TPV-QPD-JFF-300	12	JIS-300	4.72 (120)	4.06 (103)	30.2 (767)	22.0 (559)	10.6 (269)	12.8 (325)	12	M12	(18)	123 (55.8)
TPV-QPD-JFF-300-HA	12	JIS-300	4.72 (120)	4.06 (103)	30.2 (767)	22.0 (559)	10.6 (269)	12.8 (325)	12	M12	(18)	123 (55.8)
TPV-QPD-JFF-350	14	JIS-350	4.92 (125)	4.06 (103)	32.3 (820)	22.0 (559)	12.2 (310)	12.8 (325)	12	M12	(18)	143 (64.9)
TPV-QPD-JFF-350-HA	14	JIS-350	4.92 (125)	4.06 (103)	32.3 (820)	22.0 (559)	12.2 (310)	12.8 (325)	12	M12	(18)	143 (64.9)

NOTE: QPD can be replaced with QPDB, QPDG and QPDBG N=Number bolt holes M=Thread bolt diameter L=Thread depth

### JIS Flange O-Rings

SIZE	O-RINGS
150	OR-JIS-150
200	OR-JIS-200
250	OR-JIS-250
300	OR-JIS-300
350	OR-JIS-350







# Downstream Pressure Control

## Throttling SoftShut Gate Valves

### The Stainless Steel Alternative to Aluminum Pendulum Valves

Throttling SoftShut gate valves offer the equipment manufacturer a stainless steel material alternative to the Nor-Cal line of aluminum pendulum valves, without compromising on pressure control performance and particle generation. Like the Intellisys pendulum valves, the TSS valves use one common actuation method to move the gate across the valve bore all the way to the sealed position. A "lock over center" feature means that all throttling SoftShut valves remain fully sealed even when power is removed. Furthermore, the design of the throttling gate mechanism permits pressure control over an expanded range. The result is precise

pressure control over the entire spectrum of flow rates and pressures thereby eliminating the need for bypass lines containing separate pressure control valves.

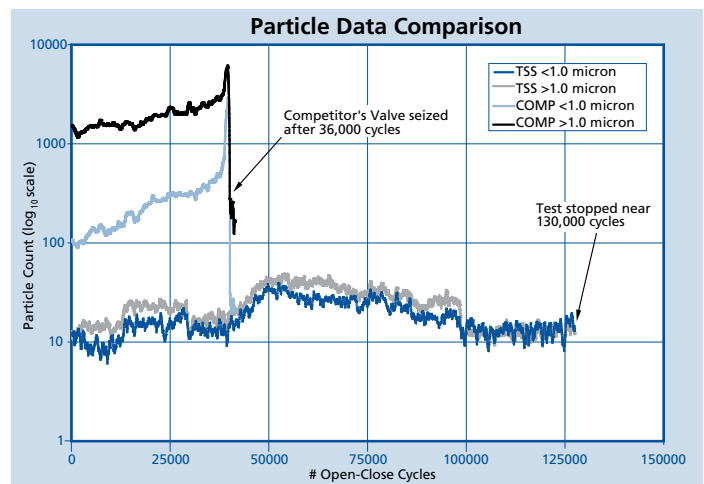
The Intellisys closed loop motor control monitors and controls the exact position of the valve's gate mechanism. When combined with an Intellisys adaptive pressure controller, the TSS gate valves provide over 6 million steps of positional resolution to position the gate exactly where it needs to be to control pressure or to seal. In addition, the Nor-Cal control system's speed of actuation is unequalled in providing optimal transient response,

pressure set-point stability and overall process improvement. The APC's adaptive algorithm outperforms "learn modes" by optimizing phase and gain settings in real time during varying chamber pressure and flow conditions.

In-situ serviceability of the valve is made possible through the incorporation of a removable rear plate cover. The entire gate assembly and sealing O-ring can be accessed without removing the valve from the system, making regular inspections, cleanings and O-ring replacements quick and easy.

### Intellisys SoftShut valves offer the lowest particle generation

Isolation and throttling gate valves have historically received questionable ratings in the area of particulate generation. This is attributable to the relatively large number of moving parts of the gate slide- and actuation mechanism, and especially when those parts are in metal-to-metal contact with each other. Overcoming particle generation concerns was a paramount goal in the design effort of the SoftShut valve. In short, the number of moving parts and metal-to-metal surface contact were both minimized. And when moving parts had to be used, they were designed in either entirely out of the gas process stream or shielded from that stream as much as possible. The results of this design focus speak for themselves, as is evident in the adjacent chart. A SoftShut valve and an equivalent competitive gate valve of the same size were tested under identical circumstances, in which they were cycled open-to-closed continuously while a particle count was recorded every 10 cycles.



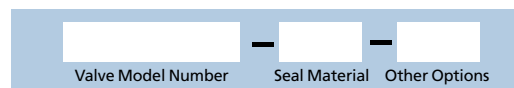
The particle measurement was taken in the volume upstream of the test valve in order to simulate what one might expect to find in the process chamber. As the data indicates, the competitive valve generated one to two orders of magnitude more particles throughout

the test and it failed completely after only 36,000 cycles. The SoftShut valve, on the other hand, showed a near constant particle generation trend until the test was stopped at a cycle count of 130,000.

### TSS Part Number and Ordering Information

Please use the following part numbering tree to add the appropriate options for a TSS to fit your application.

**Note:** All part number combinations may not be valid. Contact Nor-Cal Products for the latest pricing, availability and other options.



#### Seal Material Options

SEAL MATERIAL	CODE
Viton (Bonded)	Leave blank
Viton (O-ring)	-V
Kalrez 4079	-K79
Kalrez 8085	-K85
Kalrez 8575	-K75
Kalrez 9100	-K91
Chemraz E38	-C38
Dupra 192	-D19
Perlast G74P	-PP7

#### Other Options

OTHER OPTIONS	CODE
Motor actuator position R (default)	Leave blank
Motor actuator position T	T
Pumpout port (NW-16 on 5 through 8 inch size and NW-40 on 10 inch size)	U

**Example:** TSS-IQD2-600-ISO-160-V

6 inch TSS valve with IQD2 controller, ISO-160 flanges and Viton O-ring seals

All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.

# Downstream Pressure Control

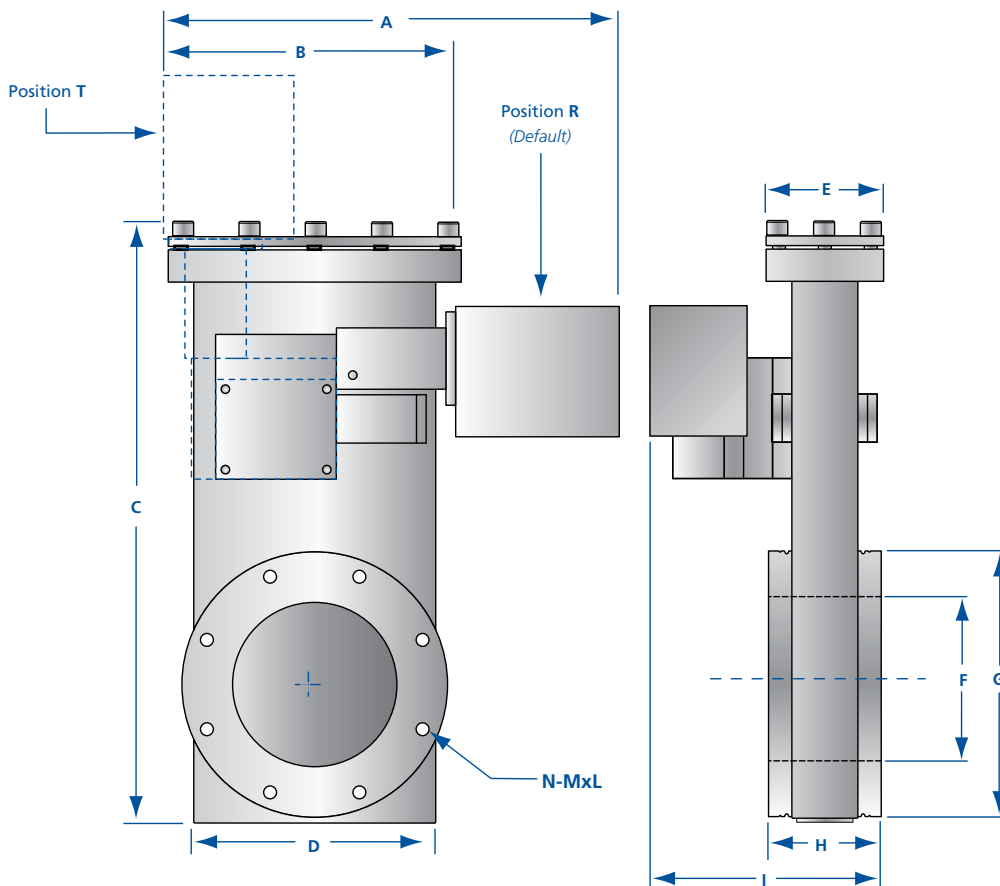
## Throttling SoftShut Gate Valves



### Throttling SoftShut Valves

MODEL NUMBER	NOM. ID	FLANGE TYPE	A	B	C	D	E	F	G	H	I	N	M	L	WT.
TSS-250-ISO-63	2.5	ISO-63	10.2 (260)	5.83 (148)	11.8 (299)	4.37 (111)	2.60 (67.0)	2.76 (70.1)	5.12 (130)	2.76 (70.1)	5.44 (138)	4	M8	(17)	19 (8.6)
TSS-300-ISO-80	3	ISO-80	10.4 (265)	6.30 (160)	12.6 (319)	5.04 (128)	2.68 (68.0)	3.27 (83.0)	5.71 (145)	2.76 (70.1)	5.33 (135)	8	M8	(14)	27 (12.3)
TSS-400-ISO-100	4	ISO-100	11.1 (281)	7.17 (182)	15.0 (381)	5.91 (150)	2.90 (73.0)	4.02 (102)	6.50 (165)	2.76 (70.1)	5.61 (143)	8	M8	(15)	36 (16.3)
TSS-600-ISO-160	6	ISO-160	12.5 (318)	10.1 (256)	19.3 (489)	8.78 (223)	3.10 (78.0)	6.02 (153)	8.86 (225)	3.15 (80.0)	6.04 (153)	8	M10	(16)	61 (27.7)
TSS-800-ISO-200	8	ISO-200	13.7 (349)	12.4 (315)	23.4 (594)	11.1 (283)	3.20 (82.0)	8.39 (213)	11.2 (285)	3.15 (80.0)	6.41 (163)	12	M10	(15)	87 (39.5)
TSS-1000-ISO-250	10	ISO-250	14.7 (374)	14.4 (366)	27.5 (699)	13.1 (333)	3.50 (90.0)	10.3 (261)	13.2 (335)	3.94 (100)	6.96 (177)	12	M10	(21)	114 (51.8)
TSS-250-CF-450	2.5	CF-450	10.2 (260)	5.80 (148)	11.8 (299)	4.37 (111)	2.60 (67.0)	2.76 (70.1)	4.45 (113)	2.76 (70.1)	5.44 (138)	8	M8	(17)	19 (8.6)
TSS-400-CF-600	4	CF-600	11.1 (281)	7.20 (182)	15.0 (381)	5.91 (150)	2.90 (73.0)	4.00 (102)	5.95 (151)	2.76 (70.1)	5.61 (143)	16	M8	(15)	36 (16.3)
TSS-600-CF-800	6	CF-800	12.5 (318)	10.1 (256)	19.3 (489)	8.78 (223)	3.10 (78.0)	6.00 (153)	8.00 (203)	3.15 (80.0)	6.04 (153)	20	M8	(17)	61 (27.7)
TSS-800-CF-1000	8	CF-1000	13.7 (349)	12.4 (315)	23.4 (594)	11.1 (283)	3.20 (82.0)	7.99 (203)	10.7 (273)	3.15 (80.0)	6.41 (163)	24	M8	(15)	87 (39.5)
TSS-1000-CF-1200	10	CF-1200	14.7 (374)	14.4 (366)	27.5 (699)	13.1 (333)	3.50 (90.0)	10.0 (254)	12.0 (305)	3.94 (100)	6.96 (177)	32	M8	(20)	114 (51.8)

N=Number bolt holes M=Thread bolt diameter L=Thread depth



### SPECIFICATIONS

#### General

**Compatible controllers:** 700-series APC buried box controllers

**Valve position:** Visual indicator

#### Construction

**Wetted materials:** 304 stainless steel, phosphor-bronze guide pins and Viton seals

**Seals:** Viton standard. Kalrez, Chemraz and Perlast and other materials available

#### Operation

**Power input:** Supplied by APC controller. Refer to APC section.

**Differential pressure:**  
With valve fully sealed: 2.1 bar max, all sizes  
(except DN250 at 1.3 bar max)

**While opening the valve:** 1 bar max (DN63, DN80, DN100 and DN160)  
307 mbar max (DN200 and DN250)

**Operating pressure:**  $1.0 \times 10^{-8}$  to 1 bar

**Heating or bakeout capabilities:**

Body: 150°C maximum with heater kits

Actuator: 60°C maximum

**Ambient operating conditions:**

0 - 60°C @ 0 - 95% humidity, noncondensing

**Leak rate:**  $1 \times 10^{-9}$  mbar-liter/sec He across seat and to atmosphere

#### Inherent performance

**Maximum speed:** Open to closed in 1 to 3 seconds, depending on size

**Control resolution:** 12 to 48 million steps, depending on valve size

**Pressure control performance**  
(when used with an Intellisys controller)

**Accuracy:** The greater of 5 mV or 0.25% of reading

**Repeatability:** Within 2.5 mV or 0.12% of reading

**Control range:** 0.5% - 100% of the vacuum gauge range

#### Reliability

(99% confidence level, in clean environment)

**O-ring cycle life:** 1 million cycles open to control closed. 200K cycles open to fully closed.

**MTBF:** >10,000 hrs. continuous operation

#### Approvals

CE (EMC and Low Voltage Directives)

All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.

# Downstream Pressure Control IQ Throttling SoftShut Gate Valves



## IQ Throttling SoftShut Valves

MODEL NUMBER	ID	FLANGE TYPE	A	B	C	D	E	F	G	H	I	N	M	L	WT.
TSS-IQA-250-ISO-63	2.5	ISO-63	11.7 (297)	5.83 (148)	11.8 (299)	4.37 (111)	2.60 (67.0)	2.76 (70.1)	5.12 (130)	2.76 (70.1)	5.61 (143)	4	M8	(17)	19 (8.6)
TSS-IQA-300-ISO-80	3	ISO-80	12.9 (328)	6.30 (160)	12.6 (319)	5.04 (128)	2.68 (68.0)	3.27 (83.0)	5.71 (145)	2.76 (70.1)	5.51 (140)	8	M8	(14)	27 (12.3)
TSS-IQA-400-ISO-100	4	ISO-100	12.6 (319)	7.17 (182)	15.0 (381)	5.91 (150)	2.90 (73.0)	4.02 (102)	6.50 (165)	2.76 (70.1)	5.79 (147)	8	M8	(15)	36 (16.3)
TSS-IQA-600-ISO-160	6	ISO-160	14.0 (356)	10.1 (256)	19.3 (489)	8.78 (223)	3.10 (78.0)	6.02 (153)	8.86 (225)	3.15 (80.0)	6.23 (158)	8	M10	(16)	61 (27.7)
TSS-IQA-800-ISO-200	8	ISO-200	15.3 (387)	12.4 (315)	23.4 (594)	11.1 (283)	3.20 (82.0)	8.39 (213)	11.2 (285)	3.15 (80.0)	6.56 (167)	12	M10	(15)	87 (39.5)
TSS-IQA-1000-ISO-250	10	ISO-250	16.3 (413)	14.4 (366)	27.5 (699)	13.1 (333)	3.50 (90.0)	10.3 (261)	13.2 (335)	3.94 (100)	7.13 (181)	12	M10	(21)	114 (51.8)
TSS-IQA-250-CF-450	2.5	CF-450	11.7 (297)	5.80 (148)	11.8 (299)	4.37 (111)	2.60 (67.0)	2.76 (70.1)	4.45 (113)	2.76 (70.1)	5.61 (143)	8	M8	(17)	19 (8.6)
TSS-IQA-400-CF-600	4	CF-600	12.8 (319)	7.20 (182)	15.0 (381)	5.91 (150)	2.90 (73.0)	4.00 (102)	5.95 (151)	2.76 (70.1)	5.79 (147)	16	M8	(15)	36 (16.3)
TSS-IQA-600-CF-800	6	CF-800	14.0 (356)	10.1 (256)	19.3 (489)	8.78 (223)	3.10 (78.0)	6.00 (153)	8.00 (203)	3.15 (80.0)	6.23 (158)	20	M8	(17)	61 (27.7)
TSS-IQA-800-CF-1000	8	CF-1000	15.3 (387)	12.4 (315)	23.4 (594)	11.1 (283)	3.20 (82.0)	7.99 (203)	10.7 (273)	3.15 (80.0)	6.56 (167)	24	M8	(15)	87 (39.5)
TSS-IQA-1000-CF-1200	10	CF-1200	16.3 (413)	14.4 (366)	27.5 (699)	13.1 (333)	3.50 (90.0)	10.0 (254)	12.0 (305)	3.94 (100)	6.13 (158)	32	M8	(20)	114 (51.8)

### SPECIFICATIONS

#### General operation

##### Controller Options :

- IQA: Analog / TTL / RS232 interface
- IQD: DeviceNet / RS232 interface
- IQD2: DeviceNet / RS232 interface, no power via DN connector
- IQE: Ethernet / RS232 interface
- IQR: RS485 interface

##### Valve position: Visual indicator

#### Construction

- Wetted materials:** 304 stainless steel, phosphor-bronze guide pins and Viton seals
- Seals:** Viton standard. Kalrez, Chemraz and Perlast and other materials available.

#### Operation

**IQ controller power input:** +24 VDC @ 3A, +/- 10%

##### Differential pressure:

With valve fully sealed: 2.1 bar max, all sizes (except DN250 at 1.3 bar max)

While opening the valve: 1 bar max (DN63, DN80, DN100 & DN160)

307 mbar max (DN200 & DN250)

##### Operating pressure:

$1.0 \times 10^{-8}$  to 1 bar

##### Heating or bakeout capabilities:

Body: 150°C max with optional heater kits

Actuator: 60°C maximum

##### Ambient operating conditions:

0 - 45°C @ 0 - 95% humidity,

non-condensing

##### Leak rate:

$1 \times 10^{-9}$  mbar-liter sec<sup>-1</sup> He across seat and to atmosphere.

#### Inherent performance

**Maximum speed:** Open to closed in 1 to 3 seconds, depending on size

**Control resolution:** 12 to 48 million steps, depending on valve size

#### Pressure control performance

(99% confidence level, in clean environment)

**Accuracy:** The greater of 5 mV or 0.25% of reading

**Repeatability:** Within 2.5 mV or 0.12% of reading

**Control range:** 0.5% - 100% of the vacuum gauge range

##### Reliability

(99% confidence level, in clean environment)

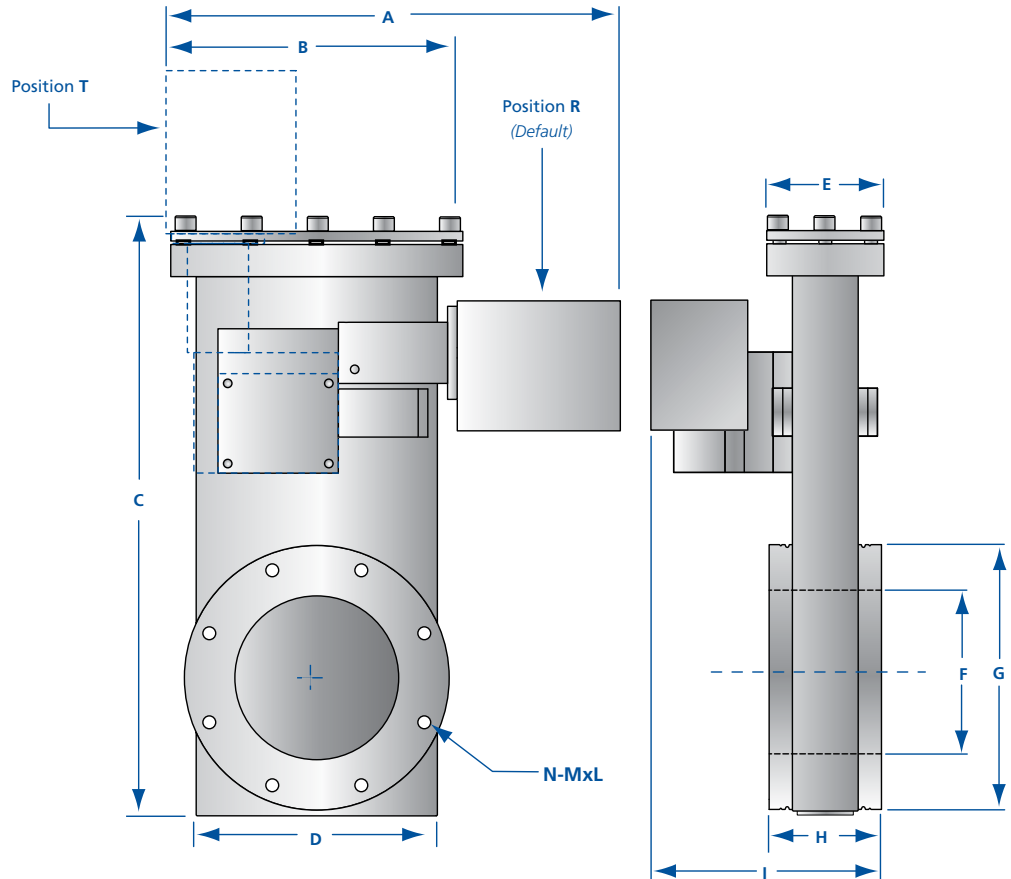
**MTBF:** >10,000 hours continuous operation

#### Approvals

CE (EMC and Low Voltage Directives)

Note: IQA can be replaced with IQD, IQD2, IQE and IQR

N=Number bolt holes M=Thread bolt diameter L=Thread depth



All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.

# Downstream Pressure Control Adaptive Pressure Controllers



## Advanced Control System Performance

The Intellisys Adaptive Pressure Controller (APC) provides advanced control system performance by combining closed loop motor control with adaptive pressure control. APCs are available in two basic configurations – the buried box style and the new on-valve IQ-series. The patented closed loop motor control technology, found at the core of the Intellisys controller technology, results in 250 times

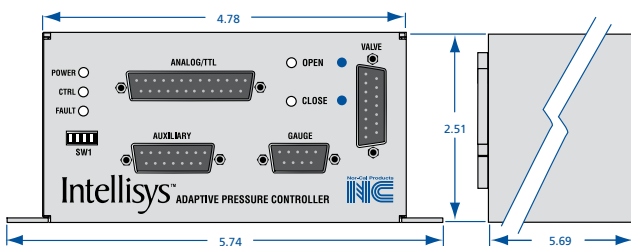
greater motor positional resolution at 10-20 times the speed compared to other existing technologies. The adaptive pressure control algorithm eliminates pressure over- and under-shoots as well as ringing during process step transitions.

APC controllers are available for all of Nor-Cal's Intellisys control valves and

drives, and can be supplied with auto-ranging AC, or low voltage DC power supplies. Depending on the model and intended valve operation, users can choose from additional optional features such as battery back-up, local and remote displays and a range of communication modes including Analog/TTL, RS-232 and RS-485 serial, as well as DeviceNet.

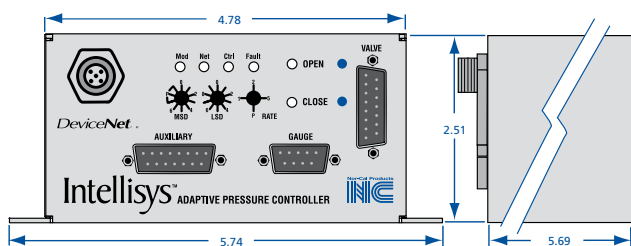
## Low Voltage Controllers

MODEL NUMBER	FOR USE WITH	BATTERY BACK-UP	WEIGHT
APC-100L-A	Geared Butterfly Valves (TBV-G-xxx)	NO	1.6 (0.7)
APC-100L-AB	Geared Butterfly Valves (TBV-G-xxx)	YES	2.5 (1.1)
APC-200L-A	Direct Drive Butterfly Valves (TBV-D-xxx)	NO	1.6 (0.7)
APC-200L-AB	Direct Drive Butterfly Valves (TBV-D-xxx)	YES	2.5 (1.1)
APC-300L-A	Sealing Butterfly Valves (TBVS-G-xxx)	NO	1.6 (0.7)
APC-300L-AB	Sealing Butterfly Valves (TBVS-G-xxx)	YES	2.5 (1.1)
APC-700L-A	SoftShut Linear Gate Valves (TSS-xxx)	NO	1.6 (0.7)
APC-700L-AB	SoftShut Linear Gate Valves (TSS-xxx)	YES	2.5 (1.1)
APC-800L-A	Pendulum Valves (TPV-xxx)	NO	1.6 (0.7)
APC-800L-AB	Pendulum Valves (TPV-xxx)	YES	2.5 (1.1)



## Low Voltage Controllers with DeviceNet

MODEL NUMBER	FOR USE WITH	BATTERY BACK-UP	WEIGHT
APC-100L-D	Geared Butterfly Valves (TBV-G-xxx)	NO	1.6 (0.7)
APC-100L-DB	Geared Butterfly Valves (TBV-G-xxx)	YES	2.5 (1.1)
APC-200L-D	Direct Drive Butterfly Valves (TBV-D-xxx)	NO	1.6 (0.7)
APC-200L-DB	Direct Drive Butterfly Valves (TBV-D-xxx)	YES	2.5 (1.1)
APC-300L-D	Sealing Butterfly Valves (TBVS-G-xxx)	NO	1.6 (0.7)
APC-300L-DB	Sealing Butterfly Valves (TBVS-G-xxx)	YES	2.5 (1.1)
APC-700L-D	SoftShut Linear Gate Valves (TSS-xxx)	NO	1.6 (0.7)
APC-700L-DB	SoftShut Linear Gate Valves (TSS-xxx)	YES	2.5 (1.1)
APC-800L-D	Pendulum Valves (TPV-xxx)	NO	1.6 (0.7)
APC-800L-DB	Pendulum Valves (TPV-xxx)	YES	2.5 (1.1)



## SPECIFICATIONS

### General

#### Construction material

Chassis: 5052-aluminum

**Power input:** +24 VDC +/-10%, 100W

max (600W nonnominal) power input

**Battery back-up:** Optional

**Ambient operating conditions:** 0 - 45°C @ 0 - 95% humidity, non-condensing

### System interface

**Serial communication:** RS-232 or RS-485 on DB-15 female connector..

**Analog/TTL communication:** Four (4) analog I/O and seven (7) TTL I/O on DB-25 female connector

**DeviceNet communication:** Micro-style 5-pin male connector

**Analog setpoint input:** 0-10 or 0-5 VDC linearly proportional to pressure or valve position

**Pressure output:** 0-10 VDC analog output proportional to pressure, one for each vacuum gauge attached

**Valve position output:** 0-10 VDC or 0-5 VDC analog output proportional to valve position

### Device interface

**Gauge connection:** Differential analog signal input with ±15 VDC power output to one or two gauges

**Valve connection:** DB-15 female connector provides power and transmits position information required to operate the high performance valve

### User Interface

**Switches:** Valve open & close, and multi-position rotary switches for communications settings

**Indicating LED's** Power, Fault, Control, Valve open and closed, DeviceNet: Mod and Net

### Pressure Control Performance

**Accuracy:** The greater of 5 mV or 0.25% of reading

**Repeatability:** Within 2.5 mV or 0.12% of reading

**Control range:** 0.5% - 100% of the vacuum gauge range

### Reliability

(99% confidence level, in clean environment)

**MTBF:** >50,000 hours continuous operation

### Approvals

CE (EMC and Low Voltage Directives)

NRTL (United States)

SCC (Canada)

EU Directives (Europe)

All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.



# Downstream Pressure Control

## Adaptive Pressure Controllers



### SPECIFICATIONS

#### Construction

##### Construction material

Chassis: 5052-aluminum

**Power input:** 100-240 VAC, 50-60Hz, 100W max (60W nominal) power input.

**Battery Back-up:** N/A

**Ambient operating conditions:** 0-45°C @ 0-95% humidity, non-condensing

#### System interface

**Serial communication:** RS-232 or RS-485 on DB-9 female connector.

**Analog / TTL communication:** Six (6) analog I/O and thirteen (13) TTL I/O on DB-37 female connector

**DeviceNet communication:** N/A

**Analog setpoint input:** 0-10 or 0-5 VDC linearly proportional to pressure or valve position

**Pressure output:** 0-10 VDC analog output proportional to pressure, one for each vacuum gauge attached

**Valve position output:** 0-10 VDC or 0-5 VDC analog output proportional to valve position

#### Device interface

**Gauge connection:** Differential analog signal input with  $\pm 15$  VDC power output to one or two gauges

**Valve connection:** DB-15 female connector provides power and transmits position information required to operate the high performance valve

#### User interface

**Switches:** Power ON/OFF, Valve OPEN / CLOSE

**Indicating LEDs:** Power, Fault, Control, Valve open and closed

**Graphic display:** N/A

(Touch screen LCD on listed model)

#### Pressure control performance

**Accuracy:** The greater of 5 mV or 0.25% of reading

**Repeatability:** Within 2.5 mV or 0.12% of reading

**Control range:** 0.5% - 100% of the vacuum gauge range

#### Reliability

(99% confidence level, in clean environment)

**MTBF:** >50,000 hours continuous operation

#### Approvals

CE (EMC and Low Voltage Directives)

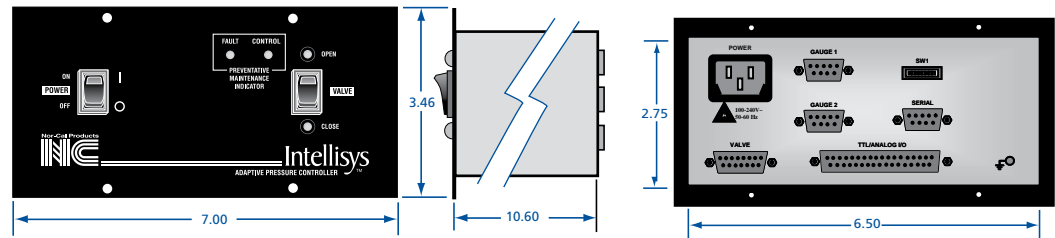
NRTL (United States)

SCC (Canada)

EU Directives (Europe)

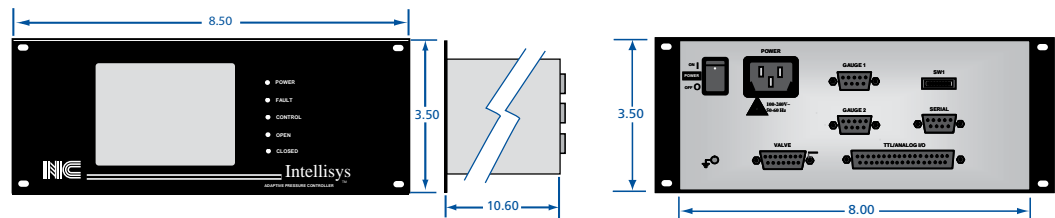
### A/C Adaptive Pressure Controllers

MODEL NUMBER	FOR USE WITH	BATTERY BACK-UP	WEIGHT
APC-100-A	Geared Butterfly Valves (TBV-G-xxx)	NO	3.5 (1.6)
APC-200-A	Direct Drive Butterfly Valves (TBV-D-xxx)	NO	3.5 (1.6)
APC-300-A	Sealing Butterfly Valves (TBVS-G-xxx)	NO	3.5 (1.6)
APC-700-A	SoftShut Linear Gate Valves (TSS-xxx)	NO	3.5 (1.6)
APC-800-A	Pendulum Valves (TPV-xxx)	NO	3.5 (1.6)



### A/C Adaptive Pressure Controllers with Touch Screen

MODEL NUMBER	FOR USE WITH	BATTERY BACK-UP	WEIGHT
APC-150-A	Geared Butterfly Valves (TBV-G-xxx)	NO	4.2 (1.9)
APC-250-A	Direct Drive Butterfly Valves (TBV-D-xxx)	NO	4.2 (1.9)
APC-350-A	Sealing Butterfly Valves (TBVS-G-xxx)	NO	4.2 (1.9)
APC-750-A	SoftShut Linear Gate Valves (TSS-xxx)	NO	4.2 (1.9)
APC-850-A	Pendulum Valves (TPV-xxx)	NO	4.2 (1.9)



All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.

# Downstream Pressure Control

## Capacitance Diaphragm Gauges

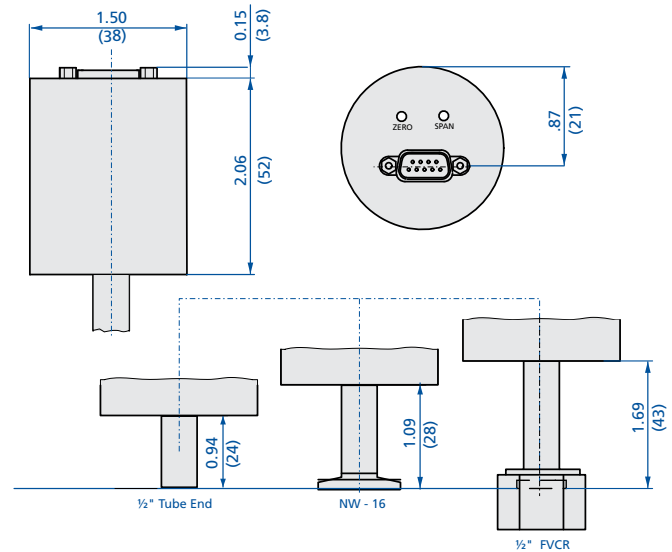


The **CMG-025-series Capacitance Diaphragm Gauge** line of economical miniature manometers is designed for stable performance in manufacturing tool environments. The corrosion resistant Inconel sensor provides excellent zero stability with a long life expectancy of several million pressure cycles, including atmospheric bursts. A robust mechanical design and digital electronics improve EMC compatibility, long term stability and temperature compensation. The **CMG-025-series** sets new standards for fast stability after power on and fast recovery from atmospheric pressure exposure.

### Advantages

- Full scale ranges from 10 Torr to 1000 Torr
- Fast stability after power on
- Fast recovery from atmospheric pressure
- Corrosion resistant Inconel sensor
- Excellent long term signal stability
- Temperature compensated
- Wide range power supply 12-30 VDC

MODEL NUMBER	F.S. RANGE	TUBE FITTING	HEATED
CMG-025-T11	10 Torr	1/2" Tube End	NO
CMG-025-T11-NW1	10 Torr	NW-16	NO
CMG-025-T11-VCR	10 Torr	1/2" FVCR	NO
CMG-025-T12	20 Torr	1/2" Tube End	NO
CMG-025-T12-NW1	20 Torr	NW-16	NO
CMG-025-T12-VCR	20 Torr	NW-16	NO
CMG-025-T21	100 Torr	1/2" Tube End	NO
CMG-025-T21-NW1	100 Torr	NW-16	NO
CMG-025-T21-VCR	100 Torr	1/2" FVCR	NO
CMG-025-T31	1,000 Torr	1/2" Tube End	NO
CMG-025-T31-NW1	1,000 Torr	NW-16	NO
CMG-025-T31-VCR	1,000 Torr	1/2" FVCR	NO



MEASUREMENT RANGE F.S. (FULL SCALE)	TORR				
	1000	100	20	10	
Accuracy <sup>1)</sup>	% of reading	0.5	0.5	0.5	0.5
Temperature effect on zero	% F.S./°C	0.005	0.005	0.005	0.005
Temperature effect on span	% of reading/°C	0.03	0.03	0.03	0.03
Resolution	% F.S.	0.01	0.01	0.01	0.01
Pressure, max.	psia	45	45	45	45
Response Time <sup>2)</sup>	ms	20	20	20	20
Lowest reading	% F.S.	0.05	0.05	0.1	0.05
Lowest suggested reading	% F.S.	0.05	0.05	0.1	0.05
Lowest suggested control pressure	% F.S.				
Temperature Operation (ambient)	°C	+5 to +50			
Bakeout at flange <sup>3)</sup>	°C	≤110			
Storage	°C	-40 to +65			
Supply voltage	VDC	12 to 32			
Power consumption	W	≤ 0.2			
Output signal (analog)	VDC	0 to +10			
Standards		CE:EMG 89/336/EEC			
Electrical connection		D-sub, 9 pin, male			
Materials exposed to vacuum		INCONEL, SS316			

<sup>1)</sup> Non-linearity, hysteresis, repeatability at 25°C ambient operating temperature without temperature effects after 2 hours operation.  
<sup>2)</sup> Increase 10 to 90% F.S. <sup>3)</sup> 18% Cr, 10% Ni, 3% Mo, 69% Fe

All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.

# Downstream Pressure Control Capacitance Diaphragm Gauges



## Measurements of Superior Accuracy and Repeatability

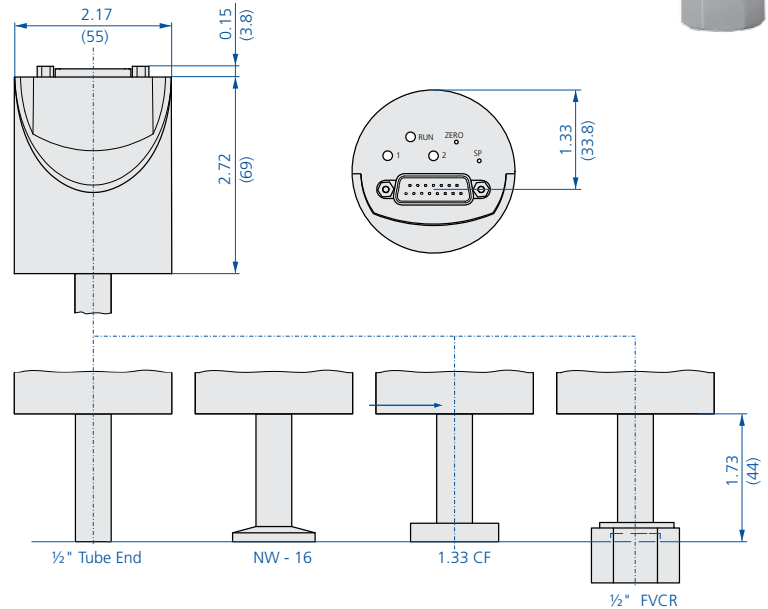
The **CDG025-series Capacitance Diaphragm Gauge** line of highly accurate temperature compensated manometers is designed for stable performance in harsh manufacturing tool environments. Advanced digital electronics improve gauge performance and offer easy handling features such as one push button zero function and set point adjustment. The corrosion resistant ultra pure ceramic sensor provides excellent zero stability with a long life expectancy of several million pressure cycles, including atmospheric bursts. A robust mechanical design and digital electronics improve EMC compatibility, long term stability and temperature compensation. The **CDG025-series** sets new standards for fast stability after power on and fast recovery from atmospheric pressure exposure.

### Advantages

- Full scale ranges from 1 Torr to 1000 Torr
- Fast stability after power on
- Fast recovery from atmospheric pressure
- Corrosion resistant ceramic sensor
- Temperature compensated
- Sensor protected from contamination
- One push button zero function
- Wide range power supply
- Excellent long term signal stability

MODEL NUMBER	F.S. RANGE	TUBE FITTING	HEATED
CDG025-T01	1 Torr	1/2" Tube End	NO
CDG025-T01-CF	1 Torr	1.33" CF	NO
CDG025-T01-NW1	1 Torr	NW-16	NO
CDG025-T01-VCR	1 Torr	1/2" FVCR	NO
CDG025-T02	2 Torr	1/2" Tube End	NO
CDG025-T02-CF	2 Torr	1.33" CF	NO
CDG025-T02-NW1	2 Torr	NW-16	NO
CDG025-T02-VCR	2 Torr	1/2" FVCR	NO
CDG025-T11	10 Torr	1/2" Tube End	NO
CDG025-T11-CF	10 Torr	1.33" CF	NO
CDG025-T11-NW1	10 Torr	NW-16	NO
CDG025-T11-VCR	10 Torr	1/2" FVCR	NO
CDG025-T12	20 Torr	1/2" Tube End	NO
CDG025-T12-CF	20 Torr	1.33" CF	NO
CDG025-T12-NW1	20 Torr	NW-16	NO
CDG025-T12-VCR	20 Torr	1/2" FVCR	NO
CDG025-T21	100 Torr	1/2" Tube End	NO
CDG025-T21-CF	100 Torr	1.33" CF	NO
CDG025-T21-NW1	100 Torr	NW-16	NO
CDG025-T21-VCR	100 Torr	1/2" FVCR	NO
CDG025-T31	1,000 Torr	1/2" Tube End	NO
CDG025-T31-CF	1,000 Torr	1.33" CF	NO
CDG025-T31-NW1	1,000 Torr	NW-16	NO
CDG025-T31-VCR	1,000 Torr	1/2" FVCR	NO

	INTERNAL VOLUME in <sup>3</sup> (cm <sup>3</sup> )	WEIGHT grams
1/2" Tube End	0.22 (3.6)	310
NW - 16	0.22 (3.6)	330
1.33 CF	0.22 (3.6)	350
1/2" FVCR®	0.22 (3.6)	370



MEASUREMENT RANGE F.S. (FULL SCALE)	TORR	MEASUREMENT RANGE			
		1000	100	20/10	2/1
Accuracy <sup>1)</sup>	% of reading	0.2	0.2	0.2	0.2
Temperature effect on zero	% F.S./°C	0.005	0.005	0.005	0.015
on span	% of reading/°C	0.01	0.01	0.01	0.01
Resolution	% F.S.	0.003	0.003	0.003	0.003
Pressure, max.	kPa (absolute)	400	260	260	260
Response Time <sup>2)</sup>	ms	30	30	30	30
Lowest reading	% F.S.			0.01	
Lowest suggested reading	% F.S.			0.05	
Lowest suggested control pressure	% F.S.			0.05	
Temperature Operation (ambient)	°C			+5 to +50	
Bakeout at flange <sup>3)</sup>	°C			≤110	
Storage	°C			-40 to +65	
Supply voltage	VDC			14 to +30	
Power consumption	W			≤1	
Output signal (analog)	VDC			0 to +10	
Degree of protection				IP 30	
Standards		EN 61000-6-2, EN 6100-6-3, EN 61010, UL 61010-1, CSA 22.2 No. 61010-1, RoHS			
Electrical connection		D-sub, 15 pin, male			
Materials exposed to vacuum		Aluminum oxide ceramic (A203), Vacon 70 <sup>4)</sup> , stainless steel (AISI 316L <sup>5)</sup> , AgCuTi hard solder, sealing glass			

<sup>1)</sup> Non-linearity, hysteresis, repeatability at 25°C ambient operating temperature without temperature effects after 2 hours operation.

<sup>2)</sup> Incease 10 to 90% F.S. <sup>3)</sup> Non operation

<sup>4)</sup> 28% Ni, 23% Co, 49% Fe <sup>5)</sup> 18% Cr, 10% Ni, 3% Mo, 69% Fe

# Downstream Pressure Control Capacitance Diaphragm Gauges



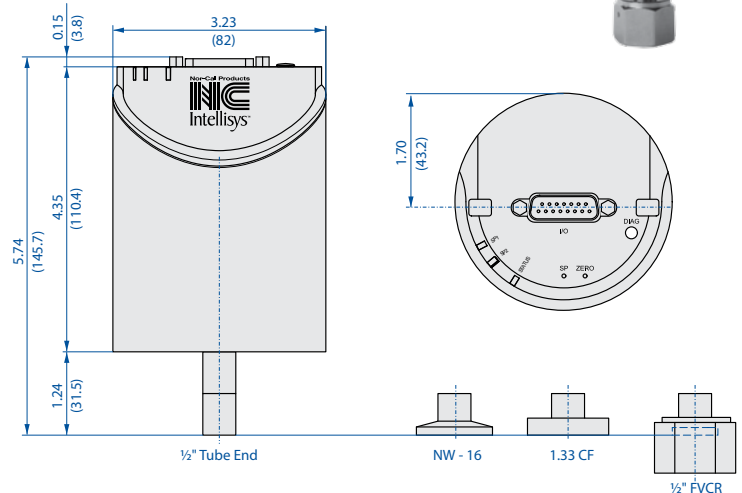
The **CDG045-series** manometers are your best choice for high accurate total pressure measurement and control.

## Advantages

- Lower cost of ownership, 50% faster warm up, energy efficient low power consumption
- Easy integration, wide variety of full scales, flanges and interfaces, standard with two set points
- Easy one push button or remote signal zero command, zero offset adjustable
- Two year warranty, longer life time with advanced heating concept and gauge protection
- No long term recalibration due to excellent signal stability and repeatability, even in harsh plasma applications
- Diagnostic port for quick service and maintenance
- Compliance & standards: CE, EN, UL, SEMI, RoHS

MODEL NUMBER	F.S. RANGE	TUBE FITTING	HEATED
CDG045-M11	100 mTorr	1/2" Tube End	45°C
CDG045-M11-CF	100 mTorr	1.33" CF	45°C
CDG045-M11-NW1	100 mTorr	NW-16	45°C
CDG045-M11-VCR	100 mTorr	1/2" FVCR	45°C
CDG045-T01	1 Torr	1/2" Tube End	45°C
CDG045-T01-CF	1 Torr	1.33" CF	45°C
CDG045-T01-NW1	1 Torr	NW-16	45°C
CDG045-T01-VCR	1 Torr	1/2" FVCR	45°C
CDG045-T02	2 Torr	1/2" Tube End	45°C
CDG045-T02-CF	2 Torr	1.33" CF	45°C
CDG045-T02-NW1	2 Torr	NW-16	45°C
CDG045-T02-VCR	2 Torr	1/2" FVCR	45°C
CDG045-T11	10 Torr	1/2" Tube End	45°C
CDG045-T11-CF	10 Torr	1.33" CF	45°C
CDG045-T11-NW1	10 Torr	NW-16	45°C
CDG045-T11-VCR	10 Torr	1/2" FVCR	45°C
CDG045-T12	20 Torr	1/2" Tube End	45°C
CDG045-T12-CF	20 Torr	1.33" CF	45°C
CDG045-T12-NW1	20 Torr	NW-16	45°C
CDG045-T12-VCR	20 Torr	1/2" FVCR	45°C
CDG045-T21	100 Torr	1/2" Tube End	45°C
CDG045-T21-CF	100 Torr	1.33" CF	45°C
CDG045-T21-NW1	100 Torr	NW-16	45°C
CDG045-T21-VCR	100 Torr	1/2" FVCR	45°C
CDG045-T31	1,000 Torr	1/2" Tube End	45°C
CDG045-T31-CF	1,000 Torr	1.33" CF	45°C
CDG045-T31-NW1	1,000 Torr	NW-16	45°C
CDG045-T31-VCR	1,000 Torr	1/2" FVCR	45°C

	INTERNAL VOLUME in <sup>3</sup> (cm <sup>3</sup> )	WEIGHT grams
1/2" Tube End	0.26 (4.2)	837
NW - 16	0.26 (4.2)	852
1.33 CF	0.26 (4.2)	875
1/2" FVCR®	0.26 (4.2)	897



MEASUREMENT RANGE F.S. (FULL SCALE)	TORR	1000	100	20/10	2/1	0.1
Accuracy <sup>1)</sup>	% of reading			0.15		
Temperature effect on zero on span	% F.S. / °C			0.0025		0.005
	% of reading / °C			0.01		
Pressure, max.	kPa (absolute)	400		260		130
Resolution	% F.S.			0.003		
Lowest reading	% F.S.			0.01		
Lowest suggested reading	% F.S.			0.05		
Lowest suggested control pressure	% F.S.			0.05		
Temperature Operation (ambient)	°C			+10 to +40		
Bakeout at flange	°C			≤110		
Storage	°C			-40 to +65		
Supply voltage				+14 to +30 VDC or ± 15 V (±5%)		
Power consumption During Heat up	W			≤12		
At operating temperature	W			≤8		
Output signal (analog)	VDC			0 to +10		
Response time <sup>2)</sup>	ms			30		130
Degree of protection				IP 40		
Standards		EN 61000-6-2/6-3, EN 61010, UL 61010-1, CSA 22.2 No. 61010-1, SEMI S-2				
Electrical connection		D-sub, 15 pin, male				
Set point Relay Contact Hysteresis	VDC / ADC % F.S.	two set points (SPT, SP2) ≤30 / ≤0.5 1				
Diagnostic port Protocol Reed Set		RS232-C Pressure, status, ID, set points, filter, zero adjust, factory reset, DC offset				
Materials exposed to vacuum		Aluminum oxide ceramic (A203), stainless steel (AISI 316L <sup>3)</sup> , Nickel, sealing glass				

<sup>1)</sup> Non-linearity, hysteresis, repeatability at 25°C ambient operating temperature without temperature effects after 2 hours operation.

<sup>2)</sup> Incease 10 to 90% F.S.

<sup>3)</sup> 18% Cr, 10% Ni, 3% Mo, 69% Fe





# Downstream Pressure Control

## Capacitance Diaphragm Gauges

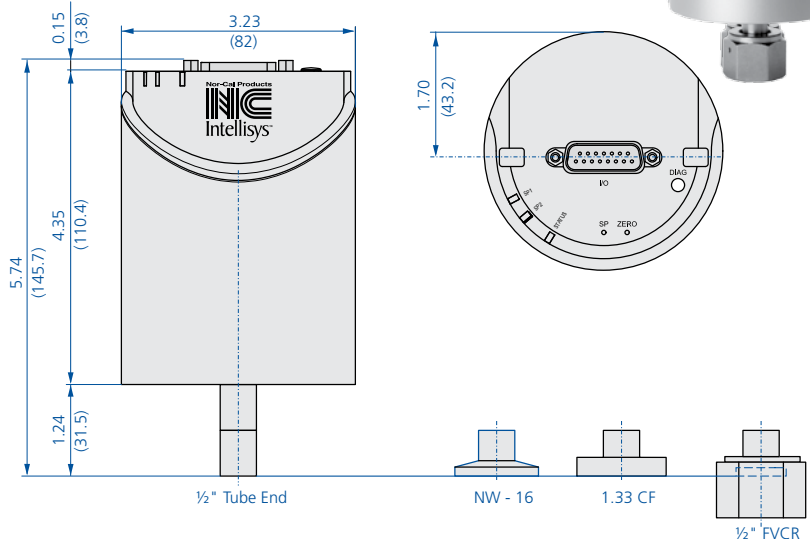
**CDG100-series** gauges are temperature controlled at 100°C for superior performance in demanding semiconductor and plasma processes.

### Advantages

- Lower cost of ownership, 50% faster warm up, energy efficient low power consumption
- Easy integration, wide variety of full scales, flanges and interfaces, standard with two set points
- Easy one push button or remote signal zero command, zero offset adjustable
- Two year warranty, longer life time with advanced heating concept and gauge protection
- No long term recalibration due to excellent signal stability and repeatability, even in harsh plasma applications
- Diagnostic port for quick service and maintenance
- Compliance & standards: CE, EN, UL, SEMI, RoHS

MODEL NUMBER	F.S. RANGE	TUBE FITTING	HEATED
CDG100-M11	100 mTorr	1/2" Tube End	100°C
CDG100-M11-CF	100 mTorr	1.33" CF	100°C
CDG100-M11-NW1	100 mTorr	NW-16	100°C
CDG100-M11-VCR	100 mTorr	1/2" FVCR	100°C
CDG100-T01	1 Torr	1/2" Tube End	100°C
CDG100-T01-CF	1 Torr	1.33" CF	100°C
CDG100-T01-NW1	1 Torr	NW-16	100°C
CDG100-T01-VCR	1 Torr	1/2" FVCR	100°C
CDG100-T02	2 Torr	1/2" Tube End	100°C
CDG100-T02-CF	2 Torr	1.33" CF	100°C
CDG100-T02-NW1	2 Torr	NW-16	100°C
CDG100-T02-VCR	2 Torr	1/2" FVCR	100°C
CDG100-T11	10 Torr	1/2" Tube End	100°C
CDG100-T11-CF	10 Torr	1.33" CF	100°C
CDG100-T11-NW1	10 Torr	NW-16	100°C
CDG100-T11-VCR	10 Torr	1/2" FVCR	100°C
CDG100-T12	20 Torr	1/2" Tube End	100°C
CDG100-T12-CF	20 Torr	1.33" CF	100°C
CDG100-T12-NW1	20 Torr	NW-16	100°C
CDG100-T12-VCR	20 Torr	1/2" FVCR	100°C
CDG100-T21	100 Torr	1/2" Tube End	100°C
CDG100-T21-CF	100 Torr	1.33" CF	100°C
CDG100-T21-NW1	100 Torr	NW-16	100°C
CDG100-T21-VCR	100 Torr	1/2" FVCR	100°C
CDG100-T31	1,000 Torr	1/2" Tube End	100°C
CDG100-T31-CF	1,000 Torr	1.33" CF	100°C
CDG100-T31-NW1	1,000 Torr	NW-16	100°C
CDG100-T31-VCR	1,000 Torr	1/2" FVCR	100°C

	INTERNAL VOLUME in <sup>3</sup> (cm <sup>3</sup> )	WEIGHT grams
1/2" Tube End	0.26 (4.2)	837
NW - 16	0.26 (4.2)	852
1.33 CF	0.26 (4.2)	875
1/2" FVCR®	0.26 (4.2)	897



MEASUREMENT RANGE F.S. (FULL SCALE)	TORR	MEASUREMENT RANGE				
		1000	100	20/10	2/1	0.1
Accuracy <sup>1)</sup>	% of reading	0.2				
Temperature effect on zero on span	% F.S. / °C	0.00025				
	% of reading / °C	0.02				
Pressure, max.	kPa (absolute)	400		260		130
Resolution	% F.S.	0.003				
Lowest reading	% F.S.	0.01				
Lowest suggested reading	% F.S.	0.05				
Lowest suggested control pressure	% F.S.	0.05				
Temperature Operation (ambient) Bakeout at flange Storage	°C °C °C	+10 to +50 ≤110 -40 to +65				
Supply voltage		+14 to +30 VDC or ± 15 V (±5%)				
Power consumption During Heat up At operating temperature	W W	≤15 ≤10				
Output signal (analog)	VDC	0 to +10				
Response time <sup>2)</sup>	ms	30				
Degree of protection		IP 40				
Standards		EN 61000-6-2/6-3, EN 61010, UL 61010-1, CSA 22.2 No. 61010-1, SEMI S-2				
Electrical connection		D-sub, 15 pin, male				
Set point Relay Contact Hysteresis	VDC / ADC % F.S.	two set points (SPT, SP2) ≤30 / ≤0.5 1				
Diagnostic port Protocol Read Set		RS232-C Pressure, status, ID, set points, filter, zero adjust, factory reset, DC offset				
Materials exposed to vacuum		Aluminum oxide ceramic (A203), stainless steel (AISI 316L <sup>3)</sup> , Nickel, sealing glass				

<sup>1)</sup> Non-linearity, hysteresis, repeatability at 25°C ambient operating temperature without temperature effects after 2 hours operation.

<sup>2)</sup> Incease 10 to 90% F.S. <sup>3)</sup> 18% Cr, 10% Ni, 3% Mo, 69% Fe

# Downstream Pressure Control Capacitance Diaphragm Gauges



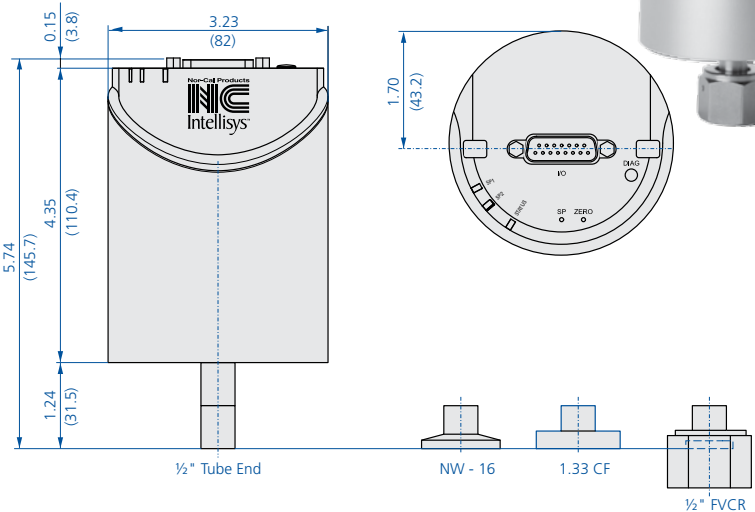
CDG160-series gauges are temperature controlled at 160°C for superior signal stability and repeatability.

## Advantages

- Lower cost of ownership, 50% faster warm up, energy efficient low power consumption
- Easy integration, wide variety of full scales, flanges and interfaces, standard with two set point
- Easy one push button or remote signal zero command, zero offset adjustable
- Two year warranty, longer life time with advanced heating concept and gauge protection
- No long term recalibration due to excellent signal stability and repeatability, even in harsh plasma applications
- Diagnostic port for quick service and maintenance
- Compliance & standards: CE, EN, UL, SEMI, RoHS s

MODEL NUMBER	F.S. RANGE	TUBE FITTING	HEATED
CDG160-T01	1 Torr	1/2" Tube End	160°C
CDG160-T01-CF	1 Torr	1.33" CF	160°C
CDG160-T01-NW1	1 Torr	NW-16	160°C
CDG160-T01-VCR	1 Torr	1/2" FVCR	160°C
CDG160-T02	2 Torr	1/2" Tube End	160°C
CDG160-T02-CF	2 Torr	1.33" CF	160°C
CDG160-T02-NW1	2 Torr	NW-16	160°C
CDG160-T02-VCR	2 Torr	1/2" FVCR	160°C
CDG160-T11	10 Torr	1/2" Tube End	160°C
CDG160-T11-CF	10 Torr	1.33" CF	160°C
CDG160-T11-NW1	10 Torr	NW-16	160°C
CDG160-T11-VCR	10 Torr	1/2" FVCR	160°C
CDG160-T12	20 Torr	1/2" Tube End	160°C
CDG160-T12-CF	20 Torr	1.33" CF	160°C
CDG160-T12-NW1	20 Torr	NW-16	160°C
CDG160-T12-VCR	20 Torr	1/2" FVCR	160°C
CDG160-T21	100 Torr	1/2" Tube End	160°C
CDG160-T21-CF	100 Torr	1.33" CF	160°C
CDG160-T21-NW1	100 Torr	NW-16	160°C
CDG160-T21-VCR	100 Torr	1/2" FVCR	160°C
CDG160-T31	1,000 Torr	1/2" Tube End	160°C
CDG160-T31-CF	1,000 Torr	1.33" CF	160°C
CDG160-T31-NW1	1,000 Torr	NW-16	160°C
CDG160-T31-VCR	1,000 Torr	1/2" FVCR	160°C

	INTERNAL VOLUME in <sup>3</sup> (cm <sup>3</sup> )	WEIGHT grams
1/2" Tube End	0.26 (4.2)	837
NW - 16	0.26 (4.2)	852
1.33 CF	0.26 (4.2)	875
1/2" FVCR®	0.26 (4.2)	897



MEASUREMENT RANGE F.S. (FULL SCALE)	TORR	1000	100	20/10	2/1
Accuracy <sup>1)</sup>	% of reading				0.4
Temperature effect on zero	% F.S./°C				0.005
on span	% of reading/°C				0.02
Pressure, max.	kPa (absolute)	400			260
Resolution	% F.S.				0.003
Lowest reading	% F.S.				0.01
Lowest suggested reading	% F.S.				0.05
Lowest suggested control pressure	% F.S.				0.05
Temperature Operation (ambient)	°C				+10 to +50
Bakeout at flange	°C				≤110
Storage	°C				-40 to +65
Supply voltage					+14 to +30 VDC or ± 15 V (±5%)
Power consumption during heat up	W				≤18
Power consumption at operating temperatures	W				≤18
Output signal (analog)	VDC				0 to +10
Response time <sup>2)</sup>	ms				30
Degree of protection					IP 40
Standards		EN 61000-6-2/6-3, EN 61010, UL 61010-1, CSA 22.2 No. 61010-1, SEMI S-2			
Electrical connection		D-sub, 15 pin, male			
Set point Relay Contact Hysteresis	VDC / ADC % F.S.				two set points (SPT, SP2) ≤30 / ≤0.5 1
Diagnostic port Protocol Reed Set					RS232-C Pressure, status, ID, set points, filter, zero adjust, factory reset, DC offset
Materials exposed to vacuum		Aluminum oxide ceramic (A203), stainless steel (AISI 316L <sup>3)</sup> ), Nickel, sealing glass			

<sup>1)</sup> Non-linearity, hysteresis, repeatability at 25°C ambient operating temperature without temperature effects after 2 hours operation.

<sup>2)</sup> Incease 10 to 90% F.S.

<sup>3)</sup> 18% Cr, 10% Ni, 3% Mo, 69% Fe



# Downstream Pressure Control Accessories and Spare Parts



## Power Supply APC-PSM-DB15

For use with all buried box DC powered APCs as well as IQ-series valves. 24 VDC, 2.5A power supply (100-240 VAC input). Includes CRD-PWR-US1 power cord and 6' (2m) DC supply cable with DB15 D-sub connector.



APC & IQ Valve  
Power Supply

Diagram 1



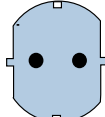
Diagram 2



Diagram 3



Diagram 4



AC Power Cord Plug  
Configurations



Oldham  
Coupling Hubs

To make the completion of an Intellisys downstream pressure control system easy, Nor-Cal Products offers a comprehensive selection of cables and related accessories. These include signal and communications cables, power cords, power supplies as well as spare parts.

## Cable Nomenclature Clarification

Most cable and cord part numbers listed below end with the number 10 as a suffix, which represents the cable length, measured in feet. Thus, Nor-Cal's standard cable length is 10' (3m). However, any length between 1' (0.3m) and 30' (9.1m) can be supplied as a special request. Please contact Nor-Cal Products for price and availability information.

## Cables and Power Cords

MODEL NUMBER	CABLE OR CORD TYPE	DESCRIPTION
<b>TBV-CRD-10</b>	Controller-to-Valve	Cable needed to connect any Intellisys throttle valve to any buried box controller. This cable is NOT needed for IQ-series valves.
<b>CDG-CRD-10</b>	Controller-to-Gauge	A/C powered APC-to-Gauge cable, where the gauge has screw terminals
<b>CDG-CRD-DB9-10</b>	Controller-to-Gauge	A/C powered APC-to-Gauge cable, where the gauge has a 9-pin D-sub connector
<b>CDG-CRD-DB15-10</b>	IQ Controller-to-Gauge	A/C powered APC-to-Gauge cable, where the gauge has a 15-pin D-sub connector. This is the correct cable to use for all Nor-Cal gauges.
<b>CDG-IQ-CRD-10</b>	IQ Controller-to-Gauge	DC powered (including all IQ models) APC-to-Gauge cable, where the gauge has screw terminals
<b>CDG-IQ-CRD-DB9-10</b>	IQ Controller-to-Gauge	DC powered (including all IQ models) APC-to-Gauge cable, where the gauge has a 9-pin D-sub connector
<b>CDG-IQ-CRD-DB15-10</b>	IQ Controller-to-Gauge	DC powered (including all IQ models) APC-to-Gauge cable, where the gauge has a 15-pin D-sub connector. This is the correct cable to use for all Nor-Cal gauges.
<b>CDG-IQ-CRD-Y</b>	IQ Controller-to-Gauge	A 1' (0.3m) long Y-cable to be used if two gauges are interfaced with a DC powered APC (including IQ). Use of this Y-cable also requires two extension cables. Use either CDG-CRD-10, CDG-IQ-CRD-DB9-10 or CDG-IQ-CRD-DB15-10.
<b>APC-CRD-RS232-10</b>	Serial Communication	Use to connect any AC powered APC to a standard PC or laptop DB-9 serial port.
<b>IQ-CRD-RS232-10</b>	Serial Communication	Same as above, but for use with DC powered APC models, including IQ.
<b>RD-PWR-US1</b>	AC Power Cord	7' (2m), 10A-125V rating. US standard power plug. See diagram 1.
<b>CRD-PWR-US2</b>	AC Power Cord	7' (2m), 10A-250V rating. US high voltage power plug. See diagram 2.
<b>CRD-PWR-UK</b>	AC Power Cord	7' (2m), 10A-250V rating. United Kingdom grounded power plug. See diagram 3.
<b>CRD-PWR-EU</b>	AC Power Cord	7' (2m), 10A-250V rating. Continental Europe grounded power plug. diagram 4.

## APC Spare Parts

APC controllers do not contain any user serviceable parts except for replacement battery packs. All other service work needs to be performed by authorized Nor-Cal personnel. Please contact us for details.

MODEL NUMBER	SPARE PART	DESCRIPTION
<b>APC-BAT-1518</b>	Replacement battery pack	15-cell, 18-volt replacement battery pack
<b>IQP-BAT-1518</b>	IQ+ Replacement battery pack	15-cell, 18-volt replacement battery pack

## TBV Spare Parts

PART NUMBER	SPARE PART	DESCRIPTION
<b>54-310-004</b>	Oldham Coupling Disk	Acetal. For all valves up to and including 4" (ISO-100)
<b>54-330-006</b>	Oldham Coupling Disk	Acetal. For 6 inch (ISO-160) valve and some UVD assemblies.
<b>54-330-016</b>	Oldham Coupling Disk	Acetal. For 8 inch (ISO-200) valve and some UVD assemblies
<b>54-330-017</b>	Oldham Coupling Disk	PEEK. For all valves up to and including 4" (ISO-100)
<i>Call for details</i>	Oldham Coupling Disk	PEEK. For 6 inch (ISO-160) valve and some UVD assemblies.
<i>Call for details</i>	Oldham Coupling Disk	PEEK. For 8 inch (ISO-200) valve and some UVD assemblies
<b>TBV-400-90</b>	Viton O-ring kit.	Set of four. For all TBV sizes up to and including 4" (ISO-100)
<b>TBV-600-90</b>	Viton O-ring kit.	Set of four. For 6 inch (ISO-160) TBV
<b>TBV-800-90</b>	Viton O-ring kit.	Set of four. For 8 inch (ISO-200) TBV and 10" (ISO-250) TBV

## TPV and TSS Spare Parts

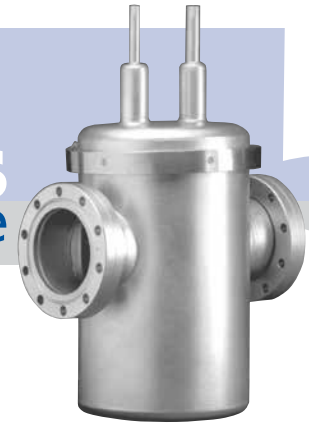
Please contact Nor-Cal Products technical support department for details.

## CDG Spare Parts

CDG gauges do not contain any user serviceable parts. All service work needs to be performed by authorized Nor-Cal personnel. Please contact us for details.

# Foreline Traps

## Section Five



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# Foreline Traps

## General Information



Custom water and metal sieve multistage trap



Electropolish finish is available on all traps

Since 1962, Nor-Cal Products has been designing and building standard and custom foreline traps for the vacuum industry. These traps range in complexity from the sealed coaxial traps, which prevent oil backstreaming, to the triple-pass water cooled traps, which remove condensable gasses that contaminate mechanical pump oil or other parts of the system. Often times our customers see a 200% increase in preventative maintenance intervals after installing one of these traps.

All traps disassemble easily with a Viton O-ring and V-clamp, with the exception of our sealed coaxial metal sieve traps which have a one piece body. The two piece body allows for easy removal for cleaning or filter replacement.

The standard trap body finish is beadblast. Electropolish inside and out is available upon request. Electropolished traps are easier to clean because the surface is more highly polished than the standard beadblast finish. Nickelplating is also available for additional corrosion resistance.



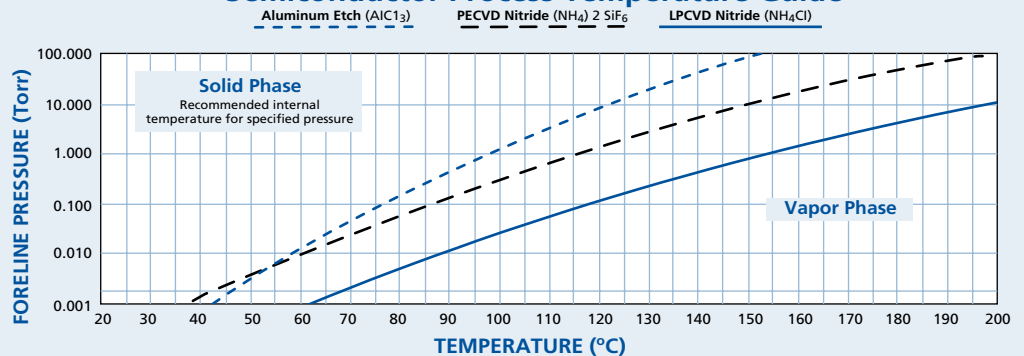
TIG Fusion Welding

### Trap Selection Guide

TRAP TYPE	METAL SIEVE		MOLECULAR	COLD		PARTICULATE	
	STAINLESS STEEL	COPPER	ZEOLITE	LN <sup>2</sup>	H <sup>2</sup> O	POLYESTER	FIBERGLASS
FILTER MATERIAL							
OIL BACKSTREAM	••	••	••	•••			
WATER VAPOR			••	•••			
ORGANICS				••	•		
ACID VAPORS				••			
PARTICLES <149°C	•	•				•••	•••
PARTICLES <370°C	•	•					•••
CONDENSIBLES - LOW VAPOR PRESSURE	••	••		•••	•••		
CONDENSIBLES - HIGH VAPOR PRESSURE	•	•		•••	•		

Blank - Trap is not appropriate for this application • - Good performance for this application  
 •• - Better performance for this application ••• - Best performance for this application

### Semiconductor Process Temperature Guide



All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.



LPCVD/TEOS trap and a heated foreline

### Comprehensive Downstream Solutions

Our experience coupled with a broad product offering allows us to integrate components, providing comprehensive solutions to semiconductor fabs and equipment manufacturers. To improve overall system performance and achieve customer defined goals, a thorough evaluation of the system is conducted. A detailed worksheet is posted on our website for you to download. Answer these questions before calling your Nor-Cal representative. This worksheet will greatly assist us in calculating your cost of ownership model. A cost of ownership model can show payback as a result of increased tool utilization and decreased planned and unplanned maintenance costs. To download the worksheet, go to [www.n-c.com](http://www.n-c.com) and select Services.

Foreline traps, thermal products, Intellisys pressure control valves, Genesis soft start valves and weldments can be provided as turnkey modules. Thermal and vacuum characterization can be performed at Nor-Cal before the assembly is supplied, leak checked, blanked off and clean room packaged.

### Custom Foreline Traps

Standard trap designs are readily altered or custom models are designed and fabricated to improve performance for your specific application. Some examples are described below. Call for more information or to discuss your specific needs.

#### Liquid Recovery Traps

Nor-Cal has provided many types of condensation traps for liquid collection before they enter the pump. Often they have valves or drains to allow the liquid to be collected and reused. Some of the liquids collected include photoresist, oil and tantalum.

#### High Capacity Particulate Traps

Nor-Cal can provide high-capacity particle traps with multi-liter capacities for applications with large particle loads, such as silicon wafer processing.

#### High Capacity Water Cooled Traps

Semiconductor CVD equipment manufacturers require high wafer counts between preventative maintenance. Unlike other manufacturers who offer one solution to fit a number of applications, Nor-Cal will design high-capacity water-cooled traps to achieve specific customer-stated goals. Port geometry, capacity, conductance and efficiency are adjusted in order to produce the optimal design for the application. Examples of processes we have provided solutions for include TiN barrier layer deposition, LPCVD Nitride and III-Vs MOCVD.

#### Liquid Nitrogen Traps

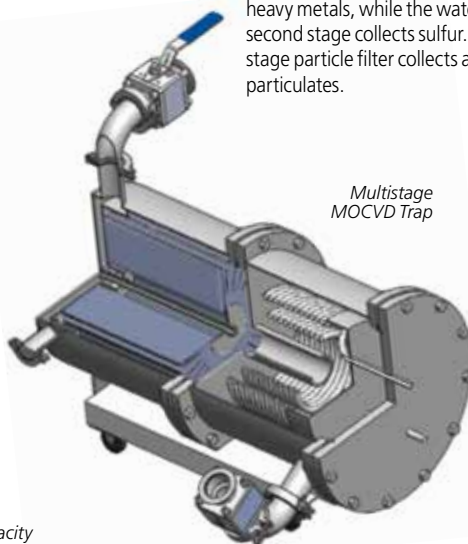
High capacity liquid nitrogen traps can be furnished for customers who require larger LN<sup>2</sup> capacity to extend the time between refills or larger trapping capacity for condensible by-product.

#### Multistage Traps

Multistage traps can be furnished for processes that require a combination of trap media, such as water-cooling and particle filtration. The trap shown here was developed for a GaAs, GaN, AsP MOCVD processes. The first stage collects the heavy metals, while the water cooled second stage collects sulfur. The third stage particle filter collects any fine particulates.



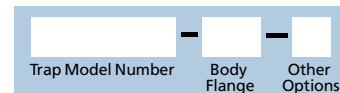
High capacity particulate trap



Multistage MOCVD Trap

### Foreline Trap Options

When ordering a trap with options, please follow the option tree below. **Note:** All options are not available on some body sizes or trap types.



**Example:** FTPA-6-2002-NWB-BF-L7

#### Body Flange Option

OPTION	FITS BODY OD
-BF	4 (101.60)
-BF	6 (152.40)
-BF	8 (203.20)

These ISO clamp style flanges are an alternative to V-clamps. Not available on sealed coaxial metal traps, or 2 or 4 1/2 inch (50.8 - 114.3mm) trap bodies.

#### Other Options

These options are trap type specific

#### Copper Sieve Option

OPTION	FITS TRAP TYPE
-CS	Metal sieve

The standard metal sieve filter is stainless steel. Copper metal sieve filters are available at no additional cost for most metal sieve traps.

#### 240 Volt Heater Option

OPTION	FITS TRAP TYPE
-240V	Molecular sieve

The standard molecular sieve trap regeneration heater is 120V. 240V heaters are available as an option at no additional cost. Other voltages available.

#### Quick Disconnect Option

OPTION	FITS TRAP TYPE
-QD	Water cooled

Immediately shuts off water flow from both directions for single-handed, no-spill removal of a water cooled trap from the system for preventative maintenance or O-ring replacement.

#### Fiberglass Particulate Filter Option

For temperatures up to 370°C

OPTION	FITS TRAP TYPE
-F	Particulate

#### High Capacity Particulate Filter Option

OPTION	FITS TRAP TYPE
-L7	Particulate

This fiberglass filter provides a reservoir for applications with heavy particle loads that might block the inlet.

# Foreline Traps

## Metal Sieve Traps



### SPECIFICATIONS

#### Material

Trap Body: 304 stainless steel  
Flanges: 304 stainless steel  
Sieve: 304 stainless steel

Vacuum range:  $\geq 1 \times 10^{-8}$  mbar

Temperature range: -20°C to 150°C

Options: Copper sieve filters, electropolish, ISO body flange

Nor-Cal metal sieve traps are provided with a fibrous stainless steel sieve for removal of hydrocarbons which backstream toward the chamber when the mechanical pump oil is at its vapor pressure. Copper sieve is available as an option at no additional cost. Add “-CS” to 2, 4 and 6 inch (12.4, 101.6 and 152.4mm) model number. The body flange option is also available for 4, 6 and 8 inch (101.6, 152.4 and 203.2mm) trap bodies. Add “-BF” to model number.

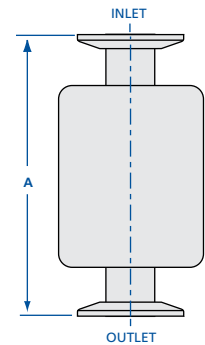
Standard designs include a sealed, single piece, coaxial body and a two-piece, clamped body with coaxial or right angle port configurations. The sealed trap design requires removal from the system before cleaning. The two-piece clamped body design makes disassembly, cleaning and sieve replacement a simple task. For proper sealing of two-piece body traps, apply a light coating of Krytox lube when cleaning or replacing the O-ring.

Standard body finish is beadblast. Electropolish finish, larger body sizes, CF and ASA flanges are also available. Call for pricing.



### Sealed Coaxial Metal Sieve Traps

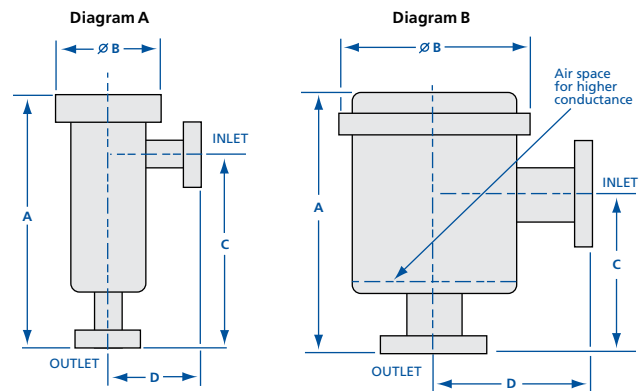
MODEL NUMBER	BODY OD	FLANGE TYPE	PORT OD	A
<b>CT-2-0502-NWB</b>	2 (50.80)	NW-10B	1/2 (12.70)	8.43 (214.12)
<b>CT-2-0752-NWB</b>	2 (50.80)	NW-16B	3/4 (19.05)	8.43 (214.12)
<b>CT-2-1002-NWB</b>	2 (50.80)	NW-25B	1 (25.40)	8.43 (214.12)
<b>CT-4-0752-NWB</b>	4 (101.60)	NW-16B	3/4 (19.05)	10.30 (261.62)
<b>CT-4-1002-NWB</b>	4 (101.60)	NW-25B	1 (25.40)	10.30 (261.62)
<b>CT-4-1502-NWB</b>	4 (101.60)	NW-40B	1 1/2 (38.10)	10.30 (261.62)
<b>CT-4-2002-NWB</b>	4 (101.60)	NW-50B	2 (50.80)	10.30 (261.62)



### Angle Metal Sieve Traps

MODEL NUMBER	DIAGRAM	BODY OD	FLANGE TYPE	PORT OD	A	B	C	D
<b>FTA-2-0502-NWB</b>	A	2* (50.80)	NW-10B	1/2 (12.70)	6.94 (176.28)	3.56 (90.42)	5.38 (136.65)	2.65 (67.31)
<b>FTA-2-0752-NWB</b>	A	2* (50.80)	NW-16B	3/4 (19.05)	6.94 (176.28)	3.56 (90.42)	5.25 (133.35)	2.65 (67.31)
<b>FTA-2-1002-NWB</b>	A	2* (50.80)	NW-25B	1 (25.40)	6.94 (176.28)	3.56 (90.42)	5.13 (130.30)	2.65 (67.31)
<b>FTA-4-0752-NWB</b>	B	4 (101.60)	NW-16B	3/4 (19.05)	8.65 (219.71)	4.80 (121.92)	6.67 (169.42)	3.65 (92.71)
<b>FTA-4-1002-NWB</b>	B	4 (101.60)	NW-25B	1 (25.40)	8.65 (219.71)	4.80 (121.92)	6.55 (166.37)	3.65 (92.71)
<b>FTA-4-1502-NWB</b>	B	4 (101.60)	NW-40B	1 1/2 (38.10)	8.65 (219.71)	4.80 (121.92)	6.29 (159.77)	3.65 (92.71)
<b>FTA-4-2002-NWB</b>	B	4 (101.60)	NW-50B	2 (50.80)	8.65 (219.71)	4.80 (121.92)	6.04 (153.42)	3.65 (92.71)
<b>FTA-6-1502-NWB</b>	B	6 (152.40)	NW-40B	1 1/2 (38.10)	8.65 (219.71)	6.90 (175.26)	5.15 (130.81)	4.65 (118.11)
<b>FTA-6-2002-NWB</b>	B	6 (152.40)	NW-50B	2 (50.80)	8.65 (219.71)	6.90 (175.26)	4.90 (124.46)	4.65 (118.11)
<b>FTA-6-3002-ISO</b>	B	6 (152.40)	ISO-80-300-OF	3 (76.20)	8.75 (222.25)	6.90 (175.26)	4.87 (123.70)	4.75 (120.65)
<b>FTA-6-4002-ISO</b>	B	6 (152.40)	ISO-100-400-OF	4 (101.60)	8.75 (222.25)	6.90 (175.26)	4.56 (115.82)	4.75 (120.65)
<b>FTA-8-2002-NWB</b>	B	8 (203.20)	NW-50B	2 (50.80)	11.65 (295.91)	9.00 (228.60)	7.78 (197.61)	5.65 (143.51)
<b>FTA-8-3002-ISO</b>	B	8 (203.20)	ISO-80-300-OF	3 (76.20)	11.75 (298.45)	9.00 (228.60)	7.38 (187.45)	5.75 (146.05)
<b>FTA-8-4002-ISO</b>	B	8 (203.20)	ISO-100-400-OF	4 (101.60)	11.75 (298.45)	9.00 (228.60)	6.88 (174.75)	5.75 (146.05)

\* ISO body flange option not available for 2 inch (50.8mm) trap bodies



All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.



### Coaxial Metal Sieve Traps

MODEL NUMBER	DIAGRAM	BODY OD	FLANGES	PORT OD	A	B
<b>FCT-2-0502-NWB</b>	A	2* (50.80)	NW-10B	1/2 (12.70)	8.50 (215.90)	3.56 (90.42)
<b>FCT-2-0752-NWB</b>	A	2* (50.80)	NW-16B	3/4 (19.05)	8.50 (215.90)	3.56 (90.42)
<b>FCT-2-1002-NWB</b>	A	2* (50.80)	NW-25B	1 (25.40)	8.50 (215.90)	3.56 (90.42)
<b>FCT-4-0752-NWB</b>	B	4 (101.60)	NW-16B	3/4 (19.05)	10.30 (261.62)	4.80 (121.92)
<b>FCT-4-1002-NWB</b>	B	4 (101.60)	NW-25B	1 (25.40)	10.30 (261.62)	4.80 (121.92)
<b>FCT-4-1502-NWB</b>	B	4 (101.60)	NW-40B	1 1/2 (38.10)	10.30 (261.62)	4.80 (121.92)
<b>FCT-4-2002-NWB</b>	B	4 (101.60)	NW-50B	2 (50.80)	10.30 (261.62)	4.80 (121.92)
<b>FCT-6-1502-NWB</b>	B	6 (152.40)	NW-40B	1 1/2 (38.10)	10.30 (261.62)	6.90 (175.26)
<b>FCT-6-2002-NWB</b>	B	6 (152.40)	NW-50B	2 (50.80)	10.30 (261.62)	6.90 (175.26)
<b>FCT-6-2502-ISO</b>	B	6 (152.40)	ISO-63-250-OF	2 1/2 (63.50)	10.50 (266.70)	6.90 (175.26)
<b>FCT-6-3002-ISO</b>	B	6 (152.40)	ISO-80-300-OF	3 (76.20)	10.50 (266.70)	6.90 (175.26)
<b>FCT-6-4002-ISO</b>	B	6 (152.40)	ISO-100-400-OF	4 (101.60)	10.50 (266.70)	6.90 (175.26)
<b>FCT-8-2002-NWB</b>	B	8 (203.20)	NW-50B	2 (50.80)	13.30 (337.82)	9.00 (228.60)
<b>FCT-8-2502-ISO</b>	B	8 (203.20)	ISO-63-250-OF	2 1/2 (63.50)	13.50 (337.82)	9.00 (128.60)
<b>FCT-8-3002-ISO</b>	B	8 (203.20)	ISO-80-300-OF	3 (76.20)	13.50 (337.82)	9.00 (128.60)
<b>FCT-8-4002-ISO</b>	B	8 (203.20)	ISO-100-400-OF	4 (101.60)	13.50 (337.82)	9.00 (128.60)

\* ISO body flange option not available for 2 inch (50.8mm) trap bodies

### SPECIFICATIONS

#### Material

Trap Body: 304 stainless steel  
Flanges: 304 stainless steel  
Sieve: 304 stainless steel

**Vacuum range:**  $\geq 1 \times 10^{-8}$  mbar

**Temperature range:** -20°C to 150°C

**Options:** ISO body flanges, copper sieve filters, electropolish

### Copper Sieve Option

Add option suffix to trap model number.

#### OPTION

**-CS**

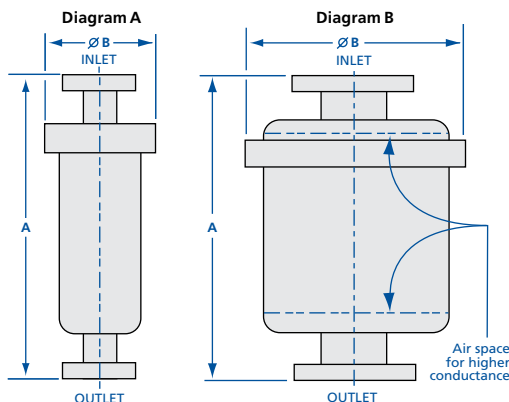
The standard metal sieve filter is stainless steel. Copper metal sieve filters are available at no additional cost for all sealed and two-piece metal sieve traps.

### Body Flange Option

Add option suffix to trap model number.

OPTION	FITS BODY OD
<b>-BF</b>	4 (101.60)
<b>-BF</b>	6 (152.40)
<b>-BF</b>	8 (203.20)

These ISO clamp style flanges are an alternative to V-clamps. Not available on sealed coaxial metal or 2 inch (50.8mm) traps.



Metal sieve cartridges

Replacement filters and other hardware are located on Page 166



All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.



# Foreline Traps

## Molecular Sieve Traps



### SPECIFICATIONS

#### Material

Body: 304 stainless steel  
Flanges: 304 stainless steel  
Desiccant: Zeolite 13X, 1/8 inch pellets

**Vacuum range:**  $\geq 1 \times 10^{-8}$  mbar

**Temperature range:** -20°C to 150°C

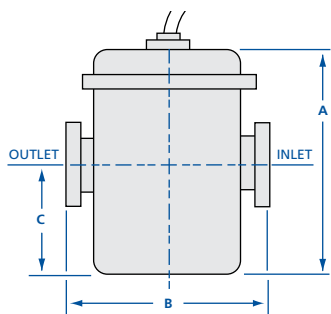
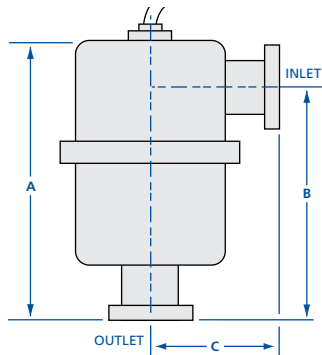
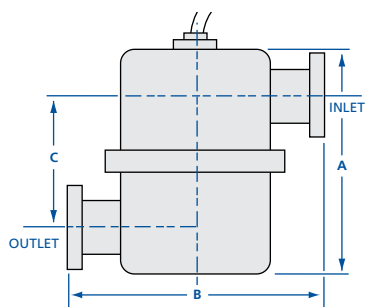
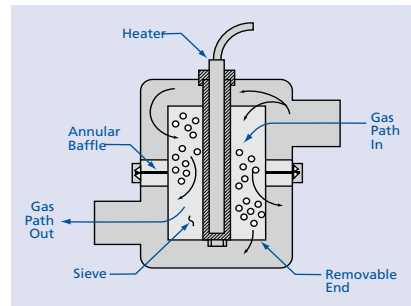
**Options:** 240V regeneration heaters and ISO body flanges See page 175

These traps perform a dual function. A zeolite desiccant removes hydrocarbons which backstream toward the chamber when the mechanical pump oil is at its vapor pressure. Also, the zeolite traps water vapor and other gasses before they reach the mechanical pump and contaminate the pump oil. Depending on the process, this can reduce the oil change frequency significantly.

Nor-Cal's molecular sieve trap utilizes the two-piece trap design for ease of maintenance and zeolite replacement. For maximum conductance the sieve material is contained in a suspended basket fabricated from perforated 304 stainless steel. This design provides conductance to the sieve at the top of the basket as well as around the periphery. A mid-basket baffle causes the gas to enter one-half of the basket and to exit the other half.

When initializing a trap, replacing the sieve or when base pressure cannot be achieved, the sieve should be regenerated by turning on the heater for a few hours and running the mechanical pump with its ballast valve open. The frequency and duration of sieve regeneration is dependent upon the kind and amount of gasses produced by the particular application. To replace the sieve, remove the trap end that contains the heater and remove the nut at the end of the basket. Dump the expired sieve material, replace with new, reattach the basket/end plate then perform the regeneration process outlined above.

A molecular sieve charge and regeneration heater are included with every trap. 208V-240V regeneration heater is available as an option. Other voltages and wattages are available upon request. The heater is held in place allowing the trap to be mounted in any position. Standard finish is beadblasted. Electropolish finish, other body and flange configurations, and larger body sizes are available.



All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.

### In-Line Molecular Sieve Traps

MODEL NUMBER	BODY OD	FLANGE TYPE	PORT OD	REGENERATION HEATER RATING*	A	B	C
<b>FTM-4-0752-NWB</b>	4 (101.60)	NW-16B	3/4 (19.05)	120V / 42W	6.20 (157.48)	7.30 (185.42)	3.50 (88.90)
<b>FTM-4-1002-NWB</b>	4 (101.60)	NW-25B	1 (25.40)	120V / 42W	6.20 (157.48)	7.30 (185.42)	3.50 (88.90)
<b>FTM-4-1502-NWB</b>	4 (101.60)	NW-40B	1 1/2 (38.10)	120V / 42W	6.20 (157.48)	7.30 (185.42)	3.50 (88.90)
<b>FTM-6-1502-NWB</b>	6 (152.40)	NW-40B	1 1/2 (38.10)	120V / 230W	8.10 (205.74)	9.30 (236.22)	4.10 (104.14)
<b>FTM-6-2002-NWB</b>	6 (152.40)	NW-50B	2 (50.80)	120V / 230W	8.10 (205.74)	9.30 (236.22)	4.10 (104.14)
<b>FTM-8-2002-NWB</b>	8 (203.20)	NW-50B	2 (50.80)	120V / 350W	13.00 (330.20)	11.30 (287.02)	6.75 (171.45)
<b>FTM-8-2502-ISO</b>	8 (203.20)	ISO-63-250-OF	2 1/2 (63.50)	120V / 350W	13.00 (330.20)	11.50 (287.02)	6.75 (171.45)
<b>FTM-8-3002-ISO</b>	8 (203.20)	ISO-80-300-OF	3 (76.20)	120V / 350W	13.00 (330.20)	11.50 (287.02)	6.75 (171.45)
<b>FTM-8-4002-ISO</b>	8 (203.20)	ISO-100-400-OF	4 (101.60)	120V / 350W	13.00 (330.20)	11.50 (287.02)	6.75 (171.45)

### Angle Molecular Sieve Traps

MODEL NUMBER	BODY OD	FLANGE TYPE	PORT OD	REGENERATION HEATER RATING*	A	B	C
<b>FTMA-4-0752-NWB</b>	4 (101.60)	NW-16B	3/4 (19.05)	120V / 42W	7.85 (199.39)	6.55 (166.37)	3.65 (92.71)
<b>FTMA-4-1002-NWB</b>	4 (101.60)	NW-25B	1 (25.40)	120V / 42W	7.85 (199.39)	6.55 (166.37)	3.65 (92.71)
<b>FTMA-4-1502-NWB</b>	4 (101.60)	NW-40B	1 1/2 (38.10)	120V / 42W	7.85 (199.39)	6.55 (166.37)	3.65 (92.71)
<b>FTMA-6-1502-NWB</b>	6 (152.40)	NW-40B	1 1/2 (38.10)	120V / 230W	9.75 (247.65)	7.75 (196.85)	4.65 (118.11)
<b>FTMA-6-2002-NWB</b>	6 (152.40)	NW-50B	2 (50.80)	120V / 230W	9.75 (247.65)	7.75 (196.85)	4.65 (118.11)
<b>FTMA-8-2002-NWB</b>	8 (203.20)	NW-50B	2 (50.80)	120V / 350W	14.65 (372.11)	11.53 (292.86)	5.65 (143.51)
<b>FTMA-8-2502-ISO</b>	8 (203.20)	ISO-63-250-OF	2 1/2 (63.50)	120V / 350W	14.75 (374.65)	11.63 (292.86)	5.75 (146.05)
<b>FTMA-8-3002-ISO</b>	8 (203.20)	ISO-80-300-OF	3 (76.20)	120V / 350W	14.75 (374.65)	11.63 (292.86)	5.75 (146.05)
<b>FTMA-8-4002-ISO</b>	8 (203.20)	ISO-100-400-OF	4 (101.60)	120V / 350W	14.75 (374.65)	11.63 (292.86)	5.75 (146.05)

### Straight-In-Line Molecular Sieve Traps

MODEL NUMBER	BODY OD	FLANGE TYPE	PORT OD	REGENERATION HEATER RATING*	A	B	C
<b>FTMS-4-0752-NWB</b>	4 (101.60)	NW-16B	3/4 (19.05)	120V / 42W	7.00 (177.80)	7.30 (185.42)	3.50 (88.90)
<b>FTMS-4-1002-NWB</b>	4 (101.60)	NW-25B	1 (25.40)	120V / 42W	7.00 (177.80)	7.30 (185.42)	3.50 (88.90)
<b>FTMS-4-1502-NWB</b>	4 (101.60)	NW-40B	1 1/2 (38.10)	120V / 42W	7.00 (177.80)	7.30 (185.42)	3.50 (88.90)
<b>FTMS-6-1502-NWB</b>	6 (152.40)	NW-40B	1 1/2 (38.10)	120V / 230W	7.00 (177.80)	9.30 (236.22)	3.50 (88.90)
<b>FTMS-6-2002-NWB</b>	6 (152.40)	NW-50B	2 (50.80)	120V / 230W	7.00 (177.80)	9.30 (236.22)	3.50 (88.90)
<b>FTMS-8-2002-NWB</b>	8 (203.20)	NW-50B	2 (50.80)	120V / 350W	10.00 (254.00)	11.30 (287.02)	5.00 (127.00)
<b>FTMS-8-2502-ISO</b>	8 (203.20)	ISO-63-250-OF	2 1/2 (63.50)	120V / 350W	10.00 (254.00)	11.50 (292.10)	5.00 (127.00)
<b>FTMS-8-3002-ISO</b>	8 (203.20)	ISO-80-300-OF	3 (76.20)	120V / 350W	10.00 (254.00)	11.50 (292.10)	5.00 (127.00)
<b>FTMS-8-4002-ISO</b>	8 (203.20)	ISO-100-400-OF	4 (101.60)	120V / 350W	10.00 (254.00)	11.50 (292.10)	5.00 (127.00)

#### \*208V-240V Heater Option

208V-240V heaters are available as an option at no additional cost. Other voltages available. Add option suffix to the end of the trap model number

OPTION	DESCRIPTION
-240V	208V-240V heater

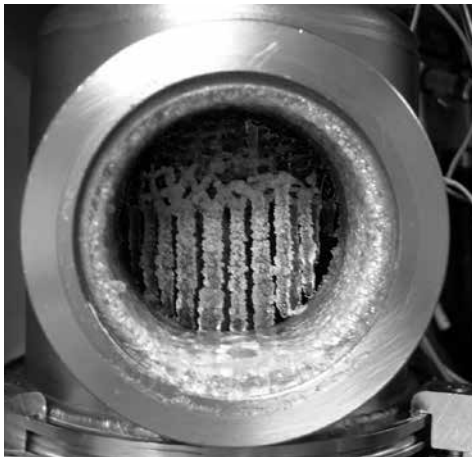


Replacement charges, heaters & other hardware are located on Page 166

Regeneration heater and Zeolite charge

# Foreline Traps

## Particulate Traps



These traps remove particles that might enter the mechanical pump and contaminate the oil. Standard traps include a polyester felt filter traps particles over 10 microns in size at 98% efficiency. Filters can be cleaned with a vacuum cleaner. Suitable for process temperatures from ambient to 149°C. Filters with other micron ratings are available upon request.

Woven, 10 micron fiberglass filters are available as an option. They provide a much longer service life than a polyester filter. Fiberglass filter is required for temperatures greater than 149°C. Maximum fiberglass filter temperature is 370°C. Filters with other micron ratings are available upon request.

The high capacity fiberglass filter option, shown in the diagram below, provides a reservoir for applications with heavy particle loads that might block the inlet. The high capacity filter option is not available for 8 inch (203.2mm) bodies.

The two-piece trap body and 304 stainless steel construction allow these traps to be easily cleaned. For proper sealing, apply a light coating of Krytox lube when cleaning or replacing the O-ring. Standard finish is beadblast. Electropolish finish, larger body sizes, ultra-high capacity and custom flange configurations available. Call for pricing.

### SPECIFICATIONS

#### Material

Trap Body: 304 stainless steel  
Flanges: 304 stainless steel  
Filter: polyester or fiberglass

**Vacuum range:**  $\geq 1 \times 10^{-8}$  mbar

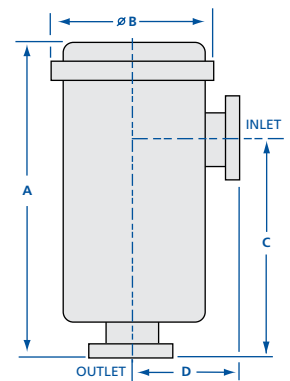
**Temperature range:** -20°C to 150°C

**Options:** ISO body flanges, woven fiberglass or high capacity fiberglass filter, electropolish

### Angle Particulate Traps

MODEL NUMBER	BODY OD	FLANGES	PORT OD	A	B	C	D
<b>FTPA-6-1502-NWB</b>	6 (152.40)	NW-40B	1½ (38.10)	13.90 (353.06)	6.90 (175.26)	10.40 (264.16)	4.65 (118.11)
<b>FTPA-6-2002-NWB</b>	6 (152.40)	NW-50B	2 (50.80)	13.90 (353.06)	6.90 (175.26)	10.15 (257.81)	4.65 (118.11)
<b>FTPA-8-1502-NWB</b>	8* (203.20)	NW-40B	1½ (38.10)	13.90 (353.06)	9.00 (228.60)	10.40 (264.16)	5.65 (143.51)
<b>FTPA-8-2002-NWB</b>	8* (203.20)	NW-50B	2 (50.80)	13.90 (353.06)	9.00 (228.60)	10.15 (257.81)	5.65 (143.51)
<b>FTPA-8-3002-ISO</b>	8* (203.20)	ISO-80	2 (50.80)	19.35 (491.49)	9.00 (228.60)	15.25 (387.35)	5.65 (143.51)
<b>FTPA-8-4002-ISO</b>	8* (203.20)	ISO-100	2 (50.80)	19.35 (491.49)	9.00 (228.60)	15.25 (387.35)	5.65 (143.51)

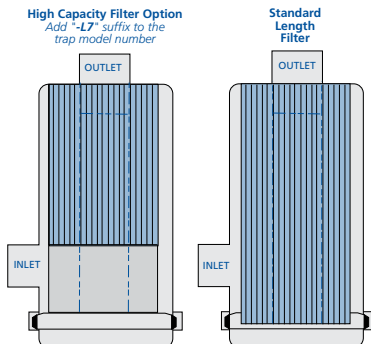
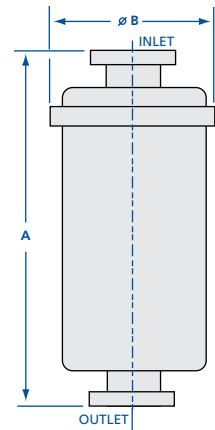
\* High capacity filter not available for 8 inch (203.2mm) body



### Coaxial Particulate Traps

MODEL NUMBER	BODY OD	FLANGES	PORT OD	A	B
<b>FTPS-6-1502-NWB</b>	6 (152.40)	NW-40B	1½ (38.10)	16.30 (414.02)	6.90 (175.26)
<b>FTPS-6-2002-NWB</b>	6 (152.40)	NW-50B	2 (50.80)	16.30 (414.02)	6.90 (175.26)
<b>FTPS-8-1502-NWB</b>	8* (203.20)	NW-40B	1½ (38.10)	16.30 (414.02)	9.00 (228.60)
<b>FTPS-8-2002-NWB</b>	8* (203.20)	NW-50B	2 (50.80)	16.30 (414.02)	9.00 (228.60)
<b>FTPS-8-3002-ISO</b>	8* (203.20)	ISO-80	2 (50.80)	16.50 (419.10)	9.00 (228.60)
<b>FTPS-8-4002-ISO</b>	8* (203.20)	ISO-100	2 (50.80)	16.50 (419.10)	9.00 (228.60)

\* High capacity filter not available for 8 inch (203.2mm) body



### Fiberglass Filter Option

The fiberglass filter option is appropriate for applications with temperatures up to 370°C. The high capacity fiberglass filter provides a reservoir for applications with heavy particle loads that might block the inlet. Add option suffix to the end of the trap model number.

OPTION	FILTER TYPE
<b>-F</b>	Fiberglass
<b>-L7</b>	High capacity

All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.

# Foreline Traps

## LPCVD-TEOS Single & Multi-Stage Traps



### SPECIFICATIONS

#### Material

Trap Body: 304 stainless steel  
Flanges: 304 stainless steel  
Filter: Stainless steel gauze

**Vacuum range:**  $\geq 1 \times 10^{-8}$  mbar

**Temperature range:** -20°C to 150°C

Increase your system's throughput and extend preventative maintenance intervals by 2X or more with Nor-Cal Products' LPCVD/TEOS multistage foreline traps. The first stage is a stainless steel gauze filter which collects crystalline TEOS before it reaches downstream piping and isolation valves. The second stage is a 10 micron fiberglass filter which removes silicon dioxide which causes frequent PM's in throttling butterfly valves. The third and final stage is a reservoir which collects liquid TEOS without restricting foreline conductance. The two-piece trap body and 304 stainless steel construction allow these traps to be easily cleaned. Standard finish is beadblasted. Electropolish is available on request.



### One Stage LPCVD-TEOS Traps

Includes one stainless steel gauze filter

MODEL NUMBER	BODY OD	PORT CONFIGURATION	FLANGES	PORT ID	A	B	C
<b>FTT1S-8-3002-ISO</b>	8 (203.20)	Coaxial	ISO-80	3 (76.20)	16.84 (427.74)	9.00 (228.6)	-
<b>FTT1A-8-3002-ISO</b>	8 (203.20)	Angle	ISO-80	3 (76.20)	15.09 (383.29)	5.75 (146.05)	12.06 (306.32)
<b>FTT1S-8-4002-ISO</b>	8 (203.20)	Coaxial	ISO-100	4 (101.60)	16.84 (427.74)	9.00 (228.6)	-
<b>FTT1A-8-4002-ISO</b>	8 (203.20)	Angle	ISO-100	4 (101.60)	15.09 (383.29)	5.75 (146.05)	12.06 (306.32)

### Two Stage LPCVD-TEOS Traps

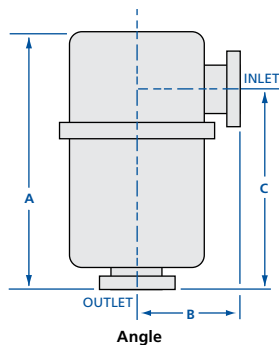
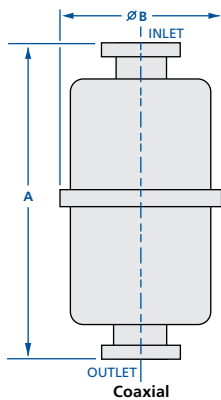
Includes one stainless steel gauze filter and one 10 micron fiberglass filter

MODEL NUMBER	BODY OD	PORT CONFIGURATION	FLANGES	PORT ID	A	B	C
<b>FTT2S-8-3002-ISO</b>	8 (203.20)	Coaxial	ISO-80	3 (76.20)	19.12 (485.65)	9.45 (240.03)	-
<b>FTT2A-8-3002-ISO</b>	8 (203.20)	Angle	ISO-80	3 (76.20)	21.00 (533.40)	5.75 (146.05)	18.00 (457.20)
<b>FTT2S-8-4002-ISO</b>	8 (203.20)	Coaxial	ISO-100	4 (101.60)	19.12 (485.65)	9.45 (240.03)	-
<b>FTT2A-8-4002-ISO</b>	8 (203.20)	Angle	ISO-100	4 (101.60)	21.00 (433.40)	5.75 (146.05)	18.00 (457.20)

### Three Stage LPCVD-TEOS Traps

Includes one stainless steel gauze filter, one 10 micron fiberglass filter, and a built-in liquid collection reservoir

MODEL NUMBER	BODY OD	PORT CONFIGURATION	FLANGES	PORT ID	A	B	C
<b>FTT3S-8-3002-ISO</b>	8 (203.20)	Coaxial	ISO-80	3 (76.20)	19.12 (485.65)	9.45 (240.03)	-
<b>FTT3A-8-3002-ISO</b>	8 (203.20)	Angle	ISO-80	3 (76.20)	21.00 (533.40)	5.75 (146.05)	18.00 (457.20)
<b>FTT3S-8-4002-ISO</b>	8 (203.20)	Coaxial	ISO-100	4 (101.60)	19.12 (485.65)	9.45 (240.03)	-
<b>FTT3A-8-4002-ISO</b>	8 (203.20)	Angle	ISO-100	4 (101.60)	21.00 (433.40)	5.75 (146.05)	18.00 (457.20)



All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.

Replacement filters and other hardware are located on Page 166



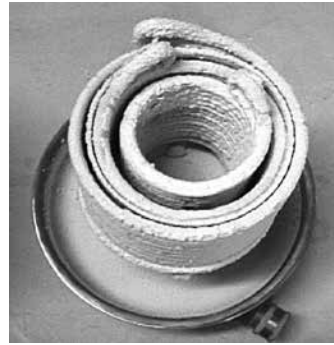
# Foreline Traps

## Water Cooled Traps



Water cooled traps protect mechanical pumps and other downstream components from condensable process gases and their by-products. They can extend or eliminate preventative maintenance intervals and pump overhauls. Nor-Cal's unique water cooled traps have up to three coils of corrosion resistant 316L stainless steel tubing to provide a large cold surface area. Internal baffles combined with the coils create a perilous path for the gas flow, maximizing resident time and increasing contact between the gas and the coils. Depending on the application, house water or refrigerated water can be used to achieve the required temperature to cause by-products to pass from gas to solid phase. (See chart on page 156) A 30 to 50 psi water supply is required. Anticipate a 1 gpm flow rate at 30 psi.

The two-piece trap body and 304 stainless steel construction allow these traps to be easily cleaned. Standard finish is beadblast. For proper sealing, apply a light coating of Krytox lube when cleaning or replacing the O-ring. Quick Disconnect Fittings immediately shut off water flow from both directions for single handed, no-spill removal of the trap for preventative maintenance or O-ring replacement. Add "-QD" to the trap model number and \$200.00 to price. Electropolish finish, larger body sizes and CF or ASA flanges are also available.



### SPECIFICATIONS

**Material**  
 Trap Body: 304 stainless steel  
 Flanges: 304 stainless steel  
 Water Coils: 316L stainless steel

**Vacuum range:**  $\geq 1 \times 10^{-8}$  mbar

**Temperature range:** -20°C to 150°C

**Options:** ISO body flanges and quick disconnect fittings. See page 157

### Coaxial Water Cooled Traps

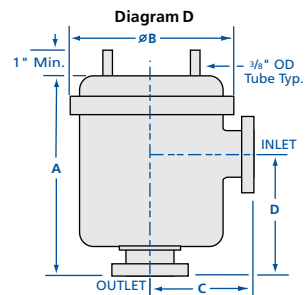
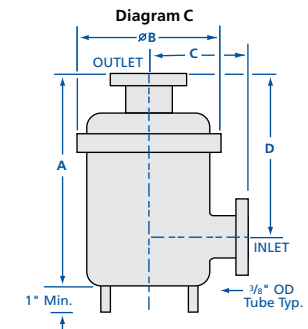
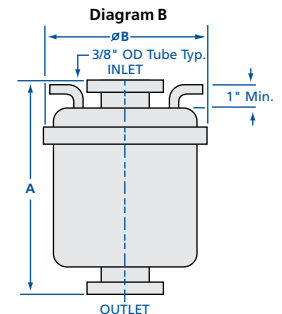
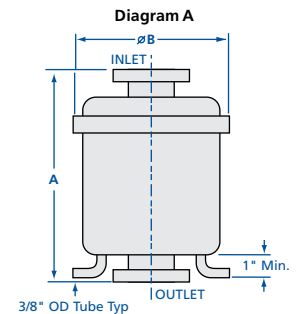
MODEL NUMBER	DIAGRAM	BODY OD	FLANGE TYPE	PORT OD	A	B
FTWS-4.5-1502-NWB	A	4 1/2 (114.30)	NW-40B	1 1/2 (38.10)	9.75 (247.65)	5.28 (134.11)
FTWS-4.5-2002-NWB	A	4 1/2 (114.30)	NW-50B	2 (50.80)	9.75 (247.65)	5.28 (134.11)
FTWS-6-1502-NWB	B	6 (152.40)	NW-40B	1 1/2 (38.10)	10.30 (261.62)	6.90 (175.26)
FTWS-6-2002-NWB	B	6 (152.40)	NW-50B	2 (50.80)	10.30 (261.62)	6.90 (175.26)
FTWS-6-2502-ISO	B	6 (152.40)	ISO-63-250-OF	2 1/2 (63.50)	10.50 (266.70)	6.90 (175.26)
FTWS-6-3002-ISO	B	6 (152.40)	ISO-80-300-OF	3 (76.20)	10.50 (266.70)	6.90 (175.26)
FTWS-8-2002-NWB	B	8 (203.20)	NW-50B	2 (50.80)	13.30 (337.82)	9.00 (228.60)
FTWS-8-2502-ISO	B	8 (203.20)	ISO-63-250-OF	2 1/2 (63.50)	13.50 (342.90)	9.00 (228.60)
FTWS-8-3002-ISO	B	8 (203.20)	ISO-80-300-OF	3 (76.20)	13.50 (342.90)	9.00 (228.60)
FTWS-8-4002-ISO	B	8 (203.20)	ISO-100-400-OF	4 (101.60)	13.50 (342.90)	9.00 (228.60)

\*NOTE: ISO body flange option not available for 4 1/2 inch (114.3mm) bodies

### Angle Water Cooled Traps

MODEL NUMBER	DIAGRAM	BODY OD	FLANGES	PORT OD	A	B	C	D
FTWA-4.5-1502-NWB	C	4 1/2 (114.30)	NW-40B	1 1/2 (38.10)	7.55 (191.77)	5.28 (134.11)	3.90 (99.06)	6.05 (153.67)
FTWA-4.5-2002-NWB	C	4 1/2 (114.30)	NW-50B	2 (50.80)	7.55 (191.77)	5.28 (134.11)	3.90 (99.06)	6.05 (153.67)
FTWA-6-1502-NWB	D	6 (152.40)	NW-40B	1 1/2 (38.10)	8.65 (219.71)	6.90 (175.26)	4.65 (118.11)	5.40 (137.16)
FTWA-6-2002-NWB	D	6 (152.40)	NW-50B	2 (50.80)	8.65 (219.71)	6.90 (175.26)	4.65 (118.11)	5.40 (137.16)
FTWA-6-2502-ISO	D	6 (152.40)	ISO-63-250-OF	2 1/2 (63.50)	8.75 (222.25)	6.90 (175.26)	4.75 (120.65)	5.50 (139.70)
FTWA-6-3002-ISO	D	6 (152.40)	ISO-80-300-OF	3 (76.20)	8.75 (222.25)	6.90 (175.26)	4.75 (120.65)	5.50 (139.70)
FTWA-8-2002-NWB	D	8 (203.20)	NW-50B	2 (50.80)	11.65 (295.91)	9.00 (228.60)	5.65 (143.51)	6.77 (171.96)
FTWA-8-2502-ISO	D	8 (203.20)	ISO-63-250-OF	2 1/2 (63.50)	11.75 (298.45)	9.00 (228.60)	5.75 (146.05)	7.87 (199.90)
FTWA-8-3002-ISO	D	8 (203.20)	ISO-80-300-OF	3 (76.20)	11.75 (298.45)	9.00 (228.60)	5.75 (146.05)	6.87 (174.50)
FTWA-8-4002-ISO	D	8 (203.20)	ISO-100-400-OF	4 (101.60)	11.75 (298.45)	9.00 (228.60)	5.75 (146.05)	6.87 (174.50)

\*NOTE: ISO body flange option not available for 4 1/2 inch (114.3mm) bodies



### Quick Disconnect Option

Add option suffix to trap model number.

OPTION	FITS TRAP TYPE
-QD	Water cooled

Immediately shuts off water flow from both directions for single-handed, no-spill removal of a water cooled trap from the system for preventative maintenance or O-ring replacement.

**Quick disconnect fittings & mounting hardware are located on Page 166**





# Foreline Traps

## Liquid Nitrogen Traps

### SPECIFICATIONS

#### Material

Trap Body: 304 stainless steel  
Flanges: 304 stainless steel

Vacuum range:  $\geq 1 \times 10^{-8}$  mbar

Temperature range: -20°C to 150°C

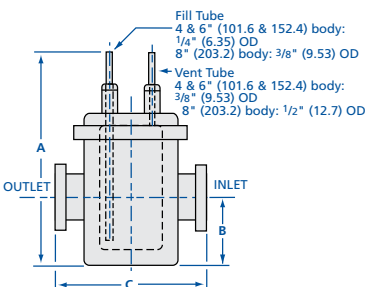
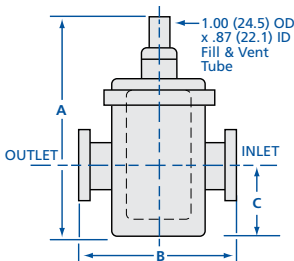
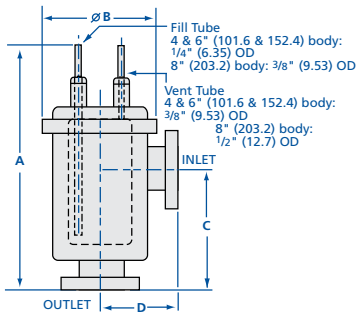
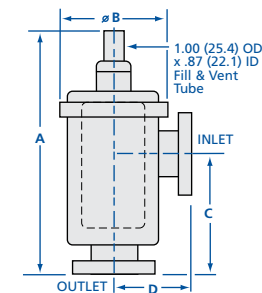
Options: ISO body flanges. See page 141

Nor-Cal's liquid nitrogen traps remove condensable gasses before they enter the mechanical pump and contaminate the oil. They also prevent mechanical pump oil vapors from contaminating the vacuum chamber. These traps actually act as a pump producing lower base pressures and faster pump down. Dual-tube traps can be attached to an automatic fill device, eliminating the necessity of manually refilling the reservoir with liquid nitrogen.

The two-piece trap body and 304 stainless steel construction allow these traps to be easily cleaned without disassembling the system. For proper sealing, apply a light coating of Krytox lube when cleaning or replacing the O-ring. Coaxial port configurations, ISO, CF or ASA flanges, electropolish finish and drain fittings are available.

### Refill Time Table for Single Tube LN<sup>2</sup> Traps

TRAP DIAMETER	HOURS
4 inch (101.60)	5
6 inch (152.40)	8
8 inch (203.20)	12



### Angle Liquid Nitrogen Traps

MODEL NUMBER	BODY OD	FLANGES	PORT OD	A	B	C	D	LN <sub>2</sub> RESERVOIR
FTNA-4-0752-NWB	4 (101.60)	NW-16B	3/4 (19.05)	13.15 (334.01)	4.80 (121.92)	7.18 (182.37)	3.65 (92.71)	0.75 Liter
FTNA-4-1002-NWB	4 (101.60)	NW-25B	1 (25.40)	13.15 (334.01)	4.80 (121.92)	7.06 (182.37)	3.65 (92.71)	0.75 Liter
FTNA-4-1502-NWB	4 (101.60)	NW-40B	1 1/2 (38.10)	13.15 (334.01)	4.80 (121.92)	6.80 (172.72)	3.65 (92.71)	0.75 Liter
FTNA-6-1502-NWB	6 (152.40)	NW-40B	1 1/2 (38.10)	15.85 (402.59)	6.90 (175.26)	8.40 (213.36)	4.65 (118.11)	1.60 Liter
FTNA-6-2002-NWB	6 (152.40)	NW-50B	2 (50.80)	15.85 (402.59)	6.90 (175.26)	8.15 (207.01)	4.65 (118.11)	1.60 Liter
FTNA-8-1502-NWB	8 (203.20)	NW-40B	1 1/2 (38.10)	16.90 (429.26)	9.00 (228.60)	9.15 (232.41)	5.65 (143.51)	4.00 Liter
FTNA-8-2002-NWB	8 (203.20)	NW-50B	2 (50.80)	16.90 (429.26)	9.00 (228.60)	8.90 (226.06)	5.65 (143.51)	4.00 Liter

### Angle Dual-Tube Liquid Nitrogen Traps

MODEL NUMBER	BODY OD	FLANGES	PORT OD	A	B	C	D	LN <sub>2</sub> RESERVOIR
NTDA-4-0752-NWB	4 (101.60)	NW-16B	3/4 (19.05)	13.15 (334.01)	4.80 (121.92)	7.18 (182.37)	3.65 (92.71)	0.75 Liter
NTDA-4-1002-NWB	4 (101.60)	NW-25B	1 (25.40)	13.15 (334.01)	4.80 (121.92)	7.06 (182.37)	3.65 (92.71)	0.75 Liter
NTDA-4-1502-NWB	4 (101.60)	NW-40B	1 1/2 (38.10)	13.15 (334.01)	4.80 (121.92)	6.80 (172.72)	3.65 (92.71)	0.75 Liter
NTDA-6-1502-NWB	6 (152.40)	NW-40B	1 1/2 (38.10)	15.85 (402.59)	6.90 (175.26)	8.40 (213.36)	4.65 (118.11)	1.60 Liter
NTDA-6-2002-NWB	6 (152.40)	NW-50B	2 (50.80)	15.85 (402.59)	6.90 (175.26)	8.15 (207.01)	4.65 (118.11)	1.60 Liter
NTDA-8-1502-NWB	8 (203.20)	NW-40B	1 1/2 (38.10)	16.90 (429.26)	9.00 (228.60)	9.15 (232.41)	5.65 (143.51)	4.00 Liter
NTDA-8-2002-NWB	8 (203.20)	NW-50B	2 (50.80)	16.90 (429.26)	9.00 (228.60)	8.90 (226.06)	5.65 (143.51)	4.00 Liter

### In-Line Liquid Nitrogen Traps

MODEL NUMBER	BODY OD	FLANGES	PORT OD	A	B	C	LN <sub>2</sub> RESERVOIR
FTN-4-0752-NWB	4 (101.60)	NW-16B	3/4 (19.05)	11.50 (292.10)	7.30 (185.42)	3.70 (93.98)	0.75 Liter
FTN-4-1002-NWB	4 (101.60)	NW-25B	1 (25.40)	11.50 (292.10)	7.30 (185.42)	3.70 (93.98)	0.75 Liter
FTN-4-1502-NWB	4 (101.60)	NW-40B	1 1/2 (38.10)	11.50 (292.10)	7.30 (185.42)	3.70 (93.98)	0.75 Liter
FTN-6-1502-NWB	6 (152.40)	NW-40B	1 1/2 (38.10)	14.20 (360.68)	9.30 (236.22)	4.50 (114.30)	1.60 Liter
FTN-6-2002-NWB	6 (152.40)	NW-50B	2 (50.80)	14.20 (360.68)	9.30 (236.22)	4.50 (114.30)	1.60 Liter
FTN-8-1502-NWB	8 (203.20)	NW-40B	1 1/2 (38.10)	15.25 (387.35)	11.30 (287.02)	5.00 (127.00)	4.00 Liter
FTN-8-2002-NWB	8 (203.20)	NW-50B	2 (50.80)	15.25 (387.35)	11.30 (287.02)	5.00 (127.00)	4.00 Liter

### In-Line Dual-Tube Liquid Nitrogen Traps

MODEL NUMBER	BODY OD	FLANGES	PORT OD	A	B	C	LN <sub>2</sub> RESERVOIR
NTD-4-0752-NWB	4 (101.60)	NW-16B	3/4 (19.05)	11.50 (292.10)	3.70 (93.98)	7.30 (185.42)	0.75 Liter
NTD-4-1002-NWB	4 (101.60)	NW-25B	1 (25.40)	11.50 (292.10)	3.70 (93.98)	7.30 (185.42)	0.75 Liter
NTD-4-1502-NWB	4 (101.60)	NW-40B	1 1/2 (38.10)	11.50 (292.10)	3.70 (93.98)	7.30 (185.42)	0.75 Liter
NTD-6-1502-NWB	6 (152.40)	NW-40B	1 1/2 (38.10)	14.20 (360.68)	4.50 (114.30)	9.30 (236.22)	1.60 Liter
NTD-6-2002-NWB	6 (152.40)	NW-50B	2 (50.80)	14.20 (360.68)	4.50 (114.30)	9.30 (236.22)	1.60 Liter
NTD-8-1502-NWB	8 (203.20)	NW-40B	1 1/2 (38.10)	15.25 (387.35)	5.00 (127.00)	11.30 (287.02)	4.00 Liter
NTD-8-2002-NWB	8 (203.20)	NW-50B	2 (50.80)	15.25 (387.35)	5.00 (127.00)	11.30 (287.02)	4.00 Liter

# Foreline Traps Oil Mist Eliminators



During rotary vane pump operation, oil mist escapes from the exhaust port; mainly when pumping between atmospheric pressure and 1 mbar. Safe operation of a rotary vane pump requires an Oil Mist Eliminator (OME) to be mounted above the pump's exhaust port. The oil mist is present in exhaust gases with a high level of separation. These mists present a potential environmental and health hazard as well as creating an oily build-up on everything in the pump's proximity. Misting increases as exhaust pressure increases.



## SPECIFICATIONS

### Material

Trap Body: 304 stainless steel, aluminum or Polyamide  
Filter: Epoxy/glass microfiber, Polypropylene

The OME's filtration system contains the mist and returns it to the pump body. The OME's internal over-pressure valve prevents vapor explosions due to exceeding the maximum permissible exhaust pressure. Oil mist eliminators do not trap gas.

**Caution:** Vent all processes properly. Oil mist eliminators are not recommended for applications with high oxygen, silane, or condensable vapor content. Seal kits, auto drain kits, and other accessories are available. Call for pricing.

## Oil Mist Eliminators

MODEL NUMBER	DIAGRAM	PROCESS USAGE	BODY MATERIAL	FLANGE TYPE
FTOME-25-S	A	General, non-corrosive	Polyamide	NW-25
FTOME-25-HP	B	General, non-corrosive. For frequent cycling or high pressure operation	Aluminum	NW-25
FTOME-40-S	C	General, non-corrosive	Aluminum	NW-40
FTOME-40-C2	D	Fluorinated, corrosive	Stainless Steel	NW-40

## Replacement Filters

MODEL NUMBER	USE WITH	FILTER MATERIAL	QUANTITY
FTOME-25-S-F	FTOME-25-S	Epoxy/glass microfiber	1
FTOME-25-HP-F	FTOME-25-HP	Epoxy/glass microfiber	1
FTOME-40-S-F	FTOME-40-S	Epoxy/glass microfiber	1
FTOME-40-C2-F	FTOME-40-C2	Polypropylene	1

Diagram A

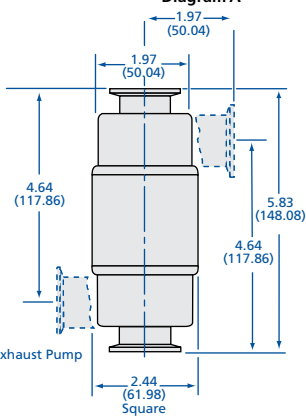


Diagram B

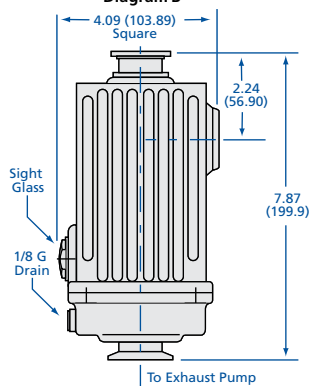


Diagram C

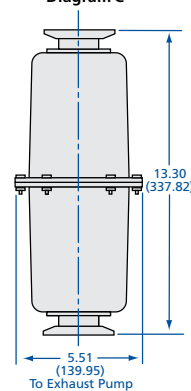
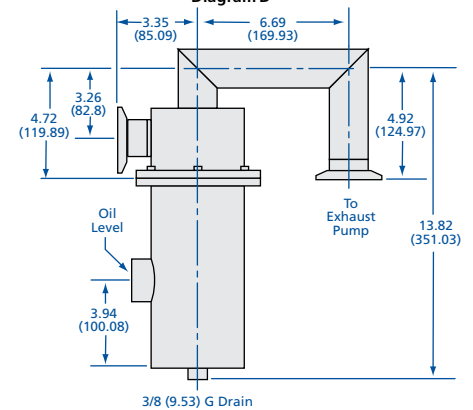


Diagram D



All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.



# Foreline Traps

## Filters, Hardware & Accessories



Metal sieve trap filters

### Metal Sieve Trap Replacement Filters

MODEL NUMBER	BODY OD	DESCRIPTION
FT-2-SS	2 (50.80)	Stainless steel gauze
FT-2-CS	2 (50.80)	Copper gauze
FT-4-SS	4 (101.60)	Stainless steel gauze
FT-4-CS	4 (101.60)	Copper gauze
FT-6-SS	6 (152.40)	Stainless steel gauze
FT-6-CS	6 (152.40)	Copper gauze
FT-8-SS	8 (203.20)	Stainless steel gauze



Trap mounting bracket

### Body Clamps

Body clamps for use with all trap types

MODEL NUMBER	BODY OD
NW-50-CP	2 (50.80)
FT-4-CP	4 (101.60)
FT-4.5-CP	4 1/2 (114.30)
FT-6-CP	6 (152.40)
FT-8-CP	8 (203.20) below S/N 292800
50248	8 (203.20) above S/N 292800
FT-CP-B	T-bolt kit*

\* T-bolt kits include replacement bolts and nuts for all size V-band clamps and brackets.

### Particulate Trap Replacement Filters

MODEL NUMBER	BODY OD	FILTER LENGTH	DESCRIPTION
FT-6-PP	6 or 8 (152.40 or 203.20)	11 1/2 (292.10)	Polyester felt, 10 micron
FT-6-PF	6 or 8 (152.40 or 203.20)	11 1/2 (292.10)	Woven fiberglass, 10 micron
FT-6-PF-L7	6 (152.40)	7 1/2 (190.50)	Woven fiberglass filter, 10 micron
FT-8-PR	8 (152.40)	11 1/2 (292.10)	Polypropylene filter, 10 micron



Particulate trap filters

### LPCVD-TEOS Trap Replacement Filters

MODEL NUMBER	BODY OD	FILTER MATERIAL	FITS TRAPS
FT-8-SS	8 (203.20)	Stainless steel gauze	FTT1
FT-8-SS-5	8 (203.20)	Stainless steel gauze	FTT2 and FTT3
FT-8-PF-5	8 (203.20)	Woven fiberglass	FTT2 and FTT3

### Body O-rings

For use with all foreline trap types.

MODEL NUMBER	BODY OD
NW-50-OR-V	2 (50.80)
FT-4-OR	4 (101.60)
FT-4.5-OR	4 1/2 (114.30)
FT-6-OR	6 (152.40)
FT-8-OR	8 (203.20) below S/N 292800
FT-8-OR-821	8 (203.20) above S/N 292800

### Molecular Sieve Trap Replacement Heaters

MODEL NUMBER	BODY OD	DESCRIPTION
FT-4-HRF-240V	4 (101.60)	Rated at 240V, 42W
FT-4-HRF	4 (101.60)	Rated at 120V, 42W
FT-6-HR	6 (152.40)	Rated at 120V, 230W
FT-6-HR-240V	6 (152.40)	Rated at 240V, 42W
FT-8-HR	8 (203.20)	Rated at 120V, 350W
FT-8-HR-240V	8 (203.20)	Rated at 240V, 350W



Molecular sieve trap heaters

### Mounting Brackets

For mounting all 6 inch trap types.

MODEL NUMBER	BODY OD
FT-6-MB	6 (152.40)



Molecular sieve trap charge

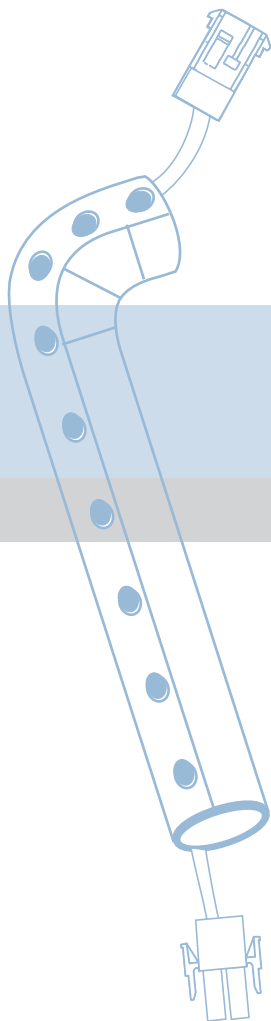
### Molecular Sieve Trap Replacement Charges

MODEL NUMBER	BODY OD	DESCRIPTION
FT-4-MS	4 (101.60)	1 lb. Zeolite charge, 4 inch (101.60) trap requires 3/4 lb.
FT-6-MS	6 (152.40)	2 lb. Zeolite charge, 6 inch (152.40) trap requires 1 1/2 lb.
FT-8-MS	8 (203.20)	5 lb. Zeolite charge, 8 inch (203.20) trap requires 4 3/4 lb.

### Water Cooled Trap Fittings

MODEL NUMBER	BODY OD	DESCRIPTION
FTW-QD	All	Quick disconnect fittings kit (DESO)
FTW-4.5-OR	4 1/2 (114.30)	Internal Viton O-ring used in this body size only

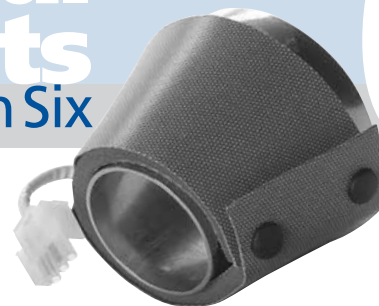




# Thermal Products

## Section Six

# 6



<b>6.1</b>	General Information	<b>168</b>
<b>6.2</b>	Designing Heated Systems	<b>171</b>
<b>6.3</b>	Heater Jackets & Insulators	<b>172</b>
<b>6.4</b>	Gas Line Heaters & Insulators	<b>176</b>
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<b>6.6</b>	Controllers, Thermostats & Accessories	<b>178</b>

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### New Products

#### 1/2 Inch Thick Heater Jackets

For heating applications where external temperatures are of concern, 1/2 inch thick insulated heater jackets are now available as a standard product. These jackets maintain a lower external temperature than the traditional 1/4 inch heater jackets.

#### Electronic Thermostat Option

As an option, we now offer electronic thermostats for fixed set-point thermal applications. These devices have an extended life (up to 10 times or more) than standard thermostat life. In addition, temperature variations are typically  $\pm 3^\circ\text{C}$ , a major improvement over typical thermostats'  $\pm 15^\circ\text{C}$ . Our electronic thermostats include a thermocouple sensor and power switch compactly integrated into the heater's power cable. A single thermostat may be attached to several heater jackets on the same line to reduce system costs. Call for more details.

Heater jackets, controllers and accessories reduce build-up of semiconductor process by-products in valves and other exhaust line components, while reducing particle generation and system downtime. Uniform line heating will minimize condensation and particle build-up in gas delivery and pump lines. Condensation and particle build-up will begin when temperatures and/or pressure falls below vapor phase. (See diagrams next page)

### Heater Jackets

Nor-Cal's silicone rubber modular heater jackets and insulators are available in 1/4 or 1/2 inch thicknesses. Straight lengths are available from 2 to 36 inches. Trimable heater jackets (-T) allow up to one inch to be trimmed off for custom test ports and odd lengths. Elbows, conical reducers and tees are available to accommodate tube ODs up to 4 inches. These can be used in combination with controllers, sensors or thermostats to apply and regulate heat to the most complex line designs, optimizing system performance.

### Controllers

Nor-Cal offers a variety of temperature control options. Up to 32 zone, full process control is possible with front panel console controllers which feature set points and alarms. PC control is available on select controllers using standard software programs. Thermostat control, thermal fuses, up-to-temperature sensors, etc. are available on request.



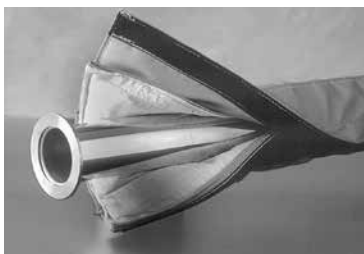
### Gas Line Heaters

Nor-Cal's upstream gas line heaters and insulators offer quick delivery from stock for heating gas delivery lines, such as BCl<sub>3</sub> and WF<sub>6</sub>. They are made from silicone rubber heater material insulated with 1/4 inch closed cell silicone rubber sponge and feature quick ON/OFF installation with snap closures. Heaters can be linked/daisy chained to a maximum of 10 amps. Insulators trim-to-fit to insure 100% line coverage. UL Listed.

### Valve Heaters

All of Nor-Cal's isolation and pressure control valves can be provided with silicone foam or fiberglass insulated heater jackets to reduce resident time of corrosives or particle build-up in semiconductor and other applications. Please call for more information.

All dimensions are called out in inches unless otherwise noted



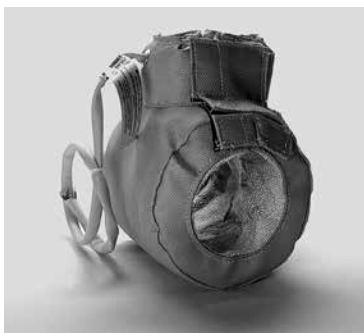
High temperature fiberglass cloth heater jacket

### High Temperature Cloth Heater Jackets

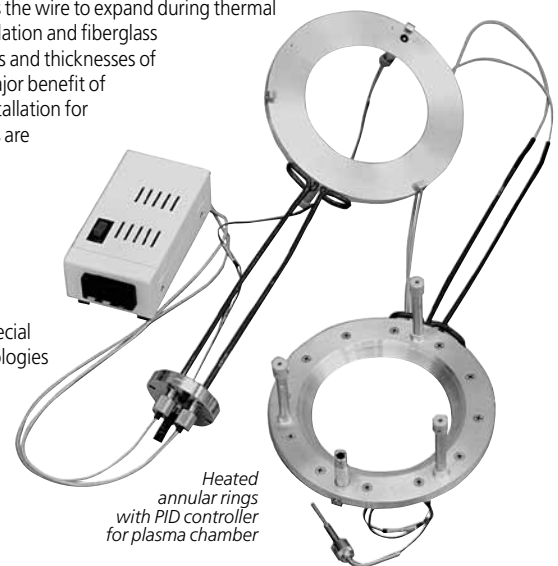
Nor-Cal offers a complete line of high temperature cloth heater jackets and insulators. Heating elements are helical wound resistive wire on a fiberglass core. This allows the wire to expand during thermal cycling with minimal metal fatigue. Jackets with fiberglass insulation and fiberglass based cloth can attain temperatures up to 482°C. Various types and thicknesses of insulation can be provided to meet specific requirements. A major benefit of cloth heater jackets is their durability and ease of removal/reinstallation for system cleaning and maintenance. Nor-Cal cloth heater jackets are sewn for an exact fit upon the piece to be heated or insulated.

### Custom Heaters

The experience gained designing heaters for our standard products has allowed us to provide thermal components for special applications. We have drawn from a number of heating technologies (silicon, fiberglass, cartridge, strip, band, tubular and thick film) in order to provide the most cost-effective solutions. Custom components include heated traps, Kapton and tube internal vacuum chamber heaters, gas delivery systems, ion pump heaters and others. Custom heater jackets for specific agency compliance, (i.e. CE, NEC 427, Semi S2-93) are also available.



Custom high temperature valve heater jacket



Heated annular rings with PID controller for plasma chamber



## The Benefits of Heating Vacuum Lines

Many semiconductor processes are carried out in vacuum chambers with internal temperatures in the 700°C range. Process by-products exit the chamber in vapor phase, but sublimate in the foreline and vacuum pump exhaust when gas temperatures drop sufficiently for them to form solids. The resultant buildup can increase wafer defects from particle back streaming, reduce throughput of vacuum lines, impede the function of throttle valves and isolation valves, damage some dry pumps and reduce the efficiency of the scrubber. This buildup can be reduced or eliminated by heating vacuum lines and associated components from the chamber to the scrubber, or by using a combination of heaters and foreline traps, which collect the by-products, preventing them from continuing downstream. Heated lines are becoming a common occurrence on semiconductor equipment and in the subfab. Here are some of the features to consider when selecting a heater jacket for your particular application.

## Heating Requirements

Thermal mass, thermal conductivity, desired ramp time, ambient temperature and gas temperature are a few of the factors that effect the design of the thermal system. Stainless steel is a relatively poor thermal conductor (approximately 1/12 that of aluminum) and requires heat to be applied very uniformly to avoid cold spots. Even when insulated, the temperature of unheated stainless steel vacuum lines will drop significantly in a matter of inches. Care should be taken to increase the watt density of heaters for heavier components, such as gate valves, especially if they are connected in series with heaters for components with dissimilar masses. Zoning of components with similar thermal masses is even better. It is important to characterize the system for internal as well as external temperature loads.

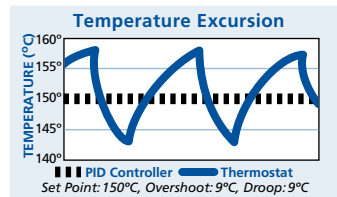
## Construction

Heating elements are helical wound resistive wire on a fiberglass core. This allows the wire to expand during thermal cycling with minimal metal fatigue. Jackets with fiberglass insulation and fiberglass based cloth can attain temperatures up to 450°C. The silicone used by Nor-Cal is UL listed to 220°C. Life testing indicates a half life of 25 years with 150°C continual operation. Fiberglass reinforced silicone encapsulates the heater element, while the insulation is silicone foam in various thicknesses. Nor-Cal's silicone jackets can be trimmed, allowing greater flexibility during installation, and they have been tested to have Class 100 clean room compatibility.

## Temperature Control

The two most common methods of controlling temperature are snap action thermostats and proportional integral derivative (PID) controllers. Although the lowest cost initially, thermostats create the highest three year operating cost due to heater failure caused by high temperature excursions. Thermostats are typically UL rated for 100,000 cycles, which can equate to as little as one year of continual operation.

PID control maintains the temperature within 2°C of the specified setpoint, eliminating high temperature excursions, and extending heater life by up to ten times. Additionally, controllers allow the operator to change setpoints, ramp temperatures, set alarm parameters and monitor system performance from outside the subfab via RS232 or RS485 connection.



## High Temp Protection

There are several methods of protecting heater jackets from reaching unsafe temperatures in the event of controller malfunction. The watt density of the jacket can be limited, but this also limits the ability of the heater to regulate the temperature in the event of high thermal loads. A thermal fuse, which cannot be reset or replaced, can open the circuit to the heater element at a specified temperature. However, that temperature degrades during the life of the thermal fuse by as much as 30°C in one year. This degradation must be taken into account to avoid premature failure of the heater. High limit cut-offs are similar to thermal fuses, but they can be reset automatically or manually. They are available in a wide temperature range with an accuracy of ±10°C of the specified temperature limit with no degradation. Safety limit controllers use thermocouples or resistance temperature detectors (RTDs) to monitor temperature. Extremely accurate, they are available with preset or adjustable temperatures and can control a variety of cut-off devices and/or alarms.

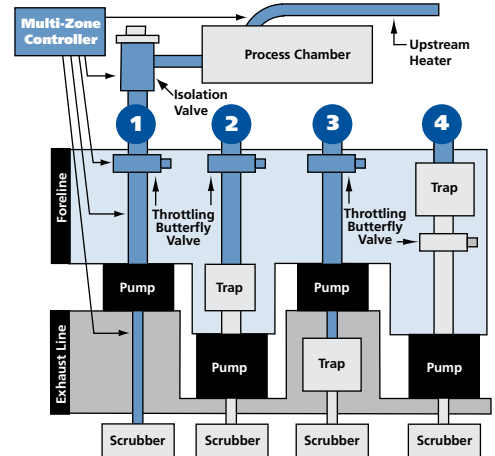
## Semiconductor Applications

Many semiconductor processes benefit from heated foreline and exhaust lines. Silicon nitride and LPCVD/TEOS and aluminum or tungsten metal etch are the most common processes requiring heated pump lines.

## Typical Pumpline Configurations

Refer to diagram at right

1. Heated foreline to pump and exhaust line to scrubber. No trap
2. Heated foreline to trap before pump
3. Heated foreline to pump and heated exhaust to trap after pump
4. Heated foreline to foreline trap



## Silicon Nitride & LPCVD/TEOS

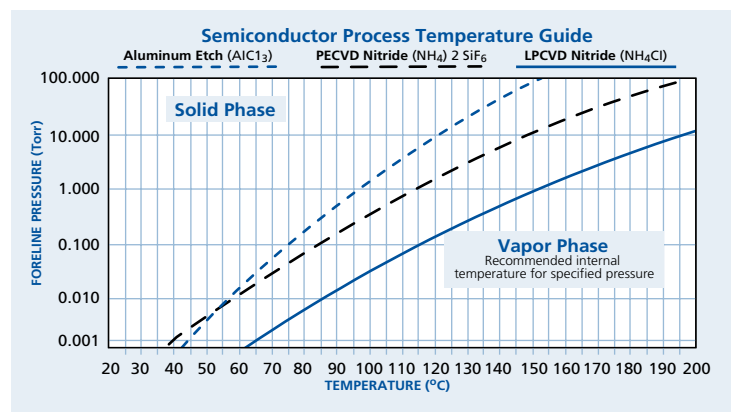
For silicon nitride LPCVD, heating the line over 110°C from the process to the dry-pump can greatly reduce the amount of solids which build up in the line. LPCVD/TEOS lines should be heated to 150°C. This extends PM intervals and reduces wafer defects in the process chamber by up to 10 times.

Preventative maintenance schedules can be extended several times, meaning larger numbers of runs between line cleaning. The heated foreline will no longer catch the majority of the condensable by-products, which can sublimate in the pump. For most applications, it is highly recommended that the dry-pump is protected by a foreline trap upstream from the pump (reference 2 and 4 on chart above). Nor-Cal offers standard and custom water-cooled, particulate, and multi-stage foreline traps for most semiconductor applications. (For more information, see Section 5 - Foreline Traps.)

## Aluminum or Tungsten Metal Etch

When heating lines for metal etch applications, keeping the lines above 90°C can greatly reduce the metal and salt build-up. This minimizes wafer defects and extends preventative maintenance schedules. For metal etch, heating both the foreline from the process tool to the pump, and the pump exhaust line to the scrubber will yield the best results. (Reference 1 on chart below.) Heating other components, such as pump mufflers, is also beneficial and helps to reduce downtime.

Variations in process equipment, process parameters and component temperature ratings will dictate different system solutions. Always review equipment specifications and process parameters before determining temperature specifications and heated line design. Failure to follow the required specifications and parameters could result in equipment damage or undesired process results.





### SPECIFICATIONS

#### Materials

**Heater jacket:** Reinforced silicone rubber fabric  
**Insulator:** 1/4 or 1/2 inch thick closed-cell silicone rubber foam  
**Fasteners:** 1/2 inch diameter metal snaps with nylon cover standard

#### Electrical

**Watt density:**  
 1 to 2 inch diameter: 1.5 W/in<sup>2</sup>  
 3 to 4 inch diameter: 1.25 W/in<sup>2</sup>  
**Voltage:** 120V or 208V standard, other voltages available  
**Power leads:** 4 inch long #18 AWG, UL 180/CSA 10A rated  
**Connectors:** Positive locking Mate-N-Lok

**Temperature range:** ≤ 200°C

Need to heat a line in a hurry? Nor-Cal maintains a large inventory of heaters for 1 1/2, 2 and 4 inch tubing, elbows and flanges. Standard voltage is 120V. Nearly all heaters are available with 208V at no extra charge, replace "-3" with "-2" in model number. Other voltages are also available. Elbow and tee heaters fit both tube ending and flanged style weld fittings. Custom heaters for valves and other components are also available.

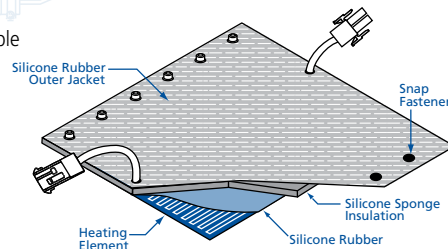


### Features

- Even heating up to 200°C
- High temperature cloth heaters for heating up to 450°C
- Easy on/off with reclosable fasteners
- Trimable, tight contact fit
- 1/4 or 1/2 inch thick closed cell silicone rubber
- 1/4 to 2 inch fiberglass based insulation for cloth heaters
- 120V or 208V standard, 208V available at no charge, replace "-3" with "-2" in model number, other voltages are also available
- Heaters are interconnectable up to a 10A circuit
- Integrates with standard controllers
- Built-in insulation with insulated lead wires
- UL recognized construction
- One year warranty

### Benefits

- Reduced system downtime
- Improved heat transfer minimizing cold spots
- Clean room compatible
- Combine standard parts to cover custom lines
- Adjustable temperatures
- Modular heating system



Thermocouple pocket is built-in to all straight length heaters three inch long and greater. Shown with optional thermocouple installed.

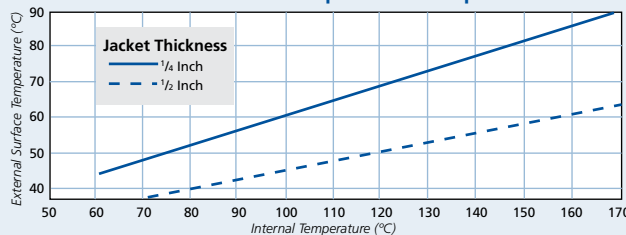


All trimable jackets allow for up to one inch of insulation to be removed. This allows you to cover almost any line completely.



Self-adhesive kapton thermocouples are available for heaters without thermocouple pockets.

### Internal/External Temperature Comparison







To achieve the optimal benefit from your Nor-Cal heating system, maximum heated coverage is needed. To accomplish this, measurement of the vacuum line is necessary. For best results, please contact your Nor-Cal representative for assistance.

### Line Measurement

Use the following guidelines to develop an approximate measurement to use for component selection and control zone layout. **NOTE:** To measure quickly, work from one end of the line to the other. Measure one component at a time. Component drawings are not necessary if detailed measurement notes are taken.

**DIAMETER:** Verify the line diameter by measuring the circumference (distance around the outside of the tubing) of a common straight section within the line.

DIAMETER	CIRCUMFERENCE
1.50"	4.71"
2.00"	6.28"
3.00"	9.42"
4.00"	12.57"

**STRAIGHT SECTIONS:** Measure the length of a straight section referencing the backside of the flange or the centerline of the weld fitting.

### 45° and 90° ELBOWS:

Measure the "L" dimension from the backside of the flange to the centerline of the opposing leg. Refer to specific heater drawings located in this catalog.

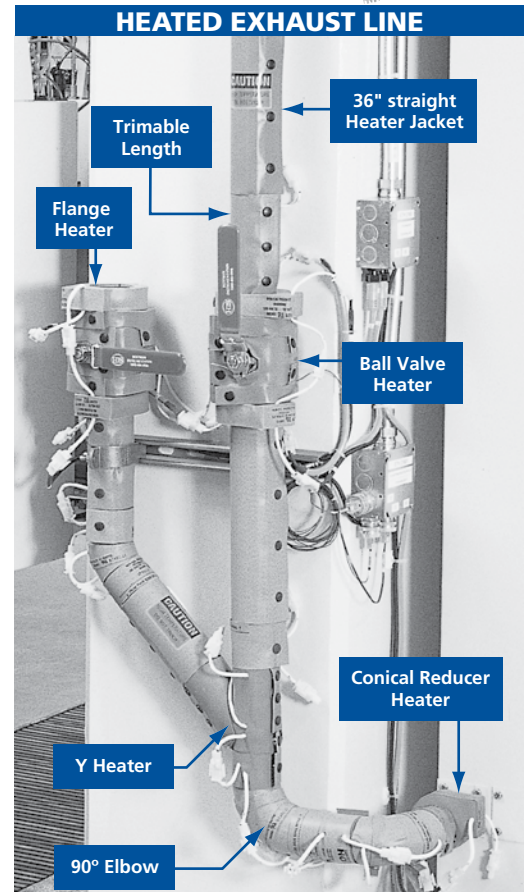
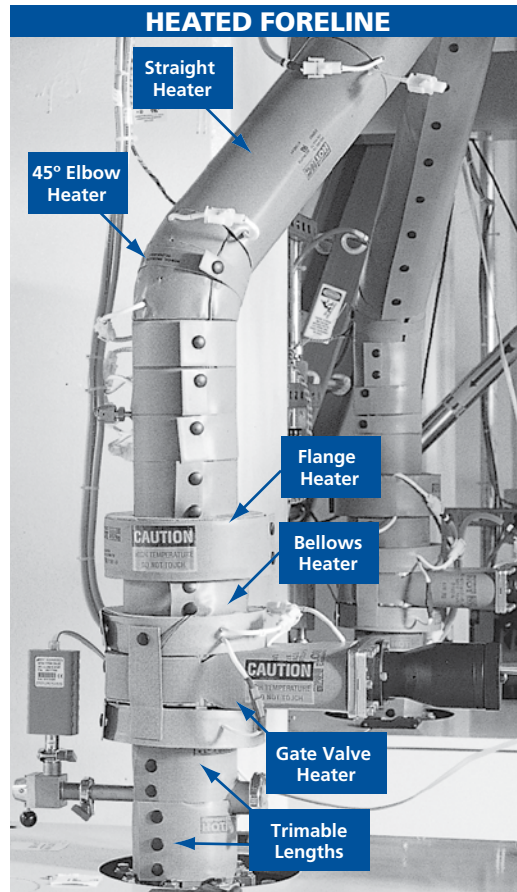
**TEE:** Measure the "L" dimension.

**FLEXIBLE SECTIONS:** Measure the bellows OD and the length. (See specific heater drawing.) **Note:** The length must be measured under compression with full vacuum pulled. If there is a noticeable "twisting" on the flexible section, adjustment of the line may be needed for proper heater installation.

**FLANGE:** Note flange type and measure.

### VALVES and OTHER SHAPES:

Nor-Cal has a large selection of existing heater designs for valves, reducers and other components. Note manufacturer, size and model number.



### Heater Jacket Selection

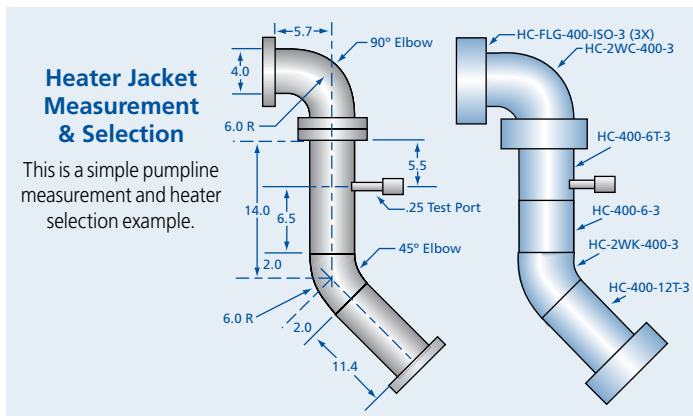
After measuring your system using the instructions on the facing page, choose the heater segments you will need from this product guide. List the model numbers with your notes.

Trimable heaters solve the problem of odd straight section lengths. For example, for a 14½ inch section, combine a 12 inch trimable and a 3 inch heater. The 12 inch heater can be cut to a minimum of 11 inches. Cut ½ inch from the 12 inch heater to make a 11½ inch length. Place cut edge towards the 3 inch heater to maximize temperature uniformity.

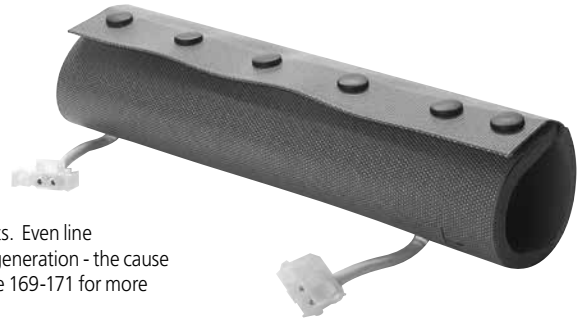
### Zone Layout and Heater Installation

- Heaters can be connected together end-to-end in order to form a larger single circuit which then can be controlled as one "zone."
- A single line may contain multiple zones, depending on the length and the complexity. Use the following rules of thumb when grouping sets of heaters into zones.
- The maximum amperage per zone is 10 amps, or 1200 watts. Please use the part number list to calculate the total wattage of your heated line. Dividing by 1080 will give you the approximate number of zones required.
- Split zones at natural break points, such as at a flange, elbow or valve.
- Each component, such as a gate valve, needs to be controlled with a separate control circuit. This is due to the difference in thermal mass between them and lengths of tubing.
- Temperature sensors (thermocouples) can be placed easily in any straight heater three inches long and up. These heaters have a built-in thermocouple pocket for easy installation of the sensor. Self-adhesive Kapton thermocouples are available for heaters without thermocouple pockets.
- Remove labels and residual glue with methanol or another solvent before attaching the heater jacket. Operating the heater on a component with a label can cause discoloration or scorching of the jacket and may cause the label to ignite and damage the heater.
- When choosing where to place the thermocouples for each zone, start at the process tool, placing the first thermocouple two to four feet from the outlet of the process.
- The jacket should fit tightly for optimum heat transfer. Loose areas can draw higher wattage and damage the insulation and/or heater element. **Note:** Heater must be attached to the component when in operation.
- **Do not immerse the heaters in water or cleaning solutions.**

See Thermal Products Worksheet on our website [www.n-c.com](http://www.n-c.com)







### SPECIFICATIONS

#### Materials

Heater jacket: Reinforced silicone rubber fabric  
 Insulator: 1/4 or 1/2 inch thick closed-cell silicone rubber foam  
 Fasteners: 1/2 inch diameter metal snaps with nylon cover standard

#### Electrical

Watt density:  
 1 to 2 inch diameter: 1.5 W/in<sup>2</sup>  
 3 to 4 inch diameter: 1.25 W/in<sup>2</sup>  
 Voltage: 120V or 208V standard, other voltages available  
 Power leads: 4 inch long #18 AWG, UL 1180/CSA 10A rated  
 Connectors: Positive locking Mate-N-Lok

Temperature range: ≤200°C

Installation of Nor-Cal's modular heaters help produce consistent process yields by reducing the build-up of by-products in valves and other exhaust line components. Even line heating minimizes cold spots, greatly reducing particle generation - the cause of most unscheduled maintenance downtime. See page 169-171 for more information on heated lines.

### 1/4" Thick Heater Jackets – 1 1/2" Tube OD

MODEL NUMBER	WATTS* 120 or 208V	POCKET Thermocouple	TRIMABLE	LENGTH L
HC-150-2-3	14			2
HC-150-2T-3	7**		✓	2
HC-150-3-3	22	✓		3
HC-150-3T-3	14	✓	✓	3
HC-150-4-3	29	✓		4
HC-150-4T-3	22	✓	✓	4
HC-150-5-3	36	✓		5
HC-150-5T-3	29	✓	✓	5
HC-150-6-3	43	✓		6
HC-150-6T-3	36	✓	✓	6
HC-150-12-3	85	✓		12
HC-150-12T-3	78	✓	✓	12
HC-150-18-3	128	✓		18
HC-150-24-3	170	✓		24
HC-150-24T-3	163	✓	✓	24
HC-150-30-3	213	✓		30
HC-150-36-3	255	✓		36
HC-150-36T-3	248	✓	✓	36

\* For 208V heaters replace the "3" with "2" at the end of the model number.  
 \*\* 208V is not available.

### 1/4" Thick Heater Jackets – 2" Tube OD

MODEL NUMBER	WATTS* 120 or 208V	POCKET Thermocouple	TRIMABLE	LENGTH L
HC-200-2-3	19			2
HC-200-2T-3	10		✓	2
HC-200-3-3	29	✓		3
HC-200-3T-3	19	✓	✓	3
HC-200-4-3	38	✓		4
HC-200-4T-3	29	✓	✓	4
HC-200-5-3	48	✓		5
HC-200-5T-3	38	✓	✓	5
HC-200-6-3	57	✓		6
HC-200-6T-3	47	✓	✓	6
HC-200-7T-3	57	✓	✓	7
HC-200-8T-3	68	✓	✓	8
HC-200-9T-3	75	✓	✓	9
HC-200-10T-3	85	✓	✓	10
HC-200-11T-3	95	✓	✓	11
HC-200-12-3	114	✓		12
HC-200-12T-3	104	✓	✓	12
HC-200-18-3	170	✓		18
HC-200-24-3	227	✓		24
HC-200-24T-3	217	✓	✓	24
HC-200-30-3	283	✓		30
HC-200-36-3	340	✓		36
HC-200-36T-3	330	✓	✓	36

\* For 208V heaters replace the "3" with "2" at the end of the model number.

### 1/2" Thick Heater Jackets – 1 1/2" Tube OD

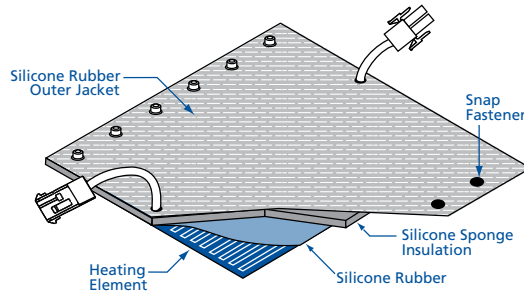
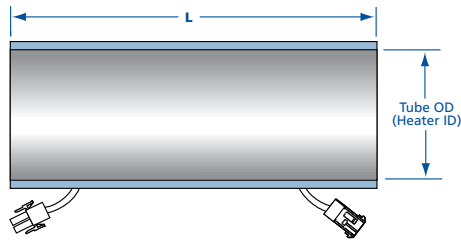
MODEL NUMBER	WATTS* 120 or 208V	POCKET Thermocouple	TRIMABLE	LENGTH L
HC2-150-2-3	14			2
HC2-150-2T-3	7**		✓	2
HC2-150-3-3	22	✓		3
HC2-150-3T-3	14	✓	✓	3
HC2-150-4-3	29	✓		4
HC2-150-4T-3	22	✓	✓	4
HC2-150-5-3	36	✓		5
HC2-150-5T-3	29	✓	✓	5
HC2-150-6-3	43	✓		6
HC2-150-6T-3	36	✓	✓	6
HC2-150-12-3	85	✓		12
HC2-150-12T-3	78	✓	✓	12
HC2-150-18-3	128	✓		18
HC2-150-24-3	170	✓		24
HC2-150-24T-3	163	✓	✓	24
HC2-150-30-3	213	✓		30
HC2-150-36-3	255	✓		36
HC2-150-36T-3	248	✓	✓	36

\* For 208V heaters replace the "3" with "2" at the end of the model number.  
 \*\* 208V is not available.

### 1/2" Thick Heater Jackets – 2" Tube OD

MODEL NUMBER	WATTS* 120 or 208V	POCKET Thermocouple	TRIMABLE	LENGTH L
HC2-200-2-3	19			2
HC2-200-2T-3	10		✓	2
HC2-200-3-3	29	✓		3
HC2-200-3T-3	19	✓	✓	3
HC2-200-4-3	38	✓		4
HC2-200-4T-3	29	✓	✓	4
HC2-200-5-3	48	✓		5
HC2-200-5T-3	38	✓	✓	5
HC2-200-6-3	57	✓		6
HC2-200-6T-3	47	✓	✓	6
HC2-200-7T-3	57	✓	✓	7
HC2-200-8T-3	68	✓	✓	8
HC2-200-9T-3	75	✓	✓	9
HC2-200-10T-3	85	✓	✓	10
HC2-200-11T-3	95	✓	✓	11
HC2-200-12-3	114	✓		12
HC2-200-12T-3	104	✓	✓	12
HC2-200-18-3	170	✓		18
HC2-200-24-3	227	✓		24
HC2-200-24T-3	217	✓	✓	24
HC2-200-30-3	283	✓		30
HC2-200-36-3	340	✓		36
HC2-200-36T-3	330	✓	✓	36

\* For 208V heaters replace the "3" with "2" at the end of the model number.



### SPECIFICATIONS

#### Materials

Heater jacket: Reinforced silicone rubber fabric  
 Insulator: 1/4 or 1/2 inch thick closed-cell silicone rubber foam  
 Fasteners: 1/2 inch diameter metal snaps with nylon cover standard

#### Electrical

Watt density:  
 1 to 2 inch diameter: 1.5 W/in<sup>2</sup>  
 3 to 4 inch diameter: 1.25 W/in<sup>2</sup>  
 Voltage: 120V or 208V standard, other voltages available  
 Power leads: 4 inch long #18 AWG, UL1180/CSA 10A rated  
 Connectors: Positive locking Mate-N-Lok

Temperature range: ≤200°C

### 1/4" Thick Heater Jackets - 3" Tube OD

MODEL NUMBER	WATTS* 120 or 208V	POCKET Thermocouple	TRIMABLE	LENGTH L
HC-300-2-3	24			2
HC-300-2T-3	12		✓	2
HC-300-3-3	36	✓		3
HC-300-3T-3	24	✓	✓	3
HC-300-4-3	48	✓		4
HC-300-4T-3	36	✓	✓	4
HC-300-5-3	59	✓		5
HC-300-5T-3	48	✓	✓	5
HC-300-6-3	71	✓		6
HC-300-6T-3	59	✓	✓	6
HC-300-12-3	141	✓		12
HC-300-12T-3	129	✓	✓	12
HC-300-18-3	213	✓		18
HC-300-24-3	283	✓		24
HC-300-24T-3	271	✓	✓	24
HC-300-30-3	354	✓		30
HC-300-36-3	425	✓		36
HC-300-36T-3	413	✓	✓	36

\* For 208V heaters replace the "3" with "2" at the end of the model number.

### 1/2" Thick Heater Jackets - 3" Tube OD

MODEL NUMBER	WATTS* 120 or 208V	POCKET Thermocouple	TRIMABLE	LENGTH L
HC2-300-2-3	24			2
HC2-300-2T-3	12		✓	2
HC2-300-3-3	36	✓		3
HC2-300-3T-3	24	✓	✓	3
HC2-300-4-3	48	✓		4
HC2-300-4T-3	36	✓	✓	4
HC2-300-5-3	59	✓		5
HC2-300-5T-3	48	✓	✓	5
HC2-300-6-3	71	✓		6
HC2-300-6T-3	59	✓	✓	6
HC2-300-12-3	141	✓		12
HC2-300-12T-3	129	✓	✓	12
HC2-300-18-3	213	✓		18
HC2-300-24-3	283	✓		24
HC2-300-24T-3	271	✓	✓	24
HC2-300-30-3	354	✓		30
HC2-300-36-3	425	✓		36
HC2-300-36T-3	413	✓	✓	36

\* For 208V heaters replace the "3" with "2" at the end of the model number.

### 1/4" Thick Heater Jackets - 4" Tube OD

MODEL NUMBER	WATTS* 120 or 208V	POCKET Thermocouple	TRIMABLE	LENGTH L
HC-400-2-3	32			2
HC-400-2T-3	16		✓	2
HC-400-3-3	48	✓		3
HC-400-3T-3	32	✓	✓	3
HC-400-4-3	63	✓		4
HC-400-4T-3	48	✓	✓	4
HC-400-5-3	79	✓		5
HC-400-5T-3	63	✓	✓	5
HC-400-6-3	95	✓		6
HC-400-6T-3	79	✓	✓	6
HC-400-7T-3	95	✓	✓	7
HC-400-8T-3	114	✓	✓	8
HC-400-9T-3	130	✓	✓	9
HC-400-10T-3	146	✓	✓	10
HC-400-11T-3	157	✓	✓	11
HC-400-12-3	189	✓		12
HC-400-12T-3	173	✓	✓	12
HC-400-18-3	283	✓		18
HC-400-24-3	377	✓		24
HC-400-24T-3	361	✓	✓	24
HC-400-30-3	472	✓		30
HC-400-36-3	566	✓		36
HC-400-36T-3	550	✓	✓	36

\* For 208V heaters replace the "3" with "2" at the end of the model number.

### 1/2" Thick Heater Jackets - 4" Tube OD

MODEL NUMBER	WATTS* 120 or 208V	POCKET Thermocouple	TRIMABLE	LENGTH L
HC2-400-2-3	32			2
HC2-400-2T-3	16		✓	2
HC2-400-3-3	48	✓		3
HC2-400-3T-3	32	✓	✓	3
HC2-400-4-3	63	✓		4
HC2-400-4T-3	48	✓	✓	4
HC2-400-5-3	79	✓		5
HC2-400-5T-3	63	✓	✓	5
HC2-400-6-3	95	✓		6
HC2-400-6T-3	79	✓	✓	6
HC2-400-7T-3	95	✓	✓	7
HC2-400-8T-3	114	✓	✓	8
HC2-400-9T-3	130	✓	✓	9
HC2-400-10T-3	146	✓	✓	10
HC2-400-11T-3	157	✓	✓	11
HC2-400-12-3	189	✓		12
HC2-400-12T-3	173	✓	✓	12
HC2-400-18-3	283	✓		18
HC2-400-24-3	377	✓		24
HC2-400-24T-3	361	✓	✓	24
HC2-400-30-3	472	✓		30
HC2-400-36-3	566	✓		36
HC2-400-36T-3	550	✓	✓	36

\* For 208V heaters replace the "3" with "2" at the end of the model number.



# Thermal Products Heater Jackets

### SPECIFICATIONS

#### Materials

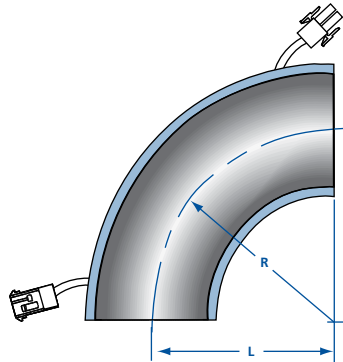
- Heater jacket: Reinforced silicone rubber fabric
- Insulator: 1/4 or 1/2 inch thick closed-cell silicone rubber foam
- Fasteners: 1/2 inch diameter metal snaps with nylon cover standard

**Fit:** Formed elbows and tees fit weld fittings and flanged style tubing

#### Electrical

- Watt density:  
1 to 2 inch diameter: 1.5 W/in<sup>2</sup>  
3 to 4 inch diameter: 1.25 W/in<sup>2</sup>
- Voltage: 120V or 208V standard, other voltages available
- Power leads: 4 inch long #18 AWG, UL 1180/CSA 10A rated
- Connectors: Positive locking Mate-N-Lok

**Temperature range:** ≤200°C



### 1/4" Thick Heater Jackets – 90° Radius Elbow

MODEL NUMBER	TANGENT	TUBE OD	LENGTH L	RADIUS R	WATTS* 120 or 240V
HC-2WC-150-3		1 1/2	2.00	2.25	25
HC-2WC-150HW-3	✓	1 1/2	2.68	2.25	36
HC-2WC-200-3		2	2.75	3.00	45
HC-2WC-200HW-3	✓	2	3.81	3.00	65
HC-2WC-300-3		3	4.00	4.50	93
HC-2WC-300HW-3	✓	3	5.81	4.50	141
HC-2WC-400-3		4	5.50	6.00	149
HC-2WC-400HW-3	✓	4	7.81	6.00	217

\* For 208V heaters replace the "-3" with "-2" at the end of the model number.

### 1/2" Thick Heater Jackets – 90° Radius Elbow

MODEL NUMBER	TANGENT	TUBE OD	LENGTH L	RADIUS R	WATTS* 120 or 240V
HC2-2WC-150-3		1 1/2	2.00	2.25	25
HC2-2WC-150HW-3	✓	1 1/2	2.68	2.25	36
HC2-2WC-200-3		2	2.75	3.00	45
HC2-2WC-200HW-3	✓	2	3.81	3.00	65
HC2-2WC-300-3		3	4.00	4.50	93
HC2-2WC-300HW-3	✓	3	5.81	4.50	141
HC2-2WC-400-3		4	5.50	6.00	149
HC2-2WC-400HW-3	✓	4	7.81	6.00	217

\* For 208V heaters replace the "-3" with "-2" at the end of the model number.

### SPECIFICATIONS

#### Materials

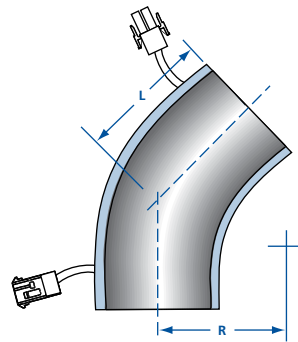
- Heater jacket: Reinforced silicone rubber fabric
- Insulator: 1/4 or 1/2 inch thick closed-cell silicone rubber foam
- Fasteners: 1/2 inch diameter metal snaps with nylon cover standard

**Fit:** Formed elbows and tees fit weld fittings and flange tubing

#### Electrical

- Watt density:  
1 to 2 inch diameter: 1.5 W/in<sup>2</sup>  
3 to 4 inch diameter: 1.25 W/in<sup>2</sup>
- Voltage: 120V or 208V standard, other voltages available
- Power leads: 4 inch long #18 AWG, UL 1180/CSA 10A rated
- Connectors: Positive locking Mate-N-Lok

**Temperature range:** ≤200°C



### 1/4" Thick Heater Jackets – 45° Radius Elbow

MODEL NUMBER	TANGENT	TUBE OD	LENGTH L	RADIUS R	WATTS* 120 or 240V
HC-2WK-150-3		1 1/2	0.69	2.25	13
HC-2KL-150HW-3	✓	1 1/2	1.38	2.25	23
HC-2WK-200-3		2	1.00	3.00	23
HC-2KL-200HW-3	✓	2	2.06	3.00	44
HC-2WK-300-3		3	1.37	4.50	47
HC-2KL-300HW-3	✓	3	3.18	4.50	95
HC-2WK-400-3		4	2.00	6.00	70
HC-2KL-400HW-3	✓	4	4.31	6.00	148

\* For 208V heaters replace the "-3" with "-2" at the end of the model number.

### 1/2" Thick Heater Jackets – 45° Radius Elbow

MODEL NUMBER	TANGENT	TUBE OD	LENGTH L	RADIUS R	WATTS* 120 or 240V
HC2-2WK-150-3		1 1/2	0.69	2.25	13
HC2-2KL-150HW-3	✓	1 1/2	1.38	2.25	23
HC2-2WK-200-3		2	1.00	3.00	23
HC2-2KL-200HW-3	✓	2	2.06	3.00	44
HC2-2WK-300-3		3	1.37	4.50	47
HC2-2KL-300HW-3	✓	3	3.18	4.50	95
HC2-2WK-400-3		4	2.00	6.00	70
HC2-2KL-400HW-3	✓	4	4.31	6.00	148

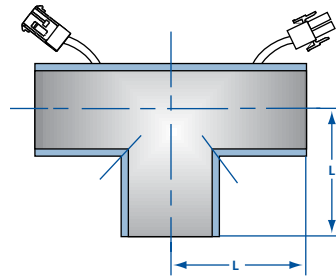
\* For 208V heaters replace the "-3" with "-2" at the end of the model number.



### Tee Heater Jackets

MODEL NUMBER	THICKNESS	TUBE OD	LENGTH L	WATTS* 120 or 240V
HC-7W-150-3	1/4	1 1/2	2	37
HC2-7W-150-3	1/2	1 1/2	2	37
HC-7W-200-3	1/4	2	2 3/4	69
HC2-7W-200-3	1/2	2	2 3/4	69
HC-7W-300-3	1/4	3	3	99
HC2-7W-300-3	1/2	3	3	99
HC-7W-400-3	1/4	4	3 5/8	140
HC2-7W-400-3	1/2	4	3 5/8	140

\* For 208V heaters replace the "-3" with "-2" at the end of the model number.



### SPECIFICATIONS

#### Materials

Heater jacket: Reinforced silicone rubber fabric  
 Insulator: 1/4 or 1/2 inch thick closed-cell silicone rubber foam  
 Fasteners: 1/2 inch diameter metal snaps with nylon cover standard

#### Electrical

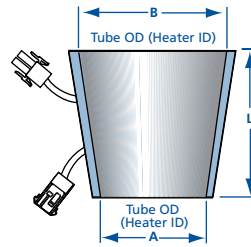
Watt density:  
 1 to 2 inch diameter: 1.5 W/in<sup>2</sup>  
 3 to 4 inch diameter: 1.25 W/in<sup>2</sup>  
 Voltage: 120V or 208V standard, other voltages available  
 Power leads: 4 inch long #18 AWG, UL 1180/CSA 10A rated  
 Connectors: Positive locking Mate-N-Lok

Temperature range: ≤200°C

### Conical Heater Jackets

MODEL NUMBER	THICKNESS	A	B	LENGTH L	WATTS* @ 120V
HC-200-150-3	1/4	1 1/2	2	1 3/8	12
HC2-200-150-3	1/2	1 1/2	2	1 3/8	12
HC-300-200-3	1/4	2	3	2 7/16	24
HC2-300-200-3	1/2	2	3	2 7/16	24
HC-400-200-3	1/4	2	4	2 5/8	31
HC2-400-200-3	1/2	2	4	2 5/8	31
HC-400-300-3	1/4	3	4	2 5/8	36
HC2-400-300-3	1/2	3	4	2 5/8	36

\* For 208V heaters replace the "-3" with "-2" at the end of the model number.



### NW & ISO Flange Heater Jackets

MODEL NUMBER	THICKNESS	FLANGE TYPE	NOMINAL TUBE OD	WATTS* @ 120V
HC-FLG-150-NW-3	1/4	NW-40	1 1/2	10
HC2-FLG-150-NW-3	1/2	NW-40	1 1/2	10
HC-FLG-200-NW-3	1/4	NW-50	2	15
HC2-FLG-200-NW-3	1/2	NW-50	2	15
HC-FLG-300-ISO-3	1/4	ISO-80	3	35
HC2-FLG-300-ISO-3	1/2	ISO-80	3	35
HC-FLG-400-ISO-3	1/4	ISO-100	4	82
HC2-FLG-400-ISO-3	1/2	ISO-100	4	82

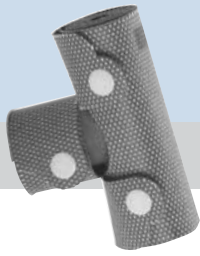
\* For 208V heaters replace the "-3" with "-2" at the end of the model number.



### NW & ISO Flange Insulators

MODEL NUMBER	THICKNESS	FLANGE TYPE	NOMINAL TUBE OD
HI-FLG-100-NW-1	1/4	NW-25	1
HI-FLG-150-NW-1	1/4	NW-40	1 1/2
HI2-FLG-150-NW-1	1/2	NW-40	1 1/2
HI-FLG-200-NW-1	1/4	NW-50	2
HI2-FLG-200-NW-1	1/2	NW-50	2
HI-FLG-300-ISO-1	1/4	ISO-80	3
HI2-FLG-300-ISO-1	1/2	ISO-80	3
HI-FLG-400-ISO-1	1/4	ISO-100	4
HI2-FLG-400-ISO-1	1/2	ISO-100	4





# Thermal Products

## Gas Line Heaters & Insulators

### SPECIFICATIONS

#### Materials

Heater and jacket: Reinforced silicone rubber fabric

Color: Orange

Insulation: 1/4 inch thick closed-cell silicone rubber foam

Fasteners: Nylon snap

#### Electrical

Watt density: 2.5 W/in<sup>2</sup> typical

Voltage: 120V standard

Power leads: 3 inch long #18 AWG, UL 1180/CSA 10A rated

Connectors: Positive locking Mate-N-Lok

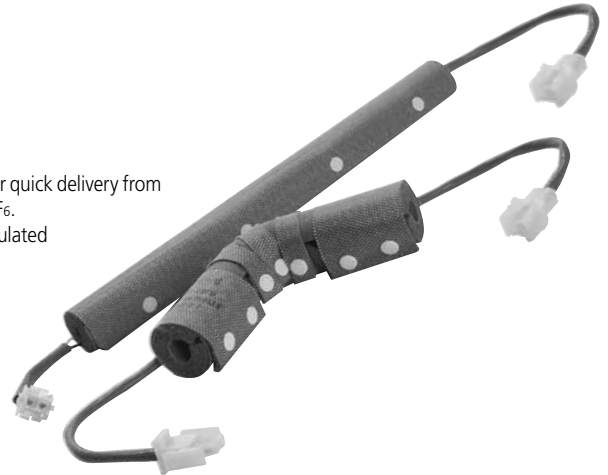
Temperature range: ≤200°C

Thermocouples: #30 AWG, Type J, Teflon insulated

Nor-Cal's upstream gas line heaters and insulators offer quick delivery from stock for heating gas delivery lines, such as BCl<sub>3</sub> and WF<sub>6</sub>.

They are made from silicone rubber heater material insulated with 1/4 inch closed cell silicone rubber sponge and feature quick ON/OFF installation with snap closures.

Heaters can be linked/daisy chained to a maximum of 10 amps. Lead pair extends 3 inches past each end of the heaters. Insulators trim-to-fit to insure 100% line coverage. Flexible elbow heaters fit most radius elbows. Meets UL94HB flammability requirements. UL Listed.



### Gas Line Heaters - 1/4" Tube OD

MODEL NUMBER	TYPE	TYPE J Thermocouple	LENGTH	WATTS @ 120V
HC-025-6-1	Straight		6	12
HC-025-6-TC-1	Straight	✓	6	12
HC-025-9-1	Straight		9	18
HC-025-9-TC-1	Straight	✓	9	18
HC-025-12-1	Straight		12	24
HC-025-12-TC-1	Straight	✓	12	24
HC-025-18-1	Straight		18	36
HC-025-18-TC-1	Straight	✓	18	36
HC-025-24-1	Straight		24	48
HC-025-24-TC-1	Straight	✓	24	48
HC-025-36-1	Straight		36	72
HC-025-36-TC-1	Straight	✓	36	72

### Gas Line Heater Elbows - 1/4" Tube OD

MODEL NUMBER	TANGENTS	LENGTH	WATTS @ 120V
HC-025-2WC-1-1	Two 1 inch	6	12
HC-025-2WC-5-1	One 5 inch	9	18

### Gas Line Heaters - 1/2" Tube OD

MODEL NUMBER	TYPE	TYPE J Thermocouple	LENGTH	WATTS @ 120V
HC-050-6-1	Straight		6	24
HC-050-6-TC-1	Straight	✓	6	24
HC-050-9-1	Straight		9	36
HC-050-9-TC-1	Straight	✓	9	36
HC-050-12-1	Straight		12	48
HC-050-12-TC-1	Straight	✓	12	48
HC-050-18-1	Straight		18	72
HC-050-18-TC-1	Straight	✓	18	72
HC-050-24-1	Straight		24	96
HC-050-24-TC-1	Straight	✓	24	96
HC-050-36-1	Straight		36	144
HC-050-36-TC-1	Straight	✓	36	144

### Gas Line Insulators - 1/4" Tube OD

MODEL NUMBER	TYPE	TRIMABLE	TUBE OD
HI-025-18T	18 inch straight length	✓	1/4
HI-025-7W-M	Micro-tee		1/4
HI-025-2WC-M	Micro-elbow		1/4

### Gas Line Insulators - 1/2" Tube OD

MODEL NUMBER	TYPE	TRIMABLE	TUBE OD
HI-050-18T	18 inch straight length	4	1/2
HI-050-7W-M	Micro-tee		1/2
HI-050-2WC-M	Micro-elbow		1/2

**Warning:** Upstream gas line heater jackets are not designed for hazardous or outdoor locations. They are not designed for total or partial immersion and should only be installed on grounded metallic tubing systems or GFI protected circuit.



### HCS-Series Heaters (1/4" and 1/2" OD Tube)

MODEL NUMBER	TUBE OD	MINIMUM LENGTH	MAXIMUM LENGTH	WATTS@120V
HCS-025-8-1*	1/4	8	10	12
HCS-025-11-1*	1/4	11	14.5	17
HCS-025-15-1	1/4	15	19	22
HCS-025-19-1	1/4	19	24	28
HCS-025-24-1	1/4	24	30.5	36
HCS-025-31-1	1/4	31	40	47
HCS-025-40-1	1/4	40	51	60
HCS-025-50-1	1/4	50	64	76
HCS-025-60-1	1/4	60	76.5	90
HCS-050-7-1*	1/2	7	10	17
HCS-050-10-1*	1/2	10	15	25
HCS-050-14-1	1/2	14	21	35
HCS-050-19-1	1/2	19	29.5	49
HCS-050-25-1	1/2	25	38.5	64
HCS-050-31-1	1/2	31	47.5	79
HCS-050-39-1	1/2	39	59.5	99
HCS-050-50-1	1/2	50	74	123
HCS-050-60-1	1/2	60	92.5	154

\* Note: 240V not available in these sizes.

(240V heaters can be ordered by changing the last "-1" to "-2")

#### SPECIFICATIONS

##### Materials

Color: Orange  
Heater: Spiral formed reinforced silicone rubber fabric

##### Electrical

Watt density:  
Max. 2.0 W/in<sup>2</sup> at 100% coverage, 80% coverage recommended  
Voltage: 120V or 240V\*  
Leads: 12" long pair located on one end, #18 AWG, UL 1180/CSA 10A rated  
Connectors: Positive locking AMP Mate-N-Lok

Temperature range: ≤200°C

### HCS-Series Insulators (3/8" Thick Insulation)

MODEL NUMBER	DESCRIPTION
HIS-025-18	INS,1/4" Spiral Wrap,18" Long
HIS-025-2WC-M	INS,1/4" Spiral Wrap,Micro Elbow
HIS-025-7W-M	INS,1/4" Spiral Wrap,Micro Tee
HIS-025-VCR	INS,1/4" Spiral Wrap,VCR Union
HIS-038-18	INS,3/8" Spiral Wrap,18" Long
HIS-038-2WC-M	INS,3/8" Spiral Wrap,Micro Elbow
HIS-038-7W-M	INS,3/8" Spiral Wrap,Micro Tee
HIS-038-VCR	INS,3/8" Spiral Wrap,VCR Union
HIS-050-18	INS,1/2" Spiral Wrap,18" Long
HIS-050-2WC-M	INS,1/2" Spiral Wrap,Micro Elbow
HIS-050-7W-M	INS,1/2" Spiral Wrap,Micro Tee
HIS-050-VCR	INS,1/2" Spiral Wrap,VCR Union

#### SPECIFICATIONS

##### Materials

Color: Insulation and outer jacket – orange  
Insulator: 3/8" thick closed cell silicone rubber

Fasteners: Cleanroom straps

Temperature range: ≤200°C

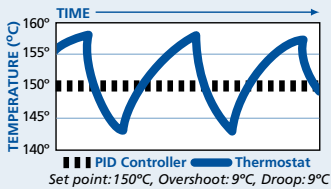
# Thermal Products

## Controllers, Thermostats & Accessories

Nor-Cal is your source for temperature controllers. Full thermal control of the process is available through front panel controls including set points and alarms. Timers and digital readouts are standard on some models. Enclosures are either Nema 4, 4x or 12. Most controllers are RS232/485 compatible. Choose from 1, 2, 4 and 8 zone controllers. Line voltage is from 100V to 240V. Custom voltages and zoning is available on request. PC control using standard software programs is available. Nor-Cal heater controllers come with a three year warranty.

### The Effect of Temperature Excursion on Heater Life

PID Controllers result in temperature control accuracy of  $\pm 2^\circ\text{C}$ , and extend heater element life by up to 10 times. Although the lowest cost initially, thermostats create the highest 3 year operating cost due to heater failure caused by temperature excursions. (See chart below) Although the highest cost initially, PID controllers with SCR Burst Firing create the lowest 3 year operating cost due to its ability to eliminate temperature excursions. This can extend heater life up to 10 times.



### Heater Controllers

HC-SD series digital indicating, microprocessor-based heater controllers are available with a single temperature sensor input from a thermocouple or RTD sensor, and control outputs for one, two and four zones. These low-cost, self contained controllers' feature a programmable alarm, small panel footprint and operate at  $\pm 0.25\%$  accuracy. The outputs may operate in a variety of modes including: heat, alarm and timer. The countdown timer function operates in a choice of delay-ON, delay-OFF, signal-ON or signal-OFF modes. Front panel lock capability rounds out the feature set. Other features include EIA-485 Modbus serial communication, 1/32 DIN package, Nema 4x control console and a universal power supply.

### Controllers

MODEL NUMBER	VOLTAGE	MAX. AMP OUTPUT / ZONE	ZONES	AC PLUG
HC-SDC15-1-1	120V	10	1	Straight blade
HC-SDC15-1-2	208-240V	10	1	Schuko
HC-SDC15-2-1	120V	5	2	Straight blade
HC-SDC15-2-2	208-240V	5	2	Schuko

### Electronic Thermostats

Nor-Cal offers UL recognized electronic thermostats for fixed set-point thermal applications. Electronic thermostats replace the thermocouple/controller assembly on a heater with a single device attached to the heater jacket. These devices have an extended life of over 10 times the standard thermostat life. In addition, temperature variations are typically  $\pm 3^\circ\text{C}$ , a major improvement over typical thermostats'  $\pm 15^\circ\text{C}$ . These thermostats include a thermocouple sensor and power switching compactly integrated into the heater's power cable. A single thermostat may be attached to several heater jackets on the same line to reduce system costs. They are pre-programmed with the thermal set point you request. Call for more details.



### Thermocouples & Cables

MODEL NUMBER	DESCRIPTION*	LENGTH IN FEET
HC-TC-K-1	K-type with one foot lead and mini-connector	1
HC-TC-K-8	K-type with eight foot lead and mini-connector	8
HC-TC-K-KAP-8	K-type kapton with eight foot lead and mini-connector	8
HC-TC-CRD-K-6	K-type thermocouple extension cable with connectors	6
HC-TC-CRD-K-10	K-type thermocouple extension cable with connectors	10
HC-TC-CRD-K-25	K-type thermocouple extension cable with connectors	25

\*Most items available in various lengths and in J-type also. Call for pricing and information.

### Control Cables and Accessories

MODEL NUMBER	DESCRIPTION	LENGTH IN FEET
HC-PLG	Termination for end of last heater, 2 prong MNL plug	-
HC-PLG-2C	Termination for end of last heater, 2 prong MNL cap	-
HC-PLG-3C	Termination for end of last heater, 3 prong MNL cap	-
HC-PLG-3P	Termination for end of last heater, 3 prong MNL plug	-
HC-PCRD-6	SD3 controller to heater or 2 circuit MNL extension, 2 circuit plug, 2 circuit cap	6
HC-PCRD-6-3	SD3 controller to heater, 2 circuit plug, 3 circuit MNL cap	6
HC-PCRD-6-3B	SD3 controller to cloth heater, 2 circuit plug, 3 circuit MNL cap, center ground	6
HC-PCRD-CPC-6-2	SDC15 controller to heater, CPC, 2 circuit MNL cap	6
HC-PCRD-CPC-6-3	SDC15 controller to heater, CPC, 3 circuit MNL cap	6
HC-PCRD-CPC-6-3B	SDC15 controller to cloth heater, CPC, 3 circuit MNL cap, center ground	6
HT-CRD-6-2P	120V straight wall to 2 circuit MNL plug	6
HT-CRD-6-3P	120V straight wall to 3 circuit MNL plug (GNV heater)	6



# Chambers & Weldments

## Section Seven



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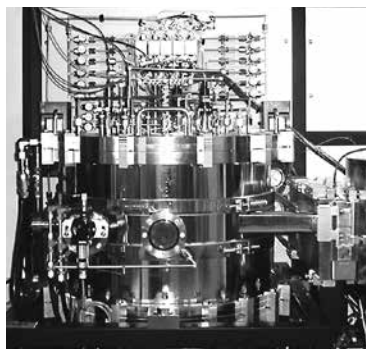






# Chambers & Weldments

## General Information

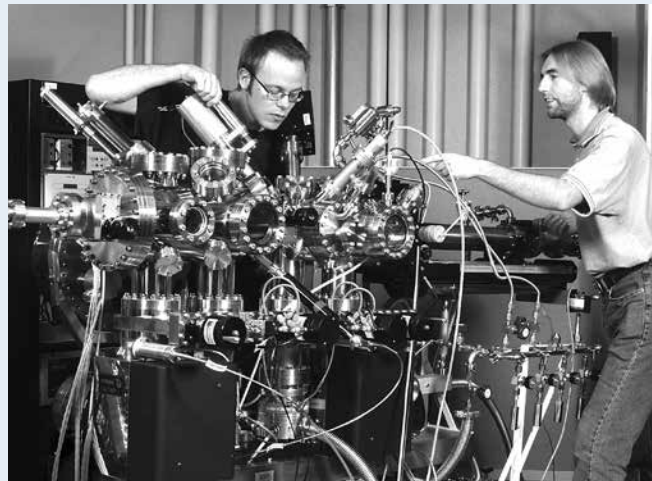


MOCVD reactor chamber

Nor-Cal Products has earned a reputation as a world-class manufacturer of high and ultra-high vacuum chambers. The quality, appearance and performance of our chambers are unequalled. We supply single chambers designed from customer specifications for university or national laboratory research projects, as well as production quantity chambers that are built-to-print for equipment manufacturers. Thin-film deposition and compound semiconductor processing are common applications for our high-vacuum, O-ring sealed chambers that operate at pressures down to  $1 \times 10^{-9}$  mbar. Vacuum fired 316L stainless steel, electropolishing and metal seals are recommended for ultra-high vacuum surface science chambers that operate at pressures in the  $1 \times 10^{-11}$  mbar range. Nor-Cal can fabricate vacuum chambers up to approximately 5 x 5 feet (1.52 x 1.52 x 1.52 Meters) with doors, stands, water jackets and Mumetal shields. (Consult the factory for exact capabilities.) We offer a complete line of vacuum chamber accessories that include load locks, sample transfer and positioning devices, liquid and electrical feedthroughs, viewports and roughing components.

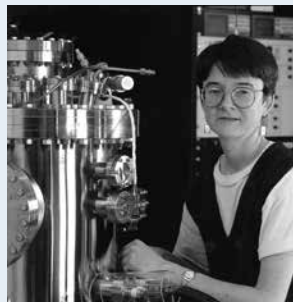


Vacuum coating chamber



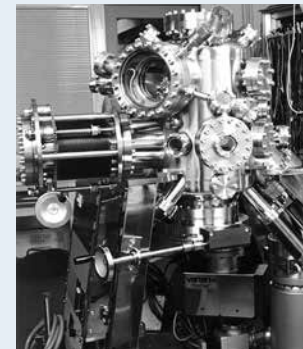
*"The system utilizes several types of analyzers around the analysis chamber. Designed to be ergonomic and user-friendly, the system's frame components are on the floor level, maximizing accessibility to the research instruments. Electropolished 316L vacuum fired stainless steel was selected for the chambers in order to obtain a base pressure less than  $3 \times 10^{-11}$  mbar. Based on previous projects, we selected Nor-Cal Products to manufacture the vacuum chambers and components. We are very pleased with their quality, service and on-time delivery."*

**Jan-Olof Forsell**  
Design Manager, Gammadata Scienta and SSRL



*"I would like to reiterate how impressed we've been by the professional service we've received from Nor-Cal Products. I've interacted with engineers and salespeople from many vacuum equipment suppliers. It never fails to surprise me how uneven the service is. Salespeople are often uncommunicative, giving the impression that they're not in the least bit interested in your business, and technical people often don't know their products. It's incredibly refreshing, therefore, to interact with people, such as those at Nor-Cal, who are both courteous and well informed."*

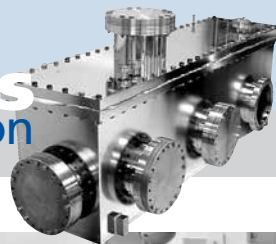
**Susan Watson, PhD**  
Department of Physics,  
University of California, San Diego



*"This vacuum system was optimized for investigations into the magnetic properties of a wide range of materials using soft x-rays from synchrotron radiation sources. For such work, ultra high vacuum is necessary and this Nor-Cal Products chamber has a base pressure of  $5 \times 10^{-11}$  mbar after baking. The use of independent rotary stages for positioning of the sample and in-vacuum electromagnet provide a very high degree of flexibility by allowing any combination of sample surface and applied field relative to the incident soft x-rays."*

**Dr. Jonathan Hunter-Dunn**  
MAX-Lab  
Lund University, Sweden

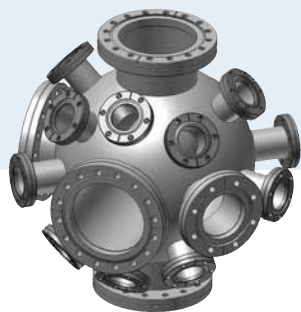
All dimensions are in inches unless otherwise noted



### Engineering

As part of our commitment to quality and customer satisfaction, Nor-Cal's engineering staff thoroughly reviews each custom vacuum component for manufacturability before the production process begins. All customers benefit from the combined experience of our engineers, whose input during the design and production phase often results in cost savings and a superior product. Questions regarding design, specifications and testing are directed back to the customer for final approval.

Our engineers design from customer specifications, sketches or drawings and oversee custom component production using existing tooling and facilities. For our customers who do not have drafting personnel available and require a complex assembly, we can provide complete CAD drawings for approval after receipt of order. Nor-Cal's engineering department employs the latest versions of SolidWorks™ drafting and solid modeling software. Drawings may be e-mailed direct to our engineering department at [prints@n-c.com](mailto:prints@n-c.com). Acceptable file formats are IGES, SAT and STEP. You may also request CAD drawings and download 3D models of our most commonly used standard components from our website.



### Manufacturing

Machining procedures are consistent with good UHV practices. Machine coolant is sulfur-free to reduce outgassing. All Nor-Cal components are designed to minimize entrapments that cause virtual leaks under vacuum. State-of-the-art CNC machining equipment is used to produce parts with consistently high quality.

GTAW fusion welding is used exclusively for a vacuum-tight metal bond. Purging with an inert gas reduces or eliminates oxygen entrainment and carbide precipitation that cause outgassing. Whenever possible welds are made on the inside, or are full penetration to eliminate entrapments and virtual leaks. External stitch welds are used in conjunction with internal vacuum welds for structural reinforcement, as necessary.



### Materials

Nor-Cal Products uses 304 stainless steel tubing, spheres or roll-ups to fabricate vacuum vessels; however, 304L, 316, 316L or 316LN stainless steel can also be supplied. We have found that optimal vacuum performance can be obtained by using 2B rolled sheet with no secondary grinding for the body followed by electropolishing after ports are welded. Normally our standard material is dual certified 304/304L low carbon range stainless steel.

Flanges and baseplates are made from 304 stainless steel that has been specially treated to remove impurities inherent in 300 series steels. Special UHV-flanges 4 1/2 inches (114.3mm) OD and smaller can be made from 304 electroslag remelt (ESR) bar stock. ESR is a refining process that produces stainless steel with higher purity, fewer inclusions and more uniform grain structure to eliminate microscopic leak paths.

Our standard flange material is certified to meet ASTM A-240 and has less than 0.01% sulfur to prevent sulfur stringers. Grain size is 3 to 6 per ASTM E-112. Maximum inclusion size is 2.5 per ASTM E-45. Roll-forged rings, Mumetal, aluminum and other materials can be supplied upon request.



### Cleaning

A biodegradable detergent is used to remove machine lubricants before the parts are washed and rinsed with deionized water. Nor-Cal offers in-house bead blasting, chem cleaning and electropolishing of vacuum chambers. Glass shot cleans, hones, polishes and peens while removing scale. Some customers request bead blast on the exterior of the chamber with electropolish on the interior.

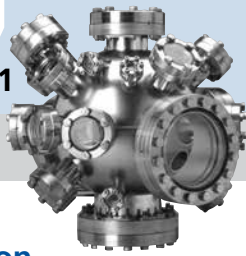


Electropolishing is considered the most desirable cleaning and surface conditioning process for stainless steel vacuum chambers. It is an electrochemical process that benefits the finished part in a number of ways simultaneously. Deburring, passivation and stress relieving are achieved while the machine-produced surface roughness is eroded. Electropolishing attacks the microscopic "peaks" of the surface more rapidly than the "valleys"; thereby maintaining critical dimensions while improving surface finishes. Normally .0003 to .0004 inches (.00762 to .01016mm) would be removed to lower the microfinish from 32 to 8 RMS. Electropolishing a 2B stainless steel rolled sheet achieves approximately a 90% reduction in surface area. This is most important for vacuum chambers because

it produces faster pumpdown and a lower base pressure. In addition to the improved mechanical properties of the surface, iron is removed electrochemically. This leaves the surface rich in chromium and nickel, which have extremely low vapor pressures. The result is the lowest outgassing rates possible from stainless steel. Having an in-house facility allows Nor-Cal to do multi-step electropolish in order to reduce "shadowed" areas on chambers with difficult geometries. Our electropolish tanks can accommodate chambers up to 60 x 50 x 65 inches (1.52 x 1.27 x 1.65 Meters).

All stainless steel parts are descaled and passivated in an acid solution to remove weld scale and other oxide layers. This process leaves the surface free from most contaminants that might impact the vacuum environment or promote intergranular corrosion. (Contact our factory for Ion Chromatography (I.C.) test data.) Chem cleaning can be used as a final cleaning step for chambers up to 35 x 53 x 33 inches (889 x 1346.2 x 838.2mm) to remove organic and metallic contaminants. The chamber is immersed in a series of controlled chemical baths and deionized water rinses and dried using filtered air. Chem cleaning results in the cleanest surface possible for ultra high vacuum components. (Contact our factory for I.C. test data.)





### Inspection

Nor-Cal uses the most up-to-date equipment and procedures for the inspection of vacuum chambers. Every weld is leak checked with a helium mass spectrometer to insure leak rates of  $1 \times 10^{-9}$  mbar l/sec. or less. Mechanical inspection is accomplished with a coordinate measuring machine (CMM). We can provide our customers with CMM inspection reports of their chambers on request.

Our chamber qualification and test equipment is available to customers for an additional fee who request residual gas analysis (RGA) scans and leak checks of their chamber after vacuum baking. The test equipment includes vacuum pumps, gauges, RGA, quartz heaters, nitrogen back fill and a leak detector. Chamber bake out is achieved with high intensity infrared radiant lamps that are strategically placed throughout the chamber. Baking under vacuum removes high and low molecular weight volatile compounds. Non-water cooled UHV chambers are typically baked for at least 24 hours at  $150^{\circ}\text{C}$ . (The maximum temperature of system components such as seals, chamber materials, valves, etc. may limit maximum baking temperatures.)

Uniform bakeout temperature is achieved by wrapping the associated system components in high temperature fiberglass materials.

After cool down our RGA will provide partial pressure data, determining the level of residual volatile compounds. Typical scans produce atomic mass levels below  $1 \times 10^{-9}$  mbar for atomic masses greater than or equal to 44. Total system pressures are between  $5 \times 10^{-9}$  and  $7 \times 10^{-10}$  mbar. Chamber design, seals and pumps used, and the maximum bake temperature over time effect the residual gas composition and ultimate pressures reached. Following chamber scanning, chambers are leak tested using a NIST traceable helium mass spectrometer leak detector with a final allowable leak rate of  $1 \times 10^{-10}$  mbar l/sec. or less.



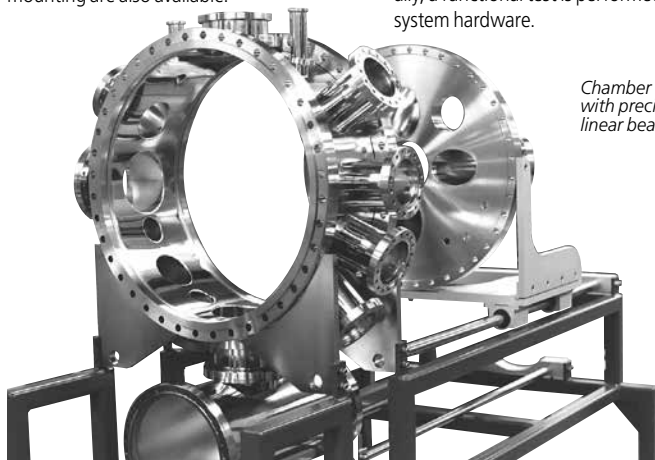
Mechanical inspection of process chamber with CMM (coordinate measuring machine)

### Frames

Frames are usually constructed from  $1\frac{1}{2}$  or 2 inch (38.1 or 28.8mm) mild steel box tubing, which is powder coated. However, aluminum or a variety of other materials are available. In addition to leveling pads and castor wheels, we can design and fabricate frames with precision rotational and linear bearings for moving components, such as chamber lids. Integrated hoist assemblies, pump mounting, cabinets and panel rack mounting are also available.

### System Integration

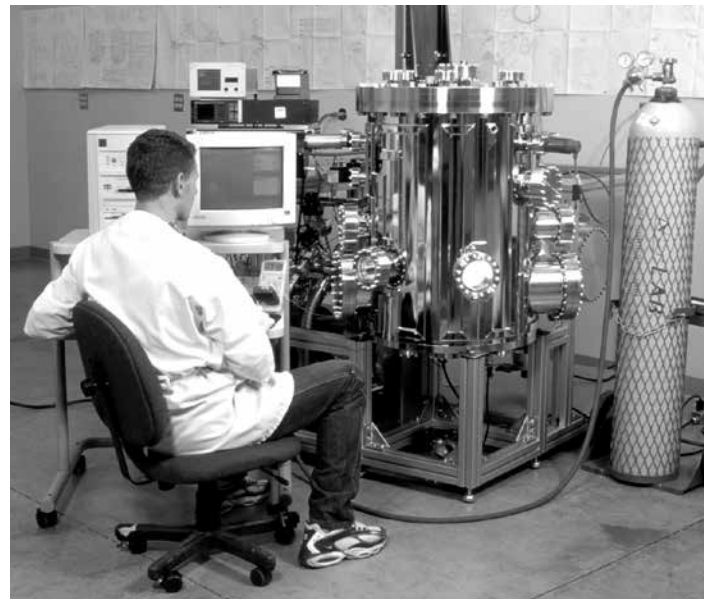
Nor-Cal can assemble an entire system including chamber, frame, pumps, gauges, valves, manipulators and other components to customer specifications in our 1,100 square foot, class 1000, final assembly area. After completion our vacuum technicians can complete a thorough system qualification, including bake out, RGA scan and leak check using the procedures described above. Additionally, a functional test is performed on all system hardware.



Chamber frame with precision linear bearings



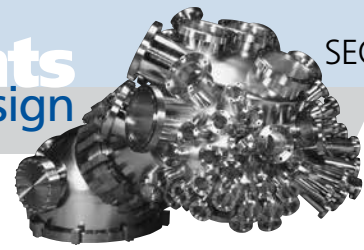
Leak testing of chamber on chamber qualification test bench



System integration

### Packaging

Vacuum chambers and other large components are packaged appropriately for truck, ship or airfreight to our customer's location. Unless specified otherwise, flanges are covered with aluminum foil to prevent internal contamination and scratching of the flange faces. Protective plastic covers are placed over the foil for additional protection. The chamber is then wrapped in 4 mil plastic and placed in a wooden crate. Foam is injected into plastic "pillows" which expand to fill the voids in the crate, suspending the chamber inside. Depending on customer specifications for systems, after qualification the chambers can be disassembled or purged with nitrogen gas, clean room packaged and shipped. Alternatively, some chambers have been packaged and shipped under vacuum.

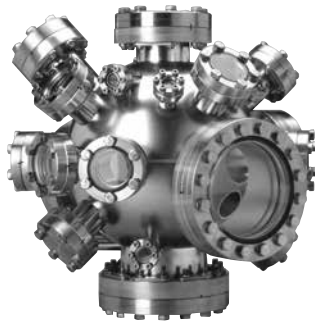


The information presented on the following three pages is provided as a general guideline to the vacuum engineer or end user to aid in the design of their vacuum chamber. In addition to the specific areas which are discussed, these considerations should be addressed when designing a vacuum chamber:

Chamber Material	Vacuum Level	Surface treatment	Special Requirements	Additional Hardware	Required Inspection Reports
304SS, 304LSS, 316SS, 316LSS, aluminum, etc.	Base pressure and acceptable leak rate	Glass bead finish, electropolish, chemical clean, etc.	Vacuum bakeout, vacuum fire or RGA scan.	Blank-off flanges, manipulators, viewports, etc.	CMM inspection report printouts or certificate of conformance and/or material certificates

By first determining the basic design parameters from those mentioned above, the actual process of designing, specifying and estimating the cost of your chamber will follow more smoothly. Nor-Cal sales estimators are available for any assistance you require. Engineering drawings can be e-mailed directly to [prints@n-c.com](mailto:prints@n-c.com).

### Typical Chamber Configurations



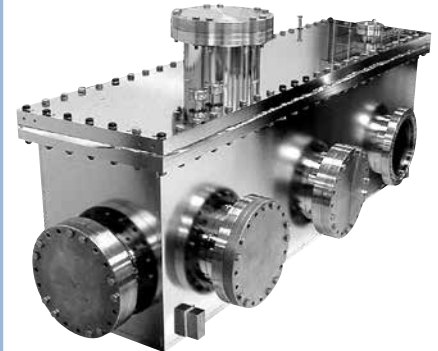
#### Spheres and Hemispheres

Spun hemispheres can be purchased in a wide range of standard sizes and welded together to form a spherical body. Often a large tube is attached to the bottom of the sphere for attachment of the pump. A number of smaller, radial ports can be positioned around the sphere for attachment of the load lock and various instruments. This is a common configuration for UHV analyzer chambers with a single target. This configuration is lighter, less expensive to manufacture and has less internal volume than cylindrical configurations with machined lids.



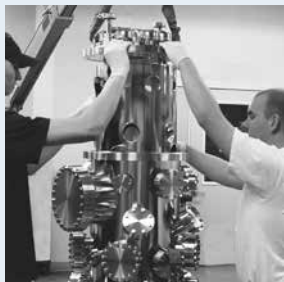
#### Cylindrical

Cylindrical chamber bodies come in a variety of sizes and are made of tubing or roll-ups. The base plate and lid of the chamber can be made from die-formed dished heads, hemispheres or blank flanges. Dished heads and hemispheres are lighter and typically less expensive than machined flanges. This configuration is commonly used for analyzer chambers with multiple levels and targets, and for processing chambers with carousels or robotic arms.



#### Rectangular

Rectangular chambers are generally more expensive than other configurations. However, they may be the preferred choice because of a requirement for accessibility, or when large chamber mass is required for vibration dampening. Rectangular chambers are fabricated from plate material that is welded, or they are machined from solid billets. Depending on material thickness and span, stiffening bars may be required to prevent deflection of the walls while the chamber is under vacuum.



Double wall construction

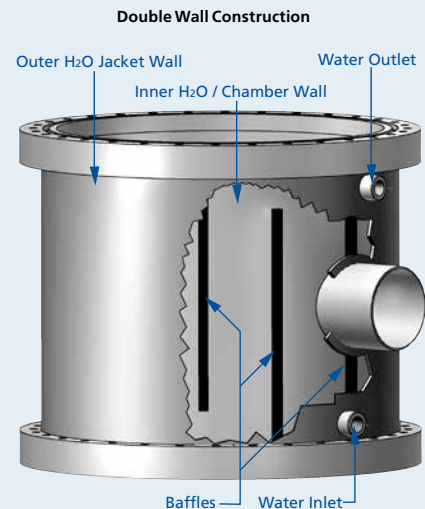


Water channel construction

### Water Cooled Chambers

Nor-Cal Products frequently provides water cooled chambers and flanges for diffusion, CVD, and other high temperature vacuum applications. Normally the construction techniques involve water channels or double walled construction. Water channels require considerable hand fitting and therefore tend to be more expensive than double walled construction. Double wall water-cooled chambers are fitted with internal baffles to provide consistent circulation throughout the chamber, resulting in excellent internal temperature uniformity.

Water-cooled chambers manufactured by Nor-Cal undergo a rigorous leak test to insure that they are free from water leaks. First the water cavities are stressed by pressurizing them with dry nitrogen. The water cavity is then pumped down with a helium leak detector, while helium is applied with a probe to all welds on the inside and outside of the chamber. (Consult the factory for pressure and integrity acceptance criteria.)







# Chambers & Weldments

## Guide to Vacuum Chamber Design

### STANDARD CHAMBER DIMENSIONS

Nor-Cal can manufacture vacuum chambers with metric size tubes, roll-ups, and spheres, however inch sized materials are more readily available in the US and can be furnished for a lower price. For further clarification, contact an estimator at the factory or see our website.

#### Chamber Wall Thickness

Recommended minimum wall thicknesses are listed in the table below. Thicker walled material should be specified for chambers with ports having angular tolerances of less than  $1/2^\circ$ , or for processes that require large mass for vibration dampening.

CHAMBER DIAMETER	WALL THICKNESS
Under 17 inches (431.80)	0.120 (3.05)
17 through 28 inches (431.80-711.20)	0.188 (4.78)
Over 28 inches (711.20)	0.250 (6.35)

#### Roll ups

Roll ups are formed from 2B rolled finish, flat sheet that is formed into a cylinder and stitch welded on the outside seam, before applying a vacuum weld to the inside. They can be obtained in a range of wall thicknesses and any diameters. Dished head and sphere diameters are typically available in the United States in nominal inch sizes.

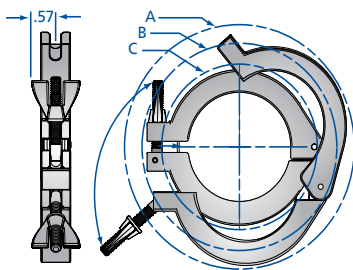
#### Tubing

Nor-Cal stocks a broad variety of 304, 304L and 316L stainless steel tubing sizes that can be used for ports. Usually the port flange determines the diameter of the port tubing, but oversized tubing (i.e.,  $1\frac{3}{4}$  inch (44.45mm) OD tubing for  $2\frac{3}{4}$  inch (69.85mm) OD CF flanges) is occasionally used for additional clearance for instrumentation. The table below lists common tubing sizes used for vacuum chamber ports.

TUBE OD	TUBE ID	WALL THICKNESS
$1/2$ (12.70)	0.402 (10.21)	0.049 (1.24)
$3/4$ (19.05)	0.680 (17.27)	0.035 (0.89)
1 (25.40)	0.870 (22.10)	0.065 (1.65)
$1\frac{1}{4}$ (31.75)	1.120 (28.45)	0.065 (1.65)
$1\frac{1}{2}$ (38.10)	1.370 (34.80)	0.065 (1.65)
$1\frac{3}{8}$ (41.28)	1.490 (37.85)	0.065 (1.65)
$1\frac{3}{4}$ (44.45)	1.630 (41.40)	0.065 (1.65)
2 (50.80)	1.870 (47.50)	0.065 (1.65)
$2\frac{1}{2}$ (63.50)	2.370 (60.20)	0.065 (1.65)
3 (76.20)	2.870 (72.90)	0.065 (1.65)
4 (101.60)	3.834 (97.38)	0.083 (2.11)
5 (127.00)	4.834 (122.78)	0.083 (2.11)
6 (152.40)	5.834 (148.18)	0.083 (2.11)
8 (203.20)	7.760 (197.10)	0.120 (3.05)
10 (254.00)	9.760 (247.90)	0.120 (3.05)
12 (304.80)	11.760 (298.70)	0.120 (3.05)

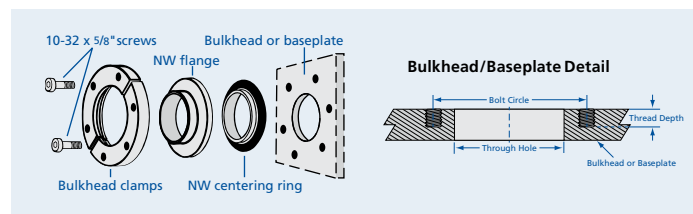
#### NW Clamp Clearance

FLANGE SIZE	Min. Dia. to Install A	Max. Dia. Closed B	Min. Dia. Closed C
NW-10	2.86 (72.64)	2.65 (67.31)	1.75 (44.45)
NW-16	2.86 (72.64)	2.65 (67.31)	1.75 (44.45)
NW-25	3.32 (84.33)	3.00 (76.20)	2.24 (56.90)
NW-40	4.00 (101.60)	3.72 (94.49)	2.90 (73.66)
NW-50	5.45 (138.43)	4.62 (117.35)	3.69 (93.73)



#### NW Bulkhead Detail

FLANGE TYPE	BOLT CIRCLE	THREAD SIZE	THREAD DEPTH	BLIND TAPPED HOLES	THROUGH HOLE
NW-16	1.50 (38.10)	10-32	0.300 (7.62)	6	0.90 (22.86)
NW-25	1.89 (48.01)	10-32	0.300 (7.62)	6	1.26 (32.00)
NW-40	2.44 (61.98)	10-32	0.300 (7.62)	6	1.84 (46.74)
NW-50	3.25 (82.55)	10-32	0.300 (7.62)	8	2.35 (59.69)



All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.



#### Port Lengths

Port lengths should be sufficiently long to allow the flange bolts to be inserted into the bolt holes from the underside of the flange unless tapped flanges are used. When designing chambers we typically dimension the ports so there is a minimum of three times the flange thickness from the port flange face to the outer wall of the chamber. If designing a chamber which utilizes NW clamps for assembly please refer to the chart below for clamp clearance details.

#### Standard Tolerances

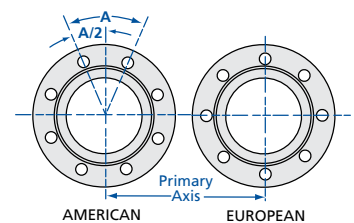
Unless otherwise specified by the customer, standard tolerances will be adhered to during fabrication. These tolerances are acceptable for most analytical or process vacuum equipment and can normally be achieved without secondary machining operations after welding. Tighter tolerances required for specific applications are frequently provided for a slightly higher cost. Standard tolerances for machined dimensions are  $\pm .005$  inches (.13mm) (although tolerances of  $\pm .002$  inches (.51mm) are commonly held on critical flange dimensions). Standard tolerance for any welded dimension, such as a port length or chamber height up to 24 inches (609.60mm), is  $\pm .020$  inches (.51mm)  $\pm .060$  inch (1.52mm) for chambers >24 inches (609.60mm), but <72 inches (1828.80mm) in length). Standard tolerance for polar and azimuthal angles is  $\pm 1/2^\circ$ .

#### TOLERANCE MEASUREMENTS

Machined dimensions	$\pm 0.005$ (.13)
Welded dimensions up to 24	$\pm 0.020$ (.51)
Welded dimensions over 24	$\pm 0.060$ (1.52)
Focal length	$\pm 0.020$ (.51)
Port alignments	$\pm 1/2^\circ$

#### Bolt Pattern Orientation

Our components are manufactured with the primary axis straddling adjacent bolt holes on the mounting flange (American Standard). Most components can be furnished with the axis passing through a bolt hole axis (European Standard) on request. Leak check groove orientation should be indicated on drawings if critical.







# Chambers & Weldments

## Bell Jars, Feedthrough Collars & Baseplates

### SPECIFICATIONS

#### Materials

Flanges and body: 304 stainless steel  
O-rings: Viton

**Finish:** Beadblast standard  
(Tumbled and electropolish available)

**Fasteners:** Wing nut, SureSeal,  
bulkhead and chain clamps

#### Vacuum range

Elastomer seal:  $\geq 1 \times 10^{-8}$  mbar -High vacuum

Metal seal:  $\geq 1 \times 10^{-11}$  mbar - UHV

#### Temperature range

Viton: -20°C to 200°C

Silicone: -50° to 230°C

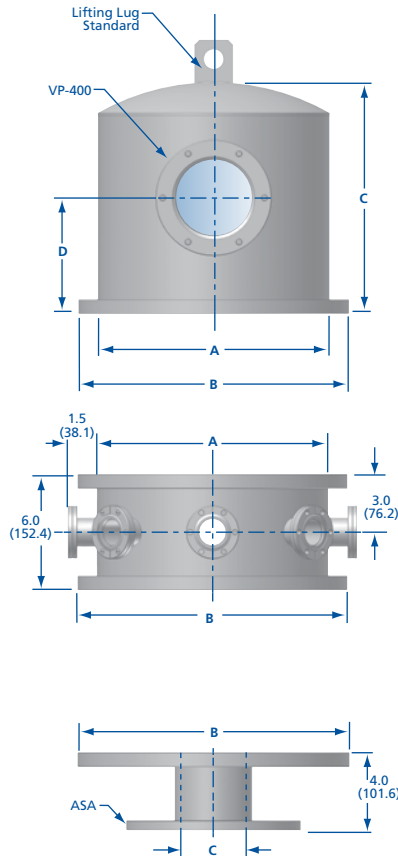
Buna: -30°C to 110°C

Metal seal: -270°C to 150°C



Nor-Cal offers stainless steel baseplates, feedthrough collars and bell jars as standard items. Used in conjunction with our other chamber accessories, an entire bell jar system can be ordered without the expense of design or custom fabrication. Any of the bell jar components shown may be altered to meet the customer's specific requirements. Our sales staff can quickly estimate the additional cost or savings.

Baseplates come in a variety of sizes with smooth faced ASA flanges to bolt directly to the vacuum pump. They may also be furnished with other types and sizes of flanges. If feedthroughs are required, a feedthrough collar with varying numbers of 2¾ inch (69.85mm) CF flanges may be inserted between the baseplate and bell jar. NW flanges can also be provided. A dovetail O-ring groove on the base of the collar effects a seal with the baseplate when the Viton O-ring provided is compressed. The feedthrough collar can be used with a glass bell jar and L-gasket or our stainless steel bell jar with 7056 glass viewport. Like the collar, the bell jar is provided with a Viton O-ring and has a dovetail groove in its base. Bead-blasted finish is standard. Water-cooled jackets are available upon request.



### Bell Jars

MODEL NUMBER	TUBE OD A	FLANGE OD B	C	D
BJ-1200	12 (304.80)	14 (355.60)	12.00 (304.80)	6.00 (152.40)
BJ-1200-EP*	12 (304.80)	14 (355.60)	12.00 (304.80)	6.00 (152.40)
BJ-1800	18 (457.20)	20 (508.00)	30.00 (762.00)	12.00 (304.80)
BJ-1800-EP*	18 (457.20)	20 (508.00)	30.00 (762.00)	12.00 (304.80)
BJ-2400	24 (609.60)	26 (660.40)	30.00 (762.00)	12.00 (304.80)
BJ-2400-EP*	24 (609.60)	26 (660.40)	30.00 (762.00)	12.00 (304.80)

NOTE: One Viton O-ring is included with all of the above.

\*Electropolished finish.



### Feedthrough Collars

MODEL NUMBER	NUMBER OF 2.75 CF PORTS	TUBE OD A	FLANGE OD B
FCO-1200-6	6	12 (304.80)	14 (355.60)
FCO-1200-6-EP*	6	12 (304.80)	14 (355.60)
FCO-1800-8	8	18 (457.20)	20 (508.00)
FCO-1800-8-EP*	8	18 (457.20)	20 (508.00)
FCO-2400-12	12	24 (609.60)	26 (660.40)
FCO-2400-12-EP*	12	24 (609.60)	26 (660.40)

NOTE: One Viton O-ring is included with all of the above.

\*Electropolished finish.



### Baseplates

MODEL NUMBER	NOMINAL SIZE	ASA FLANGE	FLANGE OD B	TUBE ID C
BP-1200	12 (304.80)	ASA-9-400N	14 (355.60)	3.83 (97.28)
BP-1200-EP*	12 (304.80)	ASA-9-400N	14 (355.60)	3.83 (97.28)
BP-1800	18 (457.20)	ASA-11-800N	20 (508.00)	7.76 (197.10)
BP-1800-EP*	18 (457.20)	ASA-11-800N	20 (508.00)	7.76 (197.10)
BP-2400	24 (609.60)	ASA-11-800N	26 (660.40)	7.76 (197.10)
BP-2400-EP*	24 (609.60)	ASA-11-800N	26 (660.40)	7.76 (197.10)

\*Electropolished finish.

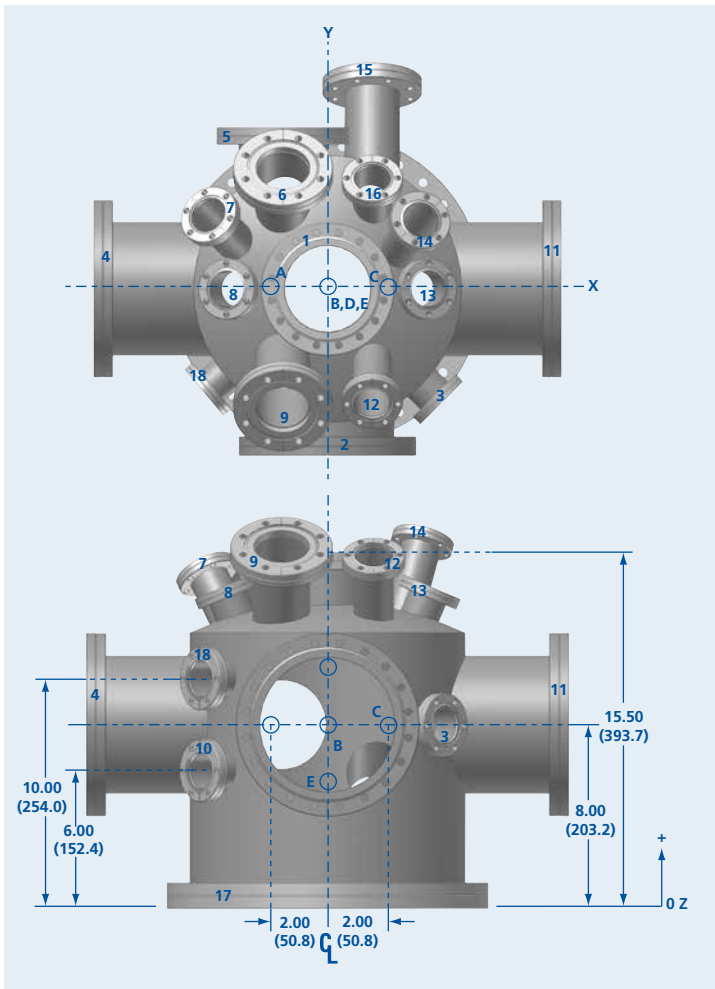
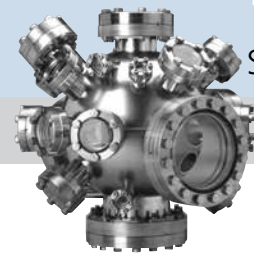
### Replacement Viton O-Rings

MODEL NUMBER

1200-OR

1800-OR

2400-OR



Nor-Cal offers a standard vacuum chamber, which incorporates the features required by many of our surface science customers at an affordable price. The chamber's geometry offers maximum flexibility, making it suitable for many types of studies and experiments. Seventeen ports can accommodate viewports, doors, feedthroughs, manipulators or analytical instruments. This design can be used as a platform and modified to meet your own specific requirements.

### SPECIFICATIONS

#### Materials

- Body and flanges:** 304 stainless steel
- Finish:** Electropolished inside and out
- Pump flange:** 14<sup>5/8</sup> inch (371.48mm) female wire seal or 14 (355.6mm) inch CF flange
- Port tubing:** Oversized 1<sup>3/4</sup> (44.45mm) on all 2<sup>3/4</sup> (69.85mm) CF flanged ports
- Ports:** 17 (431.8mm), with CF flanges

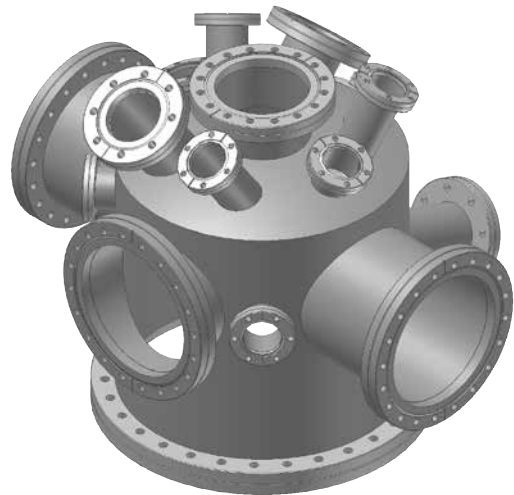
**Temperature range:** ≤450°C.

**Vacuum range:** ≥10<sup>-10</sup> mbar

**Leak rate:** ≤1 × 10<sup>-9</sup> standard cc/sec.

### Order Information

MODEL NUMBER	PUMPING PORT FLANGE (PORT 17)
SAC-12WS	14.62 Female Wire Seal
SAC-12CF	14.00 CF



### Surface Analysis Chamber Port Configuration

PORT NUMBER	FLANGE TYPE	TUBE OD	TARGET POINT	FOCAL LENGTH	POLAR ANGLE
1	6.00 CF	4 (101.60)	B (0,0,8)	7.50 (190.50)	0°
2	8.00 CF	6 (152.40)	B (0,0,8)	7.50 (190.50)	90°
3	2.75 CF	1 <sup>3/4</sup> (44.45)	B (0,0,8)	7.25 (184.15)	90°
4	8.00 CF	6 (152.40)	A (-2,0,8)	8.50 (215.90)	90°
5	6.00 CF	4 (101.60)	A (-2,0,8)	7.25 (184.15)	90°
6	4.50 CF	2 <sup>1/2</sup> (63.50)	A (-2,0,8)	8.50 (215.90)	40°
7	2.75 CF	1 <sup>3/4</sup> (44.45)	A (-2,0,8)	8.25 (209.55)	35°
8	2.75 CF	1 <sup>3/4</sup> (44.45)	A (-2,0,8)	6.50 (165.10)	23°
9	4.50 CF	2 <sup>1/2</sup> (63.50)	A (-2,0,8)	9.50 (241.30)	35°
10	2.75 CF	1 <sup>3/4</sup> (44.45)	E (0,0,6)	7.25 (184.15)	90°
11	8.00 CF	6 (152.40)	C (2,0,8)	8.50 (165.10)	90°
12	2.75 CF	1 <sup>3/4</sup> (44.45)	C (2,0,8)	9.00 (228.60)	35°
13	2.75 CF	1 <sup>3/4</sup> (44.45)	C (2,0,8)	6.50 (165.10)	23°
14	2.75 CF	1 <sup>3/4</sup> (44.45)	C (2,0,8)	9.00 (228.60)	25°
15	4.50 CF	2 <sup>1/2</sup> (63.50)	C (2,0,8)	10.00 (254.00)	110°
16	2.75 CF	1 <sup>3/4</sup> (44.45)	C (2,0,8)	7.75 (196.85)	40°
17	14.62 FWS or 14.00 CF	12 (304.80)	B (0,0,8)	8.00 (203.20)	180°
18	2.75 CF	1 <sup>3/4</sup> (44.45)	D (0,0,10)	7.25 (184.15)	90°

All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.



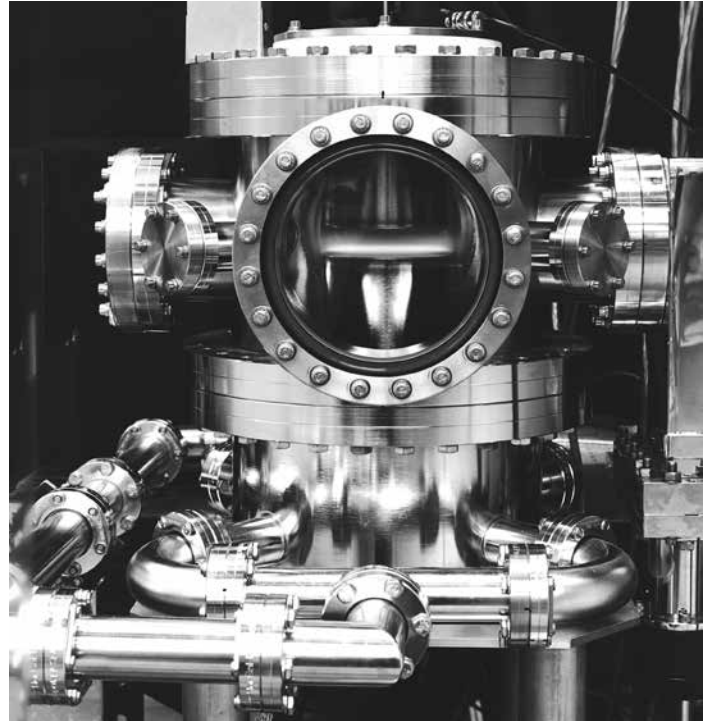


# Chambers & Weldments

## GEC Reference Cell

Detailed bill of materials and mechanical drawings of the GEC Reference Cell can be downloaded from the Vacuum Chambers section of our web site.  
[www.n-c.com](http://www.n-c.com)

The design for this system was developed at the 1988 Gaseous Electronics Conference (GEC) for research projects utilizing radio frequency (rf) discharges in various gases at a frequency of 13.56 MHz. The reference cell concept grew out of a need to provide an experimental platform for comparing plasma measurements carried out in a number of separate but identical chambers. The basic purpose of the reference cell is to provide a comparison between measurements performed on identical discharge sources by different groups to establish the necessary and sufficient conditions defining reproducible plasma parameters and establishing a reference rf-excited plasma that allows others to define and calibrate diagnostic measurements and theoretical models.



The cell is a conventional, twelve-inch (304.8mm) diameter, UHV chamber with a pair of 10 cm diameter, water-cooled, parallel plate electrodes. A unique pumpout well provides uniform pumping in the chamber. Since the reference cell's inception, Nor-Cal has worked with Sandia National Lab's design team in order to improve manufacturability and offer standard options requested by individual research groups. These options include: moveable upper electrode, RGA sampling port, wafer transfer, inductively coupled coil and heated annular ring.

### SPECIFICATIONS

#### Materials

Flanges and body: 304 stainless steel  
 Flange type: CF  
 Finish: Electropolished, inside and out

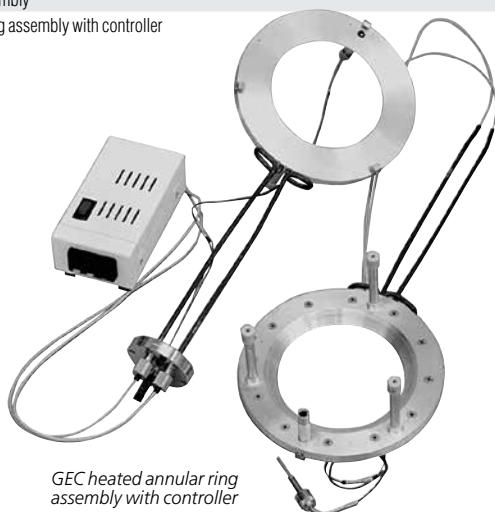
**Vacuum range:**  $\geq 1 \times 10^{-10}$  mbar - UHV

**Temperature range:** -270°C to 450°C

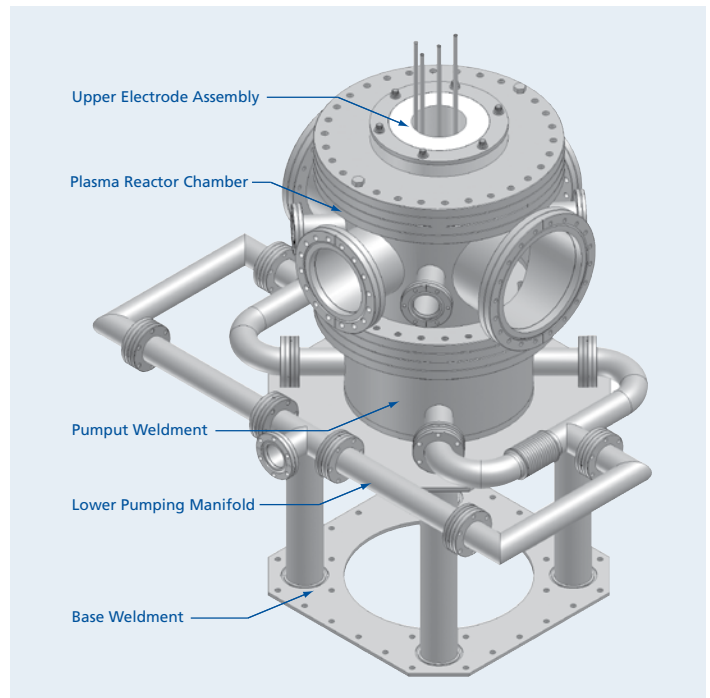
### GEC Reference Cell System Components

#### DESCRIPTION

- Plasma reactor chamber
- Pumpout weldment
- Non-moveable upper electrode assembly
- Moveable upper electrode assembly
- Lower electrode assembly
- Lower electrode (mass spectrometer test)
- Lower wafer transfer electrode
- Base weldment (aluminum)
- Lower pumping manifold assembly
- Inductive coil assembly
- Heated annular ring assembly with controller



GEC heated annular ring assembly with controller



# Chambers & Weldments

## Custom Weldments



Because we manufacture tees, elbows and other weld fittings in-house, Nor-Cal can also fabricate exhaust weldments and other special assemblies for semiconductor equipment from a single piece of tubing by utilizing some or all of the techniques described below. Welds and other manufacturing steps are eliminated, improving cleanliness and fit while reducing cost. We have demonstrated as much as 30% savings to our customers using this technique.

### SPECIFICATIONS

#### Materials

Tube ODs: 1/4 to 10 inch (6.35 to 254mm)  
 Tubes and flanges: 304 stainless steel  
 (316L available on request)  
 Finish: Electropolished or beadblasted  
 Flange types: CF, NW, ISO and ASA

#### Temperature range

Metal seal: -270°C to 450°C  
 Elastomer seal: -20°C to 200°C

#### Vacuum range

Metal seal:  $\geq 10^{-11}$  mbar - UHV  
 Elastomer seal:  $\geq 10^{-8}$  mbar - High Vacuum



### CNC Tube Bending

Nor-Cal employs a computer numerically controlled (CNC) tube bender to form elbows and custom exhaust weldments. This enables us to quickly make multiple compound angle bends in a single piece of tubing, while holding .010 inch (.25mm) tolerance between bends. Alternate methods of fabrication require welding of several prefabricated parts, resulting in greater incidence of leaks and cumulative tolerance buildup. Using our method, several welds and other manufacturing steps are eliminated, improving cleanliness and fit while reducing cost. Nor-Cal has tooling for 3/4, 1, 1 1/2 and 2-inch (19.05, 25.4, 38.1 & 50.8mm) tubing. Custom or metric tubing diameters are available upon request.



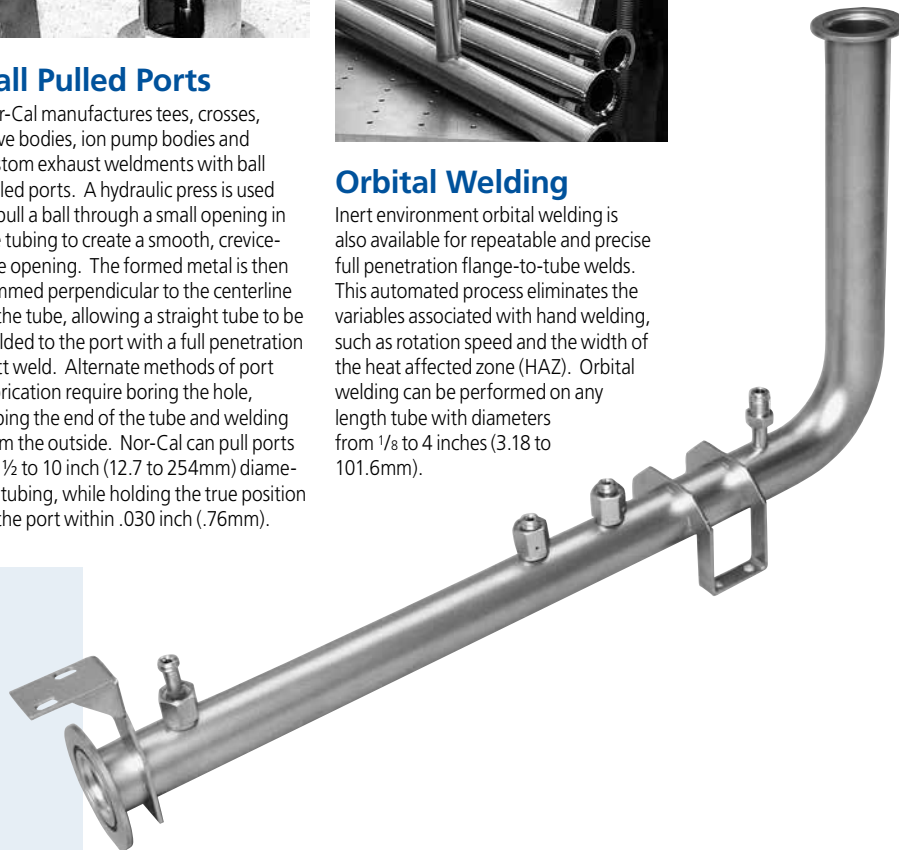
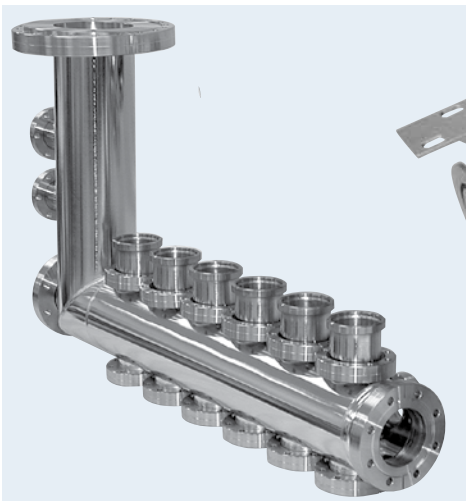
### Ball Pulled Ports

Nor-Cal manufactures tees, crosses, valve bodies, ion pump bodies and custom exhaust weldments with ball pulled ports. A hydraulic press is used to pull a ball through a small opening in the tubing to create a smooth, crevice-free opening. The formed metal is then trimmed perpendicular to the centerline of the tube, allowing a straight tube to be welded to the port with a full penetration butt weld. Alternate methods of port fabrication require boring the hole, coping the end of the tube and welding from the outside. Nor-Cal can pull ports for 1/2 to 10 inch (12.7 to 254mm) diameter tubing, while holding the true position of the port within .030 inch (.76mm).



### Orbital Welding

Inert environment orbital welding is also available for repeatable and precise full penetration flange-to-tube welds. This automated process eliminates the variables associated with hand welding, such as rotation speed and the width of the heat affected zone (HAZ). Orbital welding can be performed on any length tube with diameters from 1/8 to 4 inches (3.18 to 101.6mm).

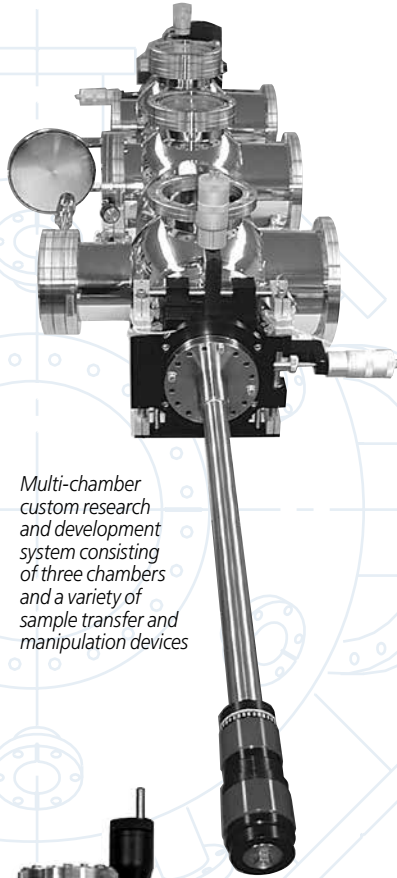
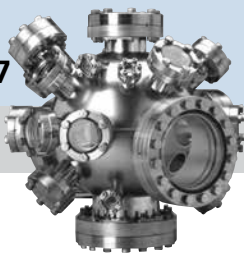


All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.



# Chambers & Weldments

## Vacuum Chamber Gallery



*Multi-chamber custom research and development system consisting of three chambers and a variety of sample transfer and manipulation devices*



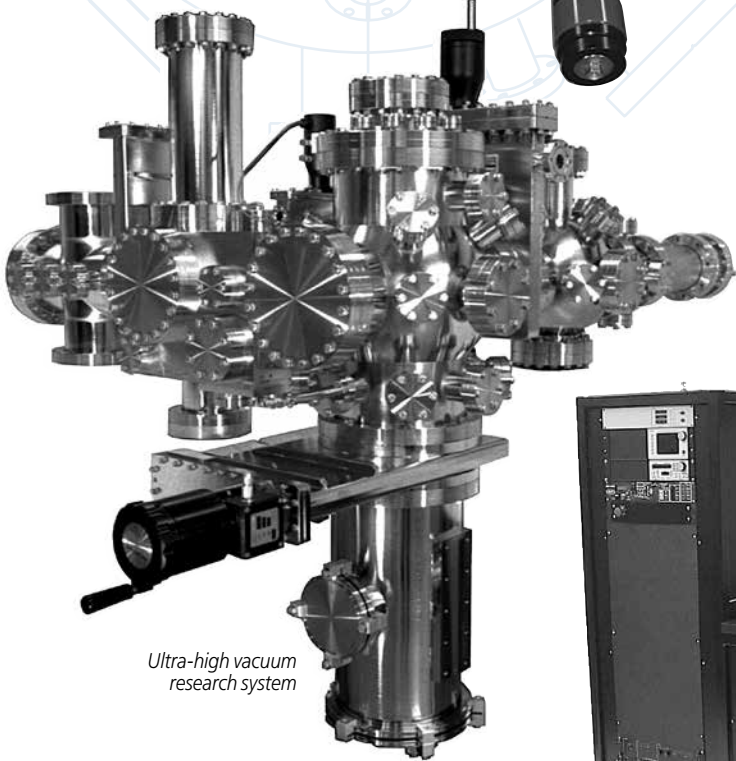
*Ultra-high vacuum research chamber*



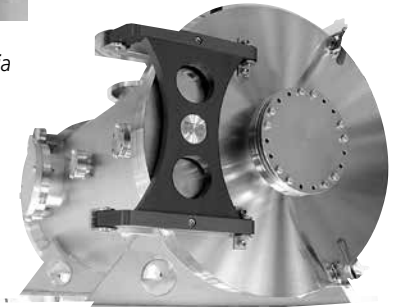
*High vacuum chamber used to house an X-ray scanner in the Sandia National Laboratory LIGA project*



*Cornell University Physics Department surface science chamber*



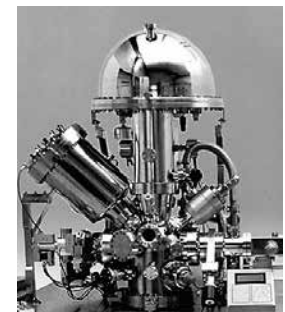
*Ultra-high vacuum research system*



*Chamber with door manufactured for Edwards Air Force Base*



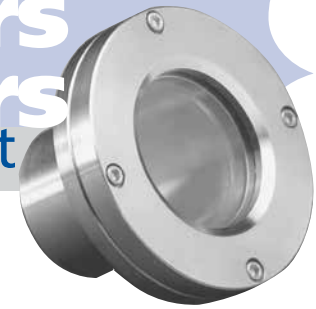
*Custom OLED (Organic Light Emitting Device) System by Trovato Mfg. Inc., incorporating a Nor-Cal high vacuum chamber*



*ESCA electron spectrometer*

# Viewports, Shutters & Glass Adapters

## Section Eight



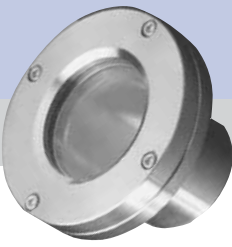
<b>8.1</b>	General Information	<b>2</b>
<b>8.2</b>	Viewports & Weld Stubs	<b>3</b>
<b>8.3</b>	Glass Adapters & Viewport Shutters	<b>4</b>

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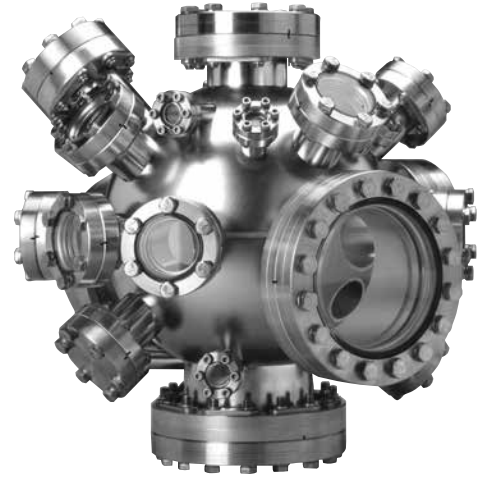






# Viewports & Shutters

## General Information



Nor-Cal Products offers a complete line of viewports for vacuum chambers with NW, ISO and CF flanges. CF flanged viewports are available with fully annealed 7056 glass or fused silica. Weld stub viewports are available for welding onto new or existing chambers. Special materials and coatings, such as sapphire and anti-reflective (AR) coating, are available on request. Glass provides a large distortion free viewing area at low cost. Quartz and fused silica provide superior ultraviolet radiation transmission and resistance to thermal shock.

Nor-Cal manufactures glass adapters in 7740 Pyrex and 7052 glass. These adapters are useful for mounting glass accessories to metal high vacuum systems, or to attach flange mounted components to glass systems. Glass adapters are available with NW, CF, and ISO flanges as standards.

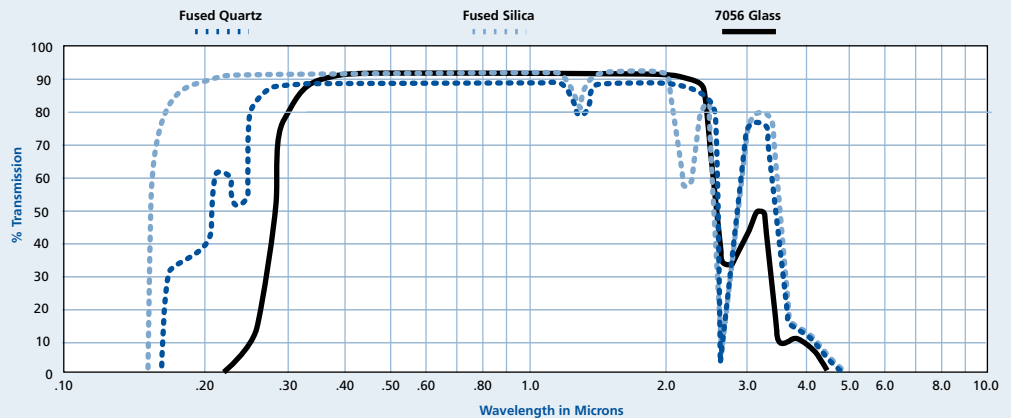
### New Products



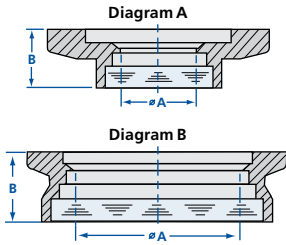
### Viewport Shutters

These shutters mount behind a viewport to prevent deposition process build-up on the viewports. We now offer CF shutters in 4 sizes for mounting to 2<sup>3</sup>/<sub>4</sub>, 4<sup>1</sup>/<sub>2</sub>, 6 and 8 inch (69.85, 114.3, 152.4 and 203.2mm) CF flanged ports. An integrated PRM-133 rotary motion feedthrough provides smooth actuation and a positive locking screw.

### Viewport Optical Transmission Curves



All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.



### NW Viewports

7056 glass NW viewports in a one-piece assembly. This viewport replaces a blank off cap and uses a standard NW centering ring assembly and clamp for sealing.

MODEL NUMBER	DIAGRAM	FLANGE TYPE	VIEW MATERIAL	VIEW Ø A	B
VP-NW-16	A	NW-16	7056 Glass	0.62 (15.75)	0.385 (9.78)
VP-NW-25	A	NW-25	7056 Glass	0.62 (15.75)	0.385 (9.78)
VP-NW-40	B	NW-40	7056 Glass	1.51 (38.35)	0.554 (14.07)
VP-NW-50	B	NW-50	7056 Glass	1.51 (38.35)	0.554 (14.07)

### SPECIFICATIONS

#### Materials

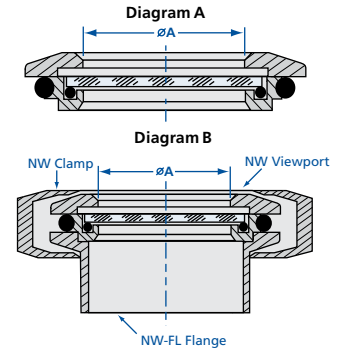
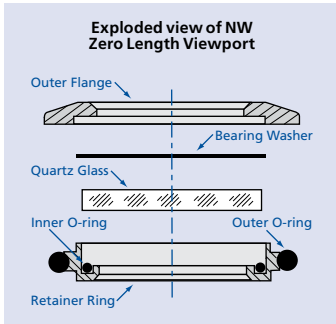
Flanges: 304 stainless steel  
Viewports: Glass or fused quartz  
Seal: Viton

**Vacuum range:**  $\geq 1 \times 10^{-9}$  mbar - High vacuum

**Temperature range:** -20°C to 200°C

### NW Zero Length Viewports

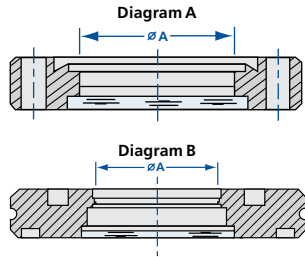
Nor-Cal's zero length viewports have an innovative design which places the viewing glass inside the centering ring. The clear, polished quartz can be removed for cleaning or replacement. Zero length viewports are available for NW-40 and NW-50 flange sizes.



MODEL NUMBER	DIAGRAM	FLANGE TYPE	VIEW MATERIALS	VIEW Ø A
ZV-NW-40	A	NW-40	Fused quartz	1.26 (32.00)
ZV-NW-50	A	NW-50	Fused quartz	1.63 (41.40)
ZV-NW-40A	B	NW-40	Fused quartz	1.26 (32.00)
ZV-NW-50A	B	NW-50	Fused quartz	1.63 (41.40)

### ISO & CF Zero Length Viewports

ISO and CF viewports are one-piece assemblies (See diagram to the left). For clamps and fastening hardware, please refer to the appropriate flange section.



MODEL NUMBER	DIAGRAM	FLANGE TYPE	VIEW MATERIALS	VIEW Ø A
ZV-075	A	1.33 CF	7056 Glass	0.63 (16.00)
ZV-100	A	2.12 CF	7056 Glass	0.63 (16.00)
ZV-150	A	2.75 CF	7056 Glass	1.49 (37.85)
ZVQ-150	A	2.75 CF	Fused silica	1.40 (35.56)
ZV-200	A	3.38 CF	7056 Glass	1.49 (37.85)
ZVQ-200	A	3.38 CF	Fused silica	1.40 (35.56)
ZV-250	A	4.50 CF	7056 Glass	2.66 (67.56)
ZVQ-250	A	4.50 CF	Fused silica	2.69 (68.33)
ZV-300	A	4.62 CF	7056 Glass	2.66 (67.56)
ZVQ-300	A	4.62 CF	Fused silica	2.69 (68.33)
ZV-400	A	6.00 CF	7056 Glass	3.97 (100.84)
ZVQ-400	A	6.00 CF	Fused silica	3.88 (98.55)
ZV-500	A	6.75 CF	7056 Glass	3.97 (100.84)
ZVQ-500	A	6.75 CF	Fused silica	3.88 (98.55)
ZV-600	A	8.00 CF	7056 Glass	5.60 (142.24)
ZVQ-600	A	8.00 CF	Fused silica	5.37 (136.40)
ZV-800	A	10.00 CF	7056 Glass	5.60 (142.24)
ZVQ-800	A	10.00 CF	Fused silica	7.78 (197.61)
ZV-ISO-63-OF	B	ISO-63	7056 Glass	1.49 (37.85)
ZV-ISO-80-OF	B	ISO-80	7056 Glass	1.49 (37.85)
ZV-ISO-100-OF	B	ISO-100	7056 Glass	2.66 (67.56)
ZV-ISO-160-OF	B	ISO-160	7056 Glass	3.97 (100.84)
ZV-ISO-200-OF	B	ISO-200	7056 Glass	5.60 (142.24)

### SPECIFICATIONS

#### Materials

Flanges: 304 stainless steel  
Tubes: 304 stainless steel  
Viewports: Glass, fused silica, or fused quartz  
Weld stub seals: Viton

#### Vacuum range

Weld stubs:  $\geq 1 \times 10^{-9}$  mbar - High vacuum  
ISO flange:  $\geq 1 \times 10^{-9}$  mbar - High vacuum  
CF flange:  $\geq 1 \times 10^{-11}$  mbar - UHV

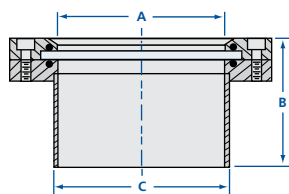
#### Temperature range

Weld stubs: -20°C to 200°C  
ISO flange: -20°C to 200°C  
CF flange, Glass: -20°C to 400°C  
CF flange, Silica: -20°C to 200°C

All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.

### Viewport Weld Stubs

Weld stub viewports are provided with a tube for welding onto an existing chamber.

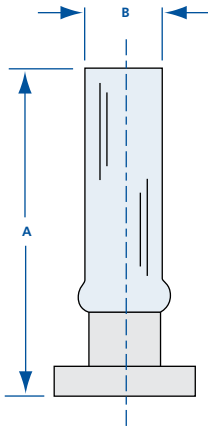
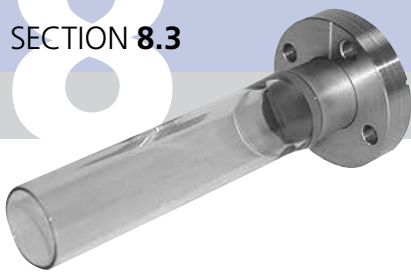


MODEL NUMBER	FLANGE OD	VIEW MATERIAL	VIEW Ø A	B	C
VP-250	4.47 (113.54)	Borosilicate glass	2.37 (60.2)	2.88 (73.15)	2.50 (63.50)
VPQ-250	4.47 (113.54)	Fused quartz	2.37 (60.2)	2.88 (73.15)	2.50 (63.50)
VP-400	5.97 (151.64)	Borosilicate glass	3.83 (97.28)	2.88 (73.15)	4.00 (101.60)
VPQ-400	5.97 (151.64)	Fused quartz	3.83 (97.28)	2.88 (73.15)	4.00 (101.60)
VP-600	7.97 (202.44)	Borosilicate glass	5.83 (148.08)	2.88 (73.15)	6.00 (152.40)
VPQ-600	7.97 (202.44)	Fused quartz	5.83 (148.08)	2.88 (73.15)	6.00 (152.40)



# Viewports & Shutters

## Glass Adapters & Viewport Shutters



### NW, ISO & CF Glass Adapters

Nor-Cal manufactures glass adapters in 7740 Pyrex and 7052 glass. These adapters are useful for mounting glass accessories to metal high vacuum systems, or to attach flange mounted components to glass systems. These adapters are available standard with NW, CF, and ISO flanges.

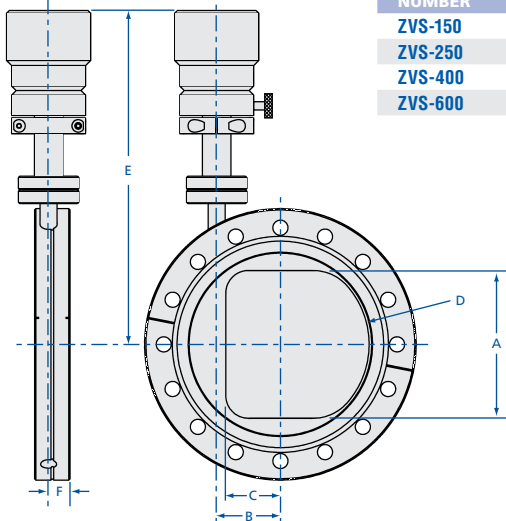
MODEL NUMBER	FLANGE TYPE	GLASS/SLEEVE MATERIALS	A	B
1GA-NW-038P	NW-10	7740 Pyrex/stainless steel	4.90 (124.46)	0.38 (9.65)
1GA-NW-075P	NW-16	7740 Pyrex/stainless steel	4.90 (124.46)	0.75 (19.05)
1GA-NW-100P	NW-25	7740 Pyrex/stainless steel	4.90 (124.46)	1.00 (25.40)
1GA-NW-150P	NW-40	7740 Pyrex/stainless steel	4.90 (124.46)	1.50 (38.10)
1GA-NW-200P	NW-50	7740 Pyrex/stainless steel	5.40 (137.16)	2.00 (50.80)
1GA-ISO-63-OF-K	ISO-63	7052 glass/Kovar	7.36 (186.94)	2.50 (63.50)
1GA-ISO-63-OF-P	ISO-63	7740 Pyrex/stainless steel	5.50 (139.70)	2.50 (63.50)
1GA-ISO-80-OF-K	ISO-80	7052 glass/Kovar	7.36 (186.94)	3.00 (76.20)
1GA-ISO-80-OF-P	ISO-80	7740 Pyrex/stainless steel	6.50 (165.10)	3.00 (76.20)
1GA-ISO-100-OF-K	ISO-100	7052 glass/Kovar	10.25 (260.35)	4.00 (101.60)
1GA-ISO-100-OF-P	ISO-100	7740 Pyrex/stainless steel	6.50 (165.10)	4.00 (101.60)
1GA-ISO-160-OF-K	ISO-160	7052 glass/Kovar	10.88 (276.35)	6.00 (152.40)
1GA-ISO-160-OF-P	ISO-160	7740 Pyrex/stainless steel	8.63 (219.20)	6.00 (152.40)
1GA-075K	1.33 CF	7052 glass/Kovar	5.43 (137.92)	0.75 (19.05)
1GA-075P	1.33 CF	7740 Pyrex/stainless steel	4.93 (125.22)	0.75 (19.05)
1GA-100K	2.12 CF	7052 glass/Kovar	5.42 (137.67)	1.00 (25.40)
1GA-100P	2.12 CF	7740 Pyrex/stainless steel	4.92 (124.97)	1.00 (25.40)
1GA-150K	2.75 CF	7052 glass/Kovar	5.46 (138.68)	1.50 (38.10)
1GA-150P	2.75 CF	7740 Pyrex/stainless steel	4.96 (125.98)	1.50 (38.10)
1GA-200K	3.38 CF	7052 glass/Kovar	5.98 (151.89)	2.00 (50.80)
1GA-200P	3.38 CF	7740 Pyrex/stainless steel	5.48 (139.19)	2.00 (50.80)
1GA-250K	4.50 CF	7052 glass/Kovar	7.76 (197.10)	2.50 (63.50)
1GA-250P	4.50 CF	7740 Pyrex/stainless steel	5.63 (143.00)	2.50 (63.50)
1GA-300K	4.62 CF	7052 glass/Kovar	7.66 (194.56)	3.00 (76.20)
1GA-300P	4.62 CF	7740 Pyrex/stainless steel	6.53 (165.86)	3.00 (76.20)
1GA-400K	6.00 CF	7052 glass/Kovar	10.44 (265.18)	4.00 (101.60)
1GA-400P	6.00 CF	7740 Pyrex/stainless steel	6.69 (169.93)	4.00 (101.60)
1GA-500K	6.75 CF	7052 glass/Kovar	10.96 (278.38)	5.00 (127.00)
1GA-500P	6.75 CF	7740 Pyrex/stainless steel	8.71 (221.23)	5.00 (127.00)
1GA-600K	8.00 CF	7052 glass/Kovar	11.00 (279.40)	6.00 (152.40)
1GA-600P	8.00 CF	7740 Pyrex/stainless steel	8.75 (222.25)	6.00 (152.40)

#### SPECIFICATIONS

- Materials**
  - Flange: 304 stainless steel
  - Glass: 7052 glass or 7740 Pyrex
  - Sleeve: Kovar or 304 stainless steel
- Vacuum range**
  - Elastomer seal:  $\geq 1 \times 10^{-8}$  mbar - High vacuum
  - Metal seal:  $\geq 1 \times 10^{-10}$  mbar - UHV
- Temperature range**
  - Elastomer seal: -20°C to 200°C
  - Metal seal: -20°C to 400°C

#### SPECIFICATIONS

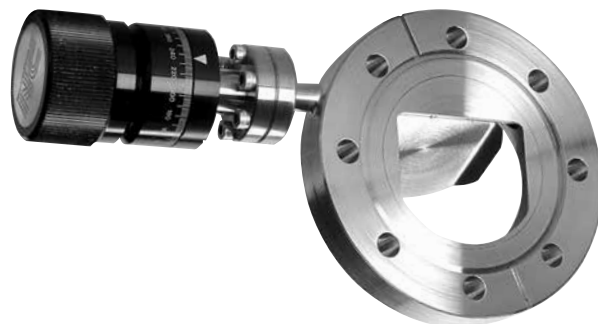
- Materials**
  - Flanges: 304 stainless steel
  - Flange type: 2 3/4 to 8 inch (69.85 to 203.2mm) CF, clearance bolt holes
  - Actuation: PRM-133 rotary feedthrough
- Temperature range:** -20°C to 150°C
- Vacuum range:**  $\geq 10^{-10}$  mbar - UHV



### Viewport Shutters

Nor-Cal Products manufactures shutters for viewport shielding. These shutters are mounted behind a viewport to prevent build-up of deposition materials on viewports while in the closed position. They use a single plate shutter with a 90° opening rotation. Nor-Cal's design completely shields the viewing glass when the shutter is in the closed position. An integrated PRM-133 rotary motion feedthrough provides smooth actuation and a positive locking screw. Please call for custom actuation options, such as motor drives or special flanges.

MODEL NUMBER	FLANGE TYPE	FITS TUBE DIAMETER	A	B	C	D	E	F
ZVS-150	2.75 CF	1.510 (38.35)	1.12 (28.45)	0.57 (14.48)	0.42 (10.67)	0.70 (17.78)	5.99 (152.15)	0.44 (11.18)
ZVS-250	4.50 CF	2.510 (63.75)	2.00 (50.80)	0.85 (21.59)	0.65 (16.51)	1.18 (29.97)	6.92 (175.77)	0.34 (8.64)
ZVS-400	6.00 CF	4.010 (101.85)	3.25 (82.55)	1.40 (35.56)	1.20 (30.48)	1.90 (48.26)	7.34 (186.44)	0.47 (11.94)
ZVS-600	8.00 CF	6.020 (152.91)	5.00 (127.00)	2.06 (52.32)	1.75 (44.45)	2.90 (73.66)	8.49 (215.65)	0.50 (12.70)



# Sample Transfer & Manipulation

## Section Nine



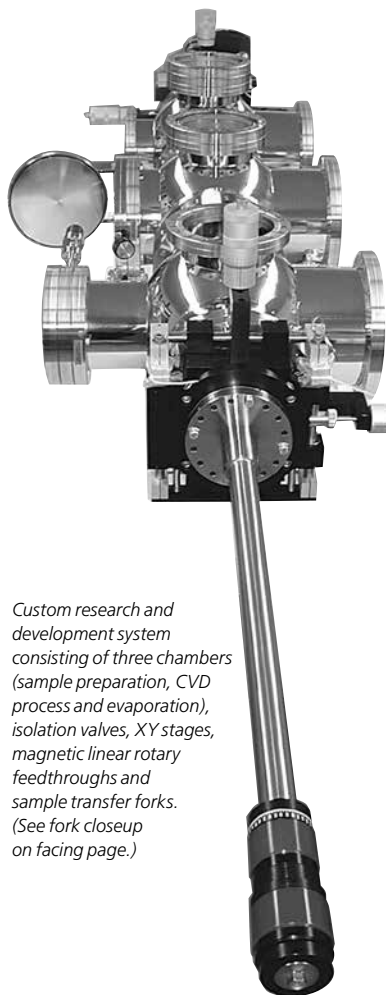
<b>9.1</b>	<b>General Information</b>	<b>196</b>
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or 530-842-4457  
Main Fax: 530-842-9130  
Sales Fax: 530-841-9189  
[www.n-c.com](http://www.n-c.com)

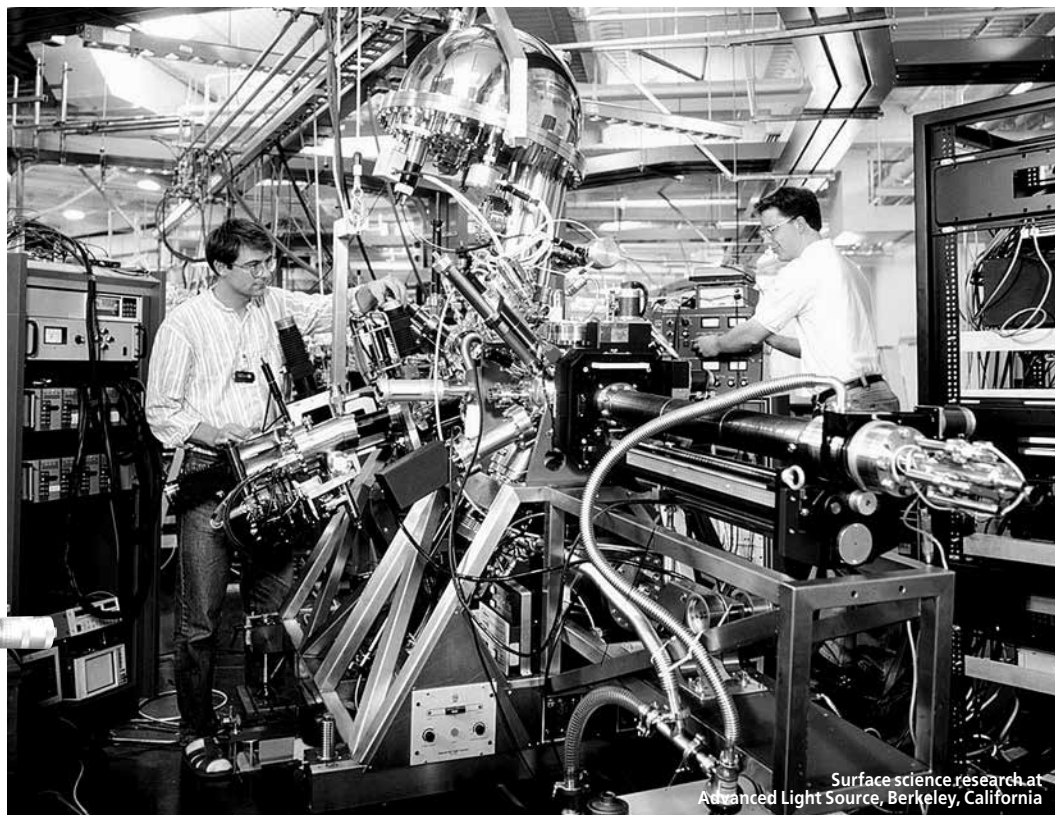






Custom research and development system consisting of three chambers (sample preparation, CVD process and evaporation), isolation valves, XY stages, magnetic linear rotary feedthroughs and sample transfer forks. (See fork closeup on facing page.)

Most sample transfer/manipulation devices include a 5 year warranty, depending on the specific product type. 5 year warranty not available in all territories. Contact the factory for details.



Surface science research at Advanced Light Source, Berkeley, California

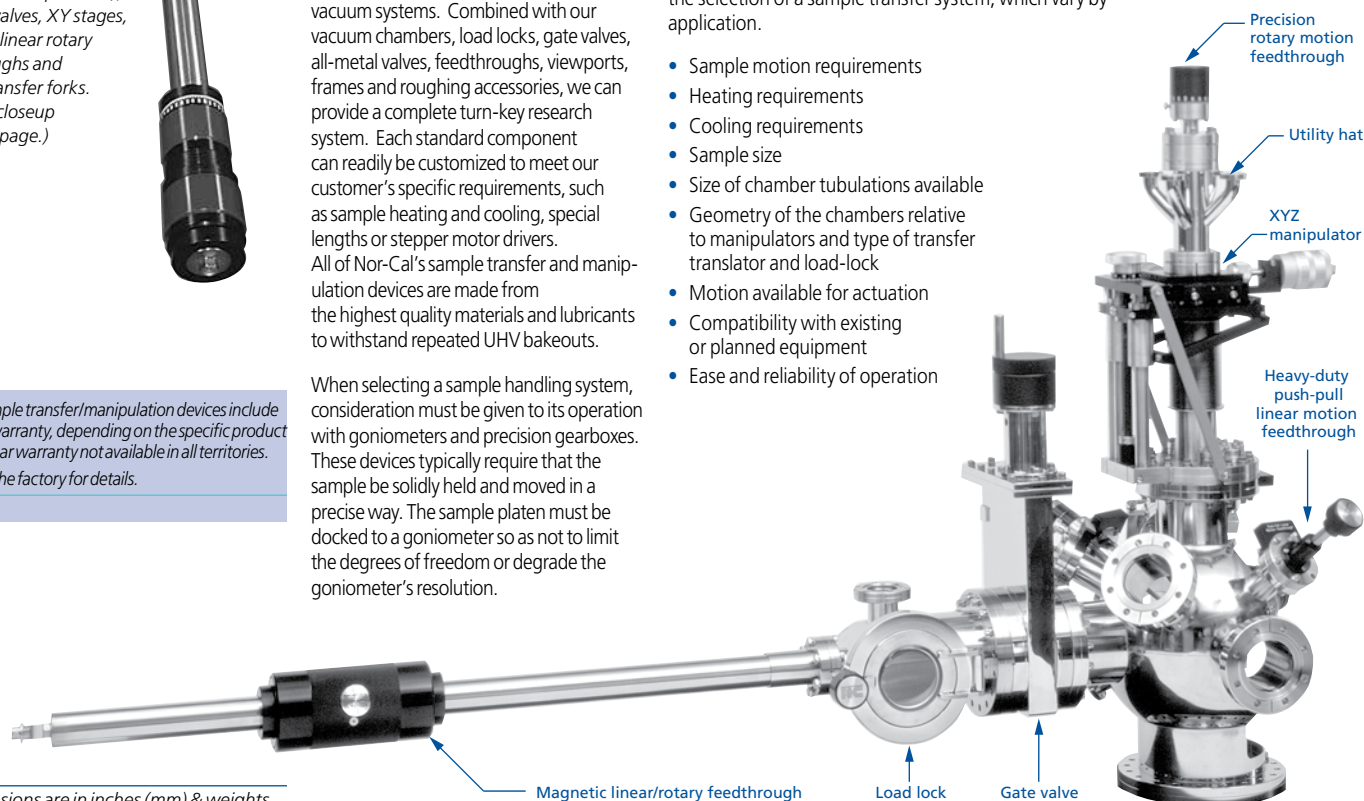
Nor-Cal Products offers the researcher complimentary devices for sample transfer and positioning in ultra-high vacuum systems. Combined with our vacuum chambers, load locks, gate valves, all-metal valves, feedthroughs, viewports, frames and roughing accessories, we can provide a complete turn-key research system. Each standard component can readily be customized to meet our customer's specific requirements, such as sample heating and cooling, special lengths or stepper motor drivers. All of Nor-Cal's sample transfer and manipulation devices are made from the highest quality materials and lubricants to withstand repeated UHV bakeouts.

When selecting a sample handling system, consideration must be given to its operation with goniometers and precision gearboxes. These devices typically require that the sample be solidly held and moved in a precise way. The sample platen must be docked to a goniometer so as not to limit the degrees of freedom or degrade the goniometer's resolution.

### Selecting a Sample Transfer System

The following list contains some of the many factors that influence the selection of a sample transfer system, which vary by application.

- Sample motion requirements
- Heating requirements
- Cooling requirements
- Sample size
- Size of chamber tubulations available
- Geometry of the chambers relative to manipulators and type of transfer translator and load-lock
- Motion available for actuation
- Compatibility with existing or planned equipment
- Ease and reliability of operation



All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.

## XYZ Manipulator

A manipulator is a 3-axis (X,Y,Z) positioning device. For most applications, the instrument hardware is mounted outside the vacuum chamber, with a welded bellows providing a flexible vacuum curtain. The X axis passes in front of the vertical, mechanical structure, or "backframe," with the Y axis moving to and away from the backframe. The Z axis is perpendicular to the X and Y axes and moves up and down directly against the vacuum pressure differential. The polar axis is the same as the Z axis.

The limit of X and Y travel is normally a circular pattern. Range is indicated as a vector sum. This means a  $\pm .50$  inch (12.7mm) range of X and Y allows the polar axis to be moved anywhere inside a 1.00 inch (25.4mm) diameter circle. The sum of the X and Y vectors is limited to .50 inch (12.7mm). Square pattern XY stages are available as options on some models.

## Z Translator

A translator is a single axis positioning device, utilizing a bellows as a vacuum seal. Referred to as a "Z only" stage, this axis is normally perpendicular to the chamber. This causes the Z axis to work directly against the force from the pressure differential.

## XY Stage

The XY stage provides the X and Y axes only. No Z motion is available.

## Polar Rotation

The polar axis is the same as the Z axis. Rotation about the polar axis is commonly achieved by mounting a rotary feedthrough at the center of the traveling flange of a manipulator or translator. This degree of freedom can also be achieved with a differentially pumped rotary seal.

## Azimuthal Axis

The azimuthal axis is perpendicular to the polar axis. Sample azimuthal rotation refers to rotation of the sample about an axis normal to the sample face and perpendicular to the polar axis.

## Tilt Motion

Tilt refers to changing the polar axis with respect to the X, Y and Z axes. This is usually done at the traveling flange of a 3-axis manipulator or other exterior mounting stage. Tilt range is often limited by the bellows ID and the OD of the probe passing through the bellows. The maximum angle practical is about  $\pm 7^\circ$ . When used in this manner, translation in X, Y and (slightly) Z will occur with adjustment of the tilt angle. Tilt stages are available in single or dual axis units.

## Flip Motion

Flip motion is the changing of an axis normal to the sample face from parallel (or coaxial) to the polar axis to coaxial with the azimuthal axis. The range of this change of axis may be  $90^\circ$ ,  $180^\circ$  or full  $360^\circ$ .

## Sample Transfer and Heating

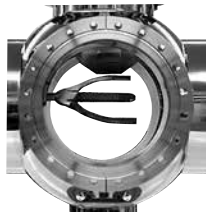
Sample transfer may reduce heating performance at high temperatures. The ideal transfer system for heating the sample to the highest temperatures should use thin sample plates made of appropriate material placed as close to the heater as possible. Thick, high mass, sample plates reduce thermal response and lower peak heating temperatures.

## Sample Transfer and Cooling

Sample transfer may reduce cooling performance at low temperatures. The ideal transfer system for cooling the sample to the lowest temperatures should use thin, highly conductive, sample plates that contact the dewar with a large surface area. Thick, high mass, sample plates reduce thermal response and reduce peak cooling performance.

## Transfer Components

- **Sample Platen** — the transferable plate that holds the sample
- **Sample Fork** — attaches to a transfer arm from the load-lock and holds the sample platen

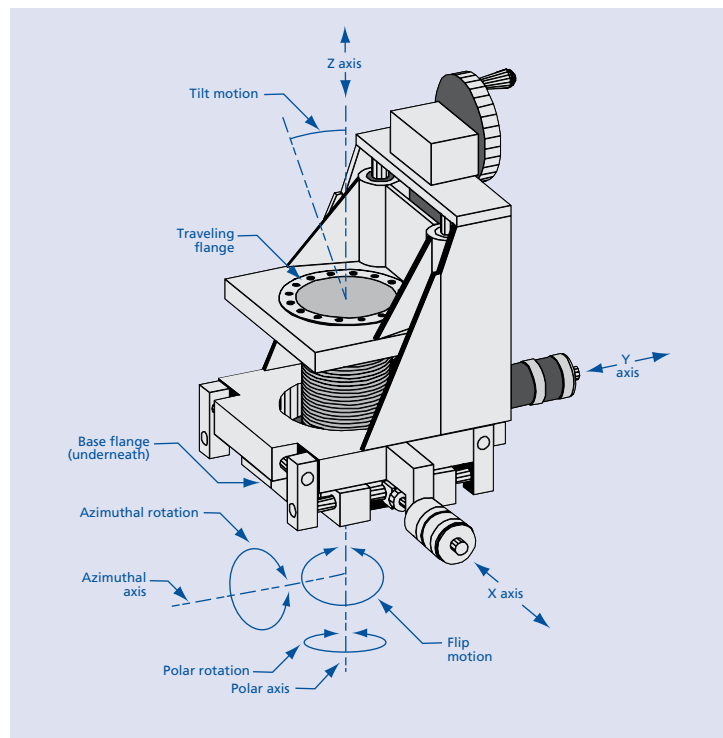


Sample transfer fork

- **Sample Dock** — attaches to a work station (manipulator) and holds the platen for processing or positioning the sample

## Fork and Dock Configurations

- **Axial Fork** — a sample fork with the plane of the sample platen face orthogonal to the axis of the transfer arm on which the fork is mounted
- **Radial Fork** — a sample fork with the plane of the sample platen face parallel to the axis of the transfer arm on which the fork is mounted
- **Axial Dock** — a sample dock with the plane of the sample platen face orthogonal to the axis of the manipulator on which the dock is mounted
- **Radial Dock** — a sample dock with the plane of the sample platen face parallel to the axis of the manipulator to which the dock is mounted

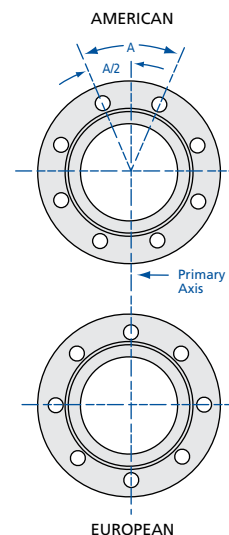
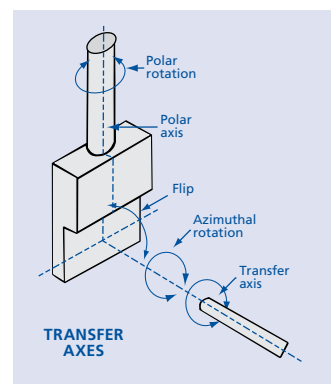


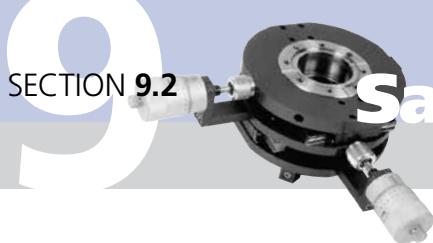
## Types of Motion Used For Transfer Actuation

- **Linear Motion** — linear movement of the sample along any axis
- **Rotary Motion** — rotary motion about any axis
- **Tilt Motion** — angular positioning movement of the horizontal or orthogonal axis. The weight of the sample, plate, fork and translator can cause deflection that misaligns the axis of transfer. A tilt stage can be used to re-align the axis to enable a transfer

## Bolt Pattern Orientation

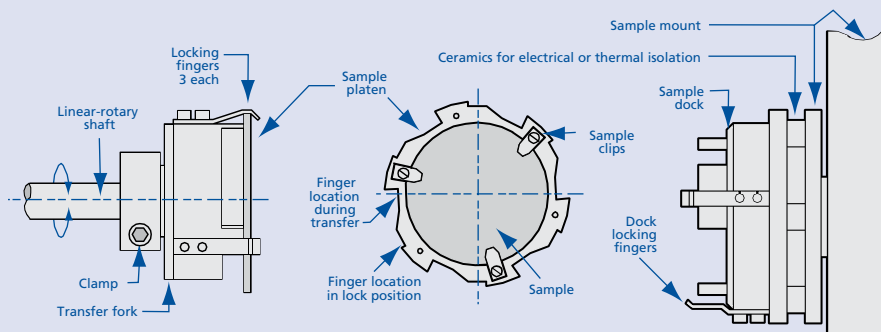
Our components are manufactured with the primary axis straddling adjacent bolt holes on the mounting flange (American standard). Most components can be furnished with the axis passing through a bolt hole axis (European standard) on request. Some equipment is field adjustable.





# Sample Transfer & Manipulation

## Sample Transfer System & Load Lock Chamber



STS Sample Transfer Systems are manufactured and protected under the following patent: 5,705,128.

### Sample Transfer System

This sample transfer system uses thin (.040 inch) sample plates with six sawtooth shaped ramps, profiled on the plate's edge. The sample transfer probe is fitted with a fork consisting of three tab-shaped spring fingers positioned radially on a barrel. The sample plate locks on to the fork by rotating the fork's fingers over three of the six ramps. When the fork is rotated, the locking fingers slide up the ramps to stops. The plate is gripped by the spring fingers, holding it tight to the barrel of the fork.

Transferring the sample from the probe fork to a manipulator sample dock is done with a rotary motion. The dock has the same type of locking fingers as the fork. The plate is mated to the dock by orienting it so that the three unused ramps can receive the dock's fingers. Rotating the fork releases the plate at the same time the fingers on the dock grip and lock the plate to the manipulator. This rotary movement makes a smooth sample transfer from the fork to dock and back again.

Nor-Cal's sample transfer system allows easy, forgiving sample transfer from a rotary/linear feedthrough to the sample dock mounted inside the chamber. Systems are available for sample sizes ranging from 1/2 inch (12.7mm) to 3 inches (76.2mm). Each system includes a dock assembly custom fitted to place the sample on target in your particular chamber, a transfer fork assembly which mounts to a rotary/linear device and two stainless steel sample plates. Molybdenum sample plates are also available. Call for details and pricing.

#### Features

- Fast thermal response and greater extremes
- Larger samples may be introduced through smaller ID plumbing
- Excellent sample plane repeatability
- Adapts to most goniometers and precision gearboxes
- Excellent performance for direct and indirect cooling
- Transferable thermocouple, optional
- Transferable intrinsic direct heating
- Five-year guarantee

MODEL NUMBER	SAMPLE OD	MINIMUM PORT OD
STS-050	1/2 (12.7)	1 1/2 (38.1)
STS-100	1 (25.4)	1 1/2 (38.1)
STS-200	2 (50.8)	2 1/2 (63.5)
STS-300	3 (76.2)	4 (101.6)

### Load Lock Chamber

Load lock chambers are an efficient means to introduce a sample into a vacuum chamber without impacting the main chamber vacuum. Load Locks are provided with a six inch CF flange for mounting to the gate valve, a six inch Add-A-Door with 7056 glass viewport, a 2 3/4 inch (70mm) CF flange for attachment of the linear feedthrough, and two 2 3/4 inch (70mm) CF flanges for pumping and gauges. Standard finish is electropolished. Custom sizes and configurations are readily available. Call for pricing.

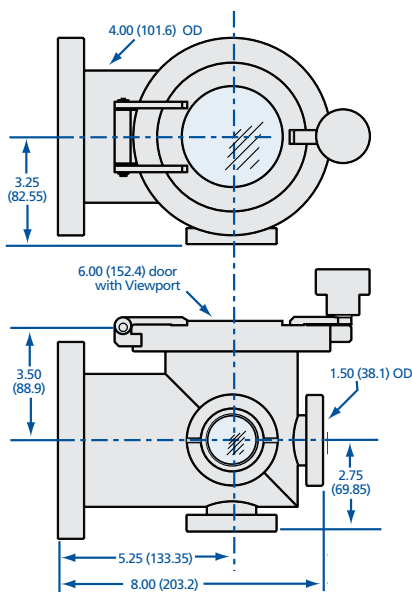
MODEL NUMBER  
LL-600-ADV-150-3

#### SPECIFICATIONS

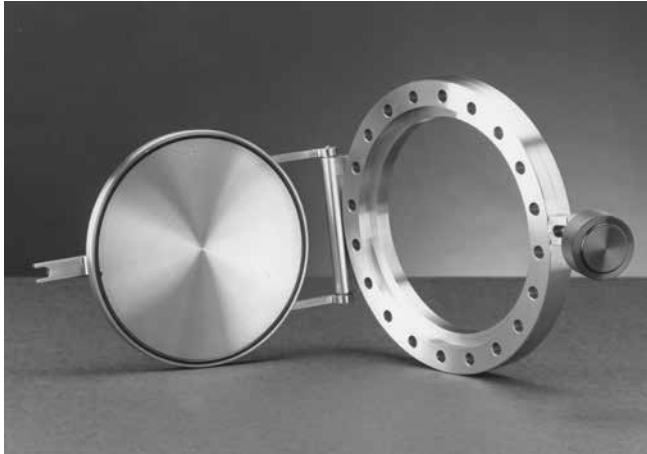
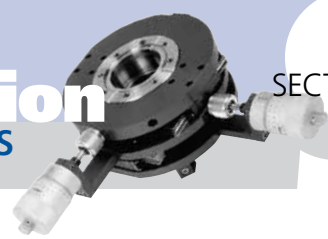
**Construction**  
Flanges: 304 stainless steel  
Body: 304 stainless steel  
Viewport: 7056 glass  
O-ring: Viton

**Temperature range:** -20°C to 200°C

**Vacuum range:** ≥ 10<sup>-8</sup> mbar (High vacuum)







An Add-A-Door can provide easy access to a vacuum system when elastomer seals are acceptable. The hinged, Viton sealed door is quickly bolted to an existing CF (Conflat style) flanged chamber port. The door is opened easily by turning a knurled knob. These doors are available for 2<sup>3</sup>/<sub>4</sub> to 10 inch (70 to 254mm) OD flanges with a solid metal door or with a viewport. Standard finish is electropolished. Custom sizes can be supplied upon request.

### SPECIFICATIONS

#### Construction

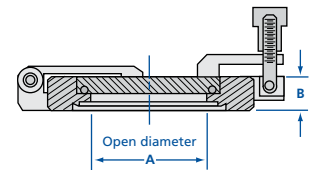
Body: 304 stainless steel  
 Flange: 2<sup>3</sup>/<sub>4</sub> to 10 inch (70 to 254mm) CF  
 Door: Blank, 7056 glass, or fused silica  
 O-ring: Viton standard

Temperature range: -20°C to 200°C

Vacuum range: ≥ 10<sup>-8</sup> mbar (High vacuum)

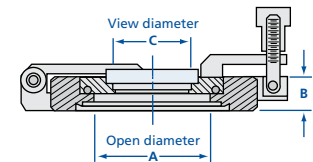
### Add-A-Doors

MODEL NUMBER	FLANGE TYPE	A	B
AD-275	2.75 CF	1.380 (35.05)	0.500 (12.70)
AD-450	4.50 CF	2.435 (61.85)	0.687 (17.45)
AD-600	6.00 CF	3.917 (99.49)	0.781 (19.84)
AD-800	8.00 CF	5.875 (149.23)	0.875 (22.23)
AD-1000	10.00 CF	7.875 (200.03)	0.968 (24.59)



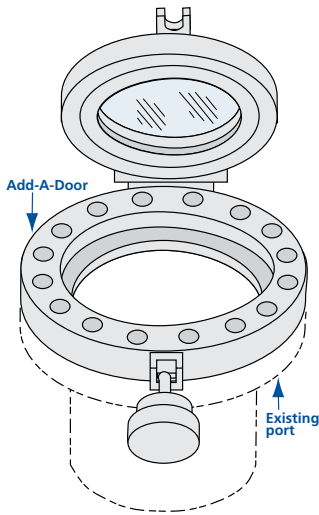
### Add-A-Doors with Viewport – 7056 Glass

MODEL NUMBER	FLANGE TYPE	A	B	C
ADV-450	4.50 CF	2.435 (61.85)	0.69 (17.53)	1.49 (37.85)
ADV-600	6.00 CF	3.917 (99.49)	1.00 (25.40)	2.65 (67.31)
ADV-800	8.00 CF	5.875 (149.23)	1.20 (30.48)	3.88 (98.55)
ADV-1000	10.00 CF	7.875 (200.03)	1.30 (33.02)	5.60 (142.24)

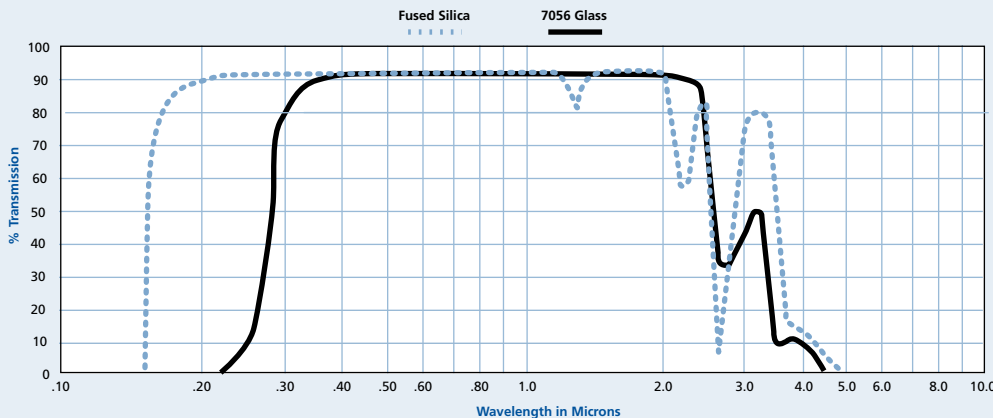


### Add-A-Doors with Viewport – Fused Silica

MODEL NUMBER	FLANGE TYPE	A	B	C
ADVQ-450	4.50 CF	2.435 (61.85)	0.74 (18.80)	1.40 (35.56)
ADVQ-600	6.00 CF	3.917 (99.49)	1.02 (25.91)	2.69 (68.33)
ADVQ-800	8.00 CF	5.875 (149.23)	1.21 (30.73)	3.88 (98.55)
ADVQ-1000	10.00 CF	7.875 (200.03)	1.28 (32.51)	5.38 (136.65)



### Viewport Optical Transmission Curves



All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.





# Sample Transfer & Manipulation

## Manipulators, Stages & Translators

### SPECIFICATIONS

#### Construction

**Bellows:** 1 7/8 inch (47.63mm) ID  
**Base flange:** 6 inch (152.4mm) CF, clearance holes with 5 mini flanges  
**Traveling flange:** 2 3/4 inch (69.85mm) CF, tapped holes  
**Guide rods:** Dual 3/4 inch (19.05mm) OD hardened stainless steel  
**Stage:** Aluminum

#### Motion

**XY travel:** ± 1/2 inch (12.7mm), circular pattern, pre-loaded large drum micrometer stage coupling with .0001 inch (.003) divisions  
**Z travel:** 2 inch (50.8mm), Acme drive with 2 inch (50.8mm) diameter drive knob (0.10 inch (2.54mm) per turn)

**Operating orientation:** Any; maximum payload 10lbs (4.54mm) when horizontally mounted

#### Temperature

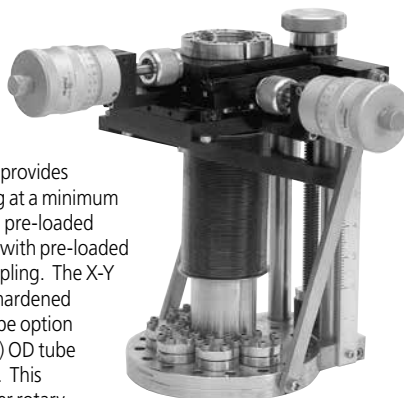
**Maximum bakeout:** 150°C, fully assembled  
**Operating:** 20°C (ambient)

**Vacuum range:** ≥ 10<sup>-10</sup> mbar (UHV)

**Options:** Support tube

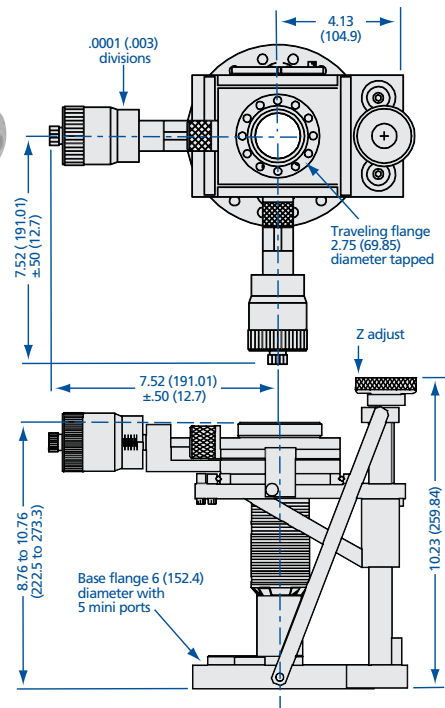
### XYZ Precision Manipulator

The PMXYZ manipulator provides high precision positioning at a minimum cost. It features precision pre-loaded cross-roller stage control with pre-loaded micrometer-to-stage coupling. The X-Y guide system is made of hardened carbon steel. Support tube option includes a 3/4 inch (19.05) OD tube and end bearing support. This increases rigidity on longer rotary shafts.



MODEL NUMBER	DESCRIPTION
PMXYZ-600-1.87-2	XYZ manipulator
-ST.25	1/4 inch (6.35) rotary shaft support tube*
-ST.38	3/8 inch (9.53) rotary shaft support tube*

\*Note: Add support tube option model number to the manipulator's model number. Example: PMXYZ-600-1.87-2-ST.38



### XY Stages with Bellows

XY stages are used to provide precise two-axis sample transfer positioning.

### SPECIFICATIONS

#### Construction

**Bellows:** Edge welded stainless steel  
**Base flange:** CF, clearance holes  
**Traveling flange:** CF, tapped holes  
**Way bearings:** Precision linear

#### Motion

**XY travel:** ± 1/2 to 1 inch (12.7 to 25.4mm), circular pattern, pre-loaded large drum micrometer stage coupling with 0.0001 inch (.003mm) divisions

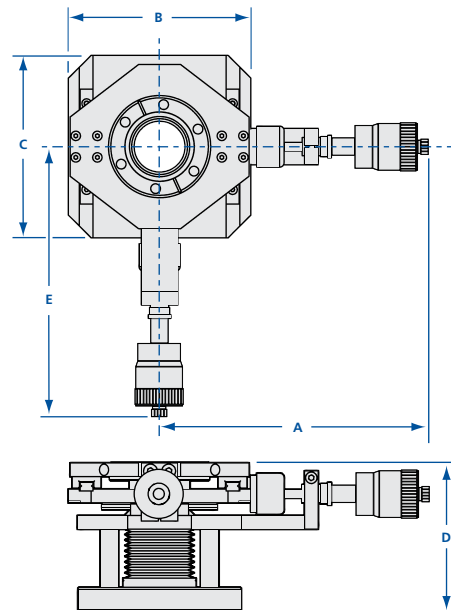
**Operating orientation:** Any; maximum payload 10 lbs (4.54kg) when horizontally mounted

#### Temperature

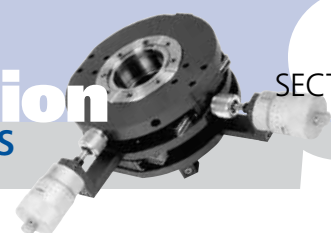
**Maximum bakeout:** 150°C, fully assembled  
**Operating:** 20°C (ambient)

**Vacuum range:** ≥ 10<sup>-10</sup> mbar (UHV)

MODEL NUMBER	FLANGE TYPE	BELLOWS ID	XY TRAVEL	A	B	C	D	E
PMXY-275-139-1	2 3/4 CF	1.39 (35.31)	± 1/2 (12.07)	7.386 (187.60)	5.000 (127.00)	5.000 (127.00)	4.100 (104.14)	7.386 (187.60)
PMXY-450-200-1	4 1/2 CF	2.00 (50.80)	± 1/2 (12.07)	9.250 (234.95)	7.750 (196.85)	7.750 (196.85)	5.400 (137.16)	9.250 (234.95)
PMXY-450-250-1	4 1/2 CF	2.50 (63.50)	± 1/2 (12.07)	9.250 (234.95)	7.750 (196.85)	7.750 (196.85)	5.400 (137.16)	9.250 (234.95)
PMXY-450-250-2	4 1/2 CF	2.50 (63.50)	± 1 (25.40)	9.250 (234.95)	7.750 (196.85)	7.750 (196.85)	5.400 (137.16)	9.250 (234.95)
PMXY-600-300-1	6 CF	3.00 (76.20)	± 1/2 (12.07)	11.960 (303.78)	9.875 (250.83)	9.312 (236.52)	6.530 (165.86)	11.087 (281.61)
PMXY-600-300-2	6 CF	3.00 (76.20)	± 1 (25.40)	11.960 (303.78)	9.875 (250.83)	9.312 (236.52)	6.530 (165.86)	11.087 (281.61)
PMXY-600-400-1	6 CF	4.00 (101.60)	± 1/2 (12.07)	11.960 (303.78)	9.875 (250.83)	9.312 (236.52)	6.530 (165.85)	11.087 (281.61)
PMXY-600-400-2	6 CF	4.00 (101.60)	± 1 (25.40)	11.960 (303.78)	9.875 (250.83)	9.312 (236.52)	6.530 (165.86)	11.087 (281.61)



All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.



### Z-Translators

Z translators feature a compact yet stable linear motion design, suitable for a variety of applications including use with our differentially pumped rotary seals. They may also be used with feedthrough utility hats and rotary motion feedthroughs.

MODEL NUMBER	DIAGRAM	TRAVELING FLANGE	BELLOWS ID	Z STROKE	BASE FLANGE	A	B	C	MIN. - MAX. D & E
MZ-275-104-2	A	2 <sup>3</sup> / <sub>4</sub> (70)	1.04 (26.42)	2	2 <sup>3</sup> / <sub>4</sub> (69.85)	3.060 (77.72)	6.94 (176.28)	1.750 (44.45)	Call
MZ-275-104-4	A	2 <sup>3</sup> / <sub>4</sub> (70)	1.04 (26.42)	4	2 <sup>3</sup> / <sub>4</sub> (69.85)	3.060 (77.72)	6.94 (176.28)	1.750 (44.45)	Call
MZ-275-104-6	A	2 <sup>3</sup> / <sub>4</sub> (70)	1.04 (26.42)	6	2 <sup>3</sup> / <sub>4</sub> (69.85)	3.060 (77.72)	6.94 (176.28)	1.750 (44.45)	Call
MZ-275-153-2	A	2 <sup>3</sup> / <sub>4</sub> (70)	1.53 (38.86)	2	2 <sup>3</sup> / <sub>4</sub> (69.85)	3.060 (77.72)	6.94 (176.28)	1.750 (44.45)	Call
MZ-275-153-4	A	2 <sup>3</sup> / <sub>4</sub> (70)	1.53 (38.86)	4	2 <sup>3</sup> / <sub>4</sub> (69.85)	3.060 (77.72)	6.94 (176.28)	1.750 (44.45)	Call
MZ-275-153-6	A	2 <sup>3</sup> / <sub>4</sub> (70)	1.53 (38.86)	6	2 <sup>3</sup> / <sub>4</sub> (69.85)	3.060 (77.72)	6.94 (176.28)	1.750 (44.45)	Call
MZ-450-188-2	A	2 <sup>3</sup> / <sub>4</sub> (70)	1.88 (47.75)	2	4 <sup>1</sup> / <sub>2</sub> (114.3)	3.250 (82.55)	6.94 (176.28)	1.750 (44.45)	Call
MZ-450-188-4	A	2 <sup>3</sup> / <sub>4</sub> (70)	1.88 (47.75)	4	4 <sup>1</sup> / <sub>2</sub> (114.3)	3.250 (82.55)	6.94 (176.28)	1.750 (44.45)	Call
MZ-450-188-6	A	2 <sup>3</sup> / <sub>4</sub> (70)	1.88 (47.75)	6	4 <sup>1</sup> / <sub>2</sub> (114.3)	3.250 (82.55)	6.94 (176.28)	1.750 (44.45)	Call
MZ-450-250-2	A	4 <sup>1</sup> / <sub>2</sub> (114)	2.50 (63.50)	2	4 <sup>1</sup> / <sub>2</sub> (114.3)	3.250 (82.55)	6.94 (176.28)	1.750 (44.45)	Call
MZ-450-250-4	A	4 <sup>1</sup> / <sub>2</sub> (114)	2.50 (63.50)	4	4 <sup>1</sup> / <sub>2</sub> (114.3)	3.250 (82.55)	6.94 (176.28)	1.750 (44.45)	Call
MZ-450-250-6	A	4 <sup>1</sup> / <sub>2</sub> (114)	2.50 (63.50)	6	4 <sup>1</sup> / <sub>2</sub> (114.3)	3.250 (82.55)	6.94 (176.28)	1.750 (44.45)	Call
MZ-600-300-2	B	6 (152.40)	3.00 (76.20)	2	6 (152.40)	12.125 (307.98)	-	6.426 (163.22)	Call
MZ-600-300-4	B	6 (152.40)	3.00 (76.20)	4	6 (152.40)	12.125 (307.98)	-	6.426 (163.22)	Call
MZ-600-300-6	B	6 (152.40)	3.00 (76.20)	6	6 (152.40)	12.125 (307.98)	-	6.426 (163.22)	Call
MZ-600-400-2	B	6 (152.40)	4.00 (101.60)	2	6 (152.40)	12.125 (307.98)	-	6.426 (163.22)	Call
MZ-600-400-4	B	6 (152.40)	4.00 (101.60)	4	6 (152.40)	12.125 (307.98)	-	6.426 (163.22)	Call
MZ-600-400-6	B	6 (152.40)	4.00 (101.60)	6	6 (152.40)	12.125 (307.98)	-	6.426 (163.22)	Call

### SPECIFICATIONS

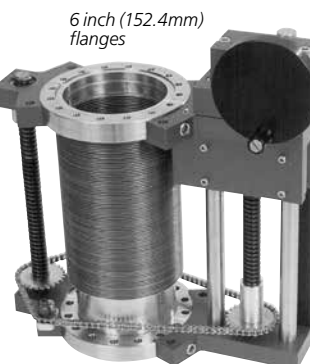
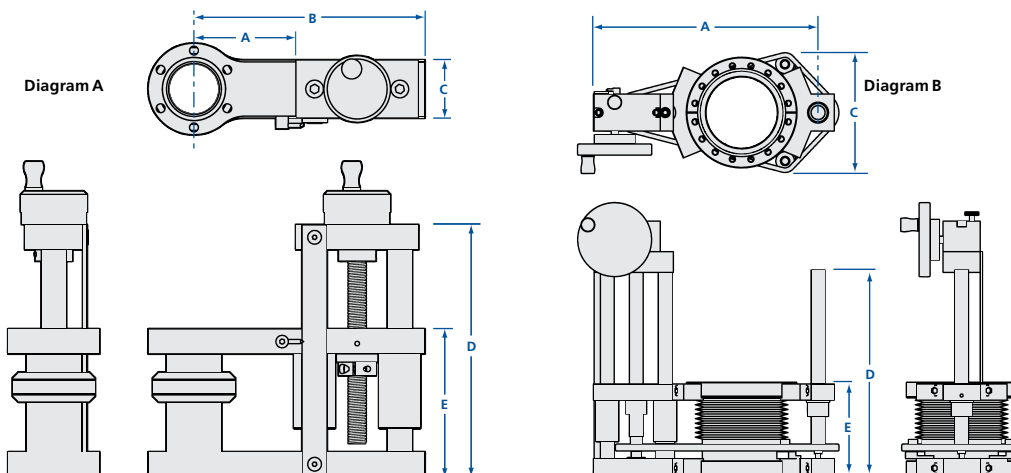
**Construction**  
 Bellows: 1.04 to 4 inch (26.42 to 101.6mm) ID edge welded stainless steel  
 Base flange: 2<sup>3</sup>/<sub>4</sub> to 6 inch (70 to 152.4mm) CF, clearance holes  
 Traveling flange: 2<sup>3</sup>/<sub>4</sub> to 6 inch (70 to 152.4mm) CF, tapped holes  
 Guide rods: Dual 3/4 inch (19.05mm) OD hardened stainless steel  
 Stage: Aluminum

**Motion:** 2 to 6 inches (50.8 to 152.4mm) Z travel, Acme drive with position indicator scale

**Operating orientation:** Any

**Temperature**  
 Maximum bakeout: 150°C, fully assembled  
 Operating: 20°C (ambient)

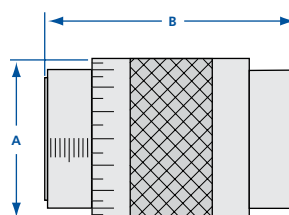
**Vacuum range:** ≥ 10<sup>-10</sup> mbar (UHV)



### Linear Motion Thimbles

The compact design and reliable operation of these linear motion thimbles allows precision linear probe positioning to distances up to 2 inches (50.8mm). Features include a clear bore design with a stainless steel welded bellows. Anodized aluminum collar is threaded to perform linear movement.

MODEL NUMBER	NOMINAL OD A	MINIMUM - MAXIMUM B	ID
LMT-133	1 <sup>3</sup> / <sub>4</sub> (44.45)	1.800 - 2.800 (45.72 - 71.12)	0.54 (13.72)
LMT-275	3 <sup>1</sup> / <sub>4</sub> (82.55)	3.060 - 5.060 (77.72 - 128.52)	1.43 (36.32)



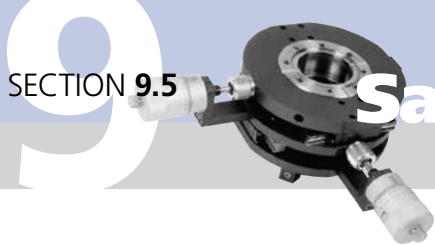
### SPECIFICATIONS

**Construction**  
 Bellows: 0.54 or 1.43 inch (13.72 or 36.32mm) ID stainless steel  
 Flanges: 1<sup>1</sup>/<sub>3</sub> or 2<sup>3</sup>/<sub>4</sub> inch (34 or 70mm) CF, tapped holes  
 Collar: Anodized aluminum

**Motion:** Up to 2 inches (50.8mm) linear movement, 360° graduations laser engraved on the collar

**Temperature range:** -20°C to 350°C

**Vacuum range:** ≥ 10<sup>-10</sup> mbar (UHV)



# Sample Transfer & Manipulation

## Utility Hat & Alignment Gimbals

### SPECIFICATIONS

#### Construction

Material: 304 stainless steel  
Flanges: CF, tapped and clearance holes  
see diagram for details  
Finish: Electropolished

Operating orientation: Any

Temperature range: -200°C to 450°C

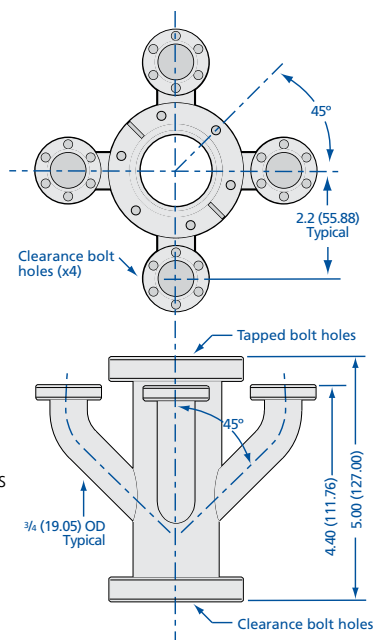
Vacuum range:  $\geq 10^{-10}$  mbar (UHV)

### Utility Hat

Feedthroughs can be mounted to the base flange of the XYZ Manipulator or to a utility hat. A utility hat is the preferred method when X-Y movements of the sample will cause excessive flexing and abrading of utility lines in vacuum. The utility hat can be mounted between the precision rotary feedthrough and the traveling flange on top of the XYZ to provide X-Y movement of utility lines with the sample. Additionally, the utility hat can be used on top of a differentially pumped rotary seal to allow 360° polar rotation of utility lines along with the sample. (See photo next page.) The standard utility hat comes with a 1 $\frac{3}{4}$  inch (44.45mm) tube, two 2 $\frac{3}{4}$  inch (69.85mm) CF flanges and four 1 $\frac{1}{3}$  inch (34mm) CF ports for mounting feedthroughs. Standard finish is electropolished. Custom sizes can be supplied upon request.

#### MODEL NUMBER

UH-175-2-133-4



### SPECIFICATIONS

#### Construction

Bellows: 1 $\frac{1}{2}$  inch (38.1mm) ID stainless steel  
Flanges: 2 $\frac{3}{4}$  inch (70mm) CF, tapped holes  
Pivots: Roller bearing

Motion:  $\pm 5^\circ$  XY adjustment range, knurled knob adjustment

Operating orientation: Any

#### Temperature

Maximum bakeout: 200°C  
Operating: 20°C (ambient)

Vacuum range:  $\geq 10^{-10}$  mbar (UHV)

Options: Micrometers "-M1" and "-M2"

### Alignment Gimbals

Alignment gimbals allow a precise angle alignment to be established (and repeated) between two flanges. When the base flange of a gimbal is attached to the chamber flange (or traveling stage of a positioning device) and a probe is attached to the tilting flange, probe angle and tip position can be changed. Alignment gimbals were designed as an inexpensive method to align docking systems and actuate sample transfers. Gimbals cantilever the (horizontal) load when the linear feedthrough flange and the load lock are horizontally mounted and can also compensate for droop in long horizontal mounted linear feedthrough probes. Single axis alignment gimbals are also available. Call for pricing and availability.

#### MODEL NUMBER

#### DESCRIPTION

AG-275-150

Knurled knob adjustment on both axes

AG-275-150-M1

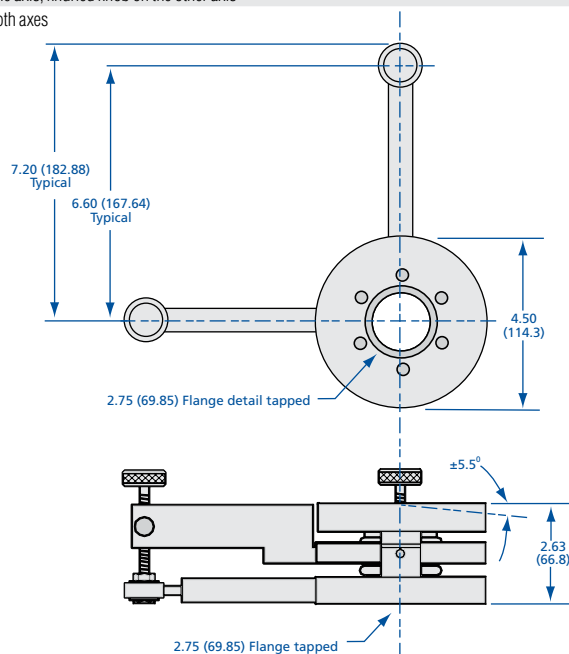
Micrometer adjustment on one axis, knurled knob on the other axis

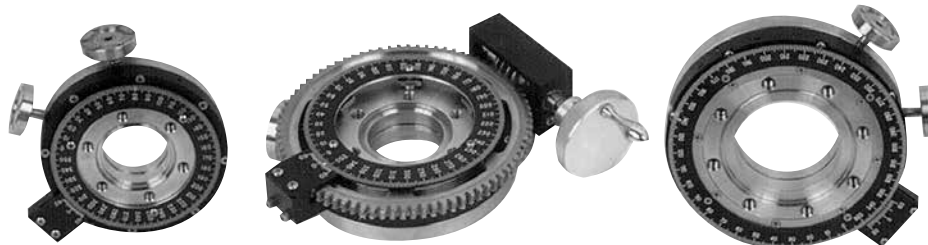
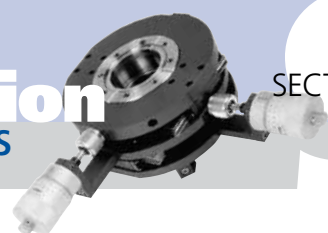
AG-275-150-M2

Micrometer adjustment on both axes



Shown with micrometer option "-M2"





### Differentially Pumped Rotary Seals

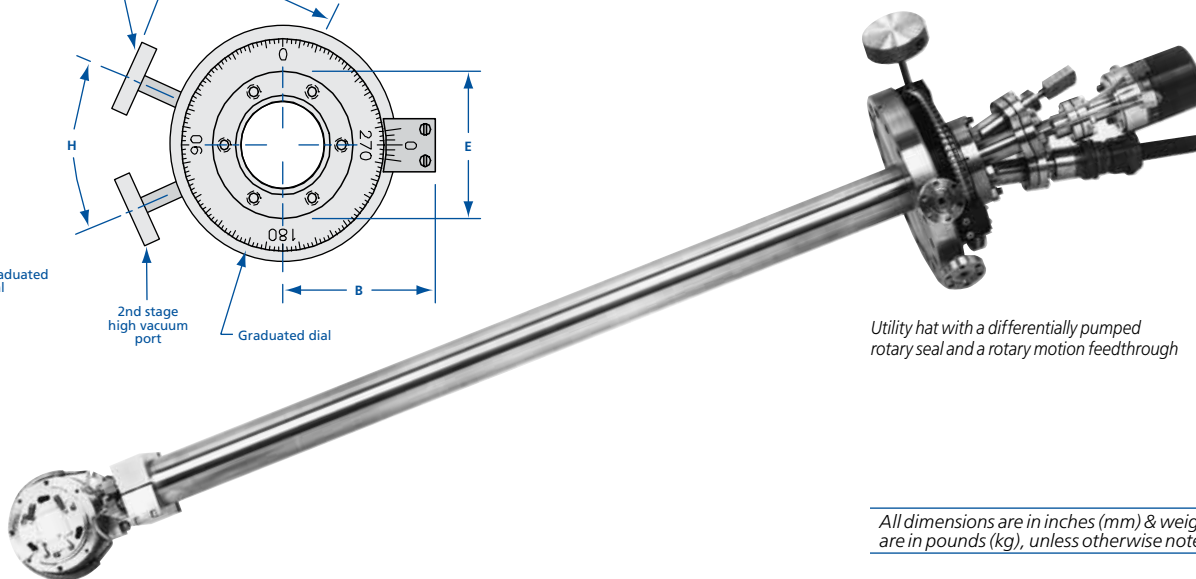
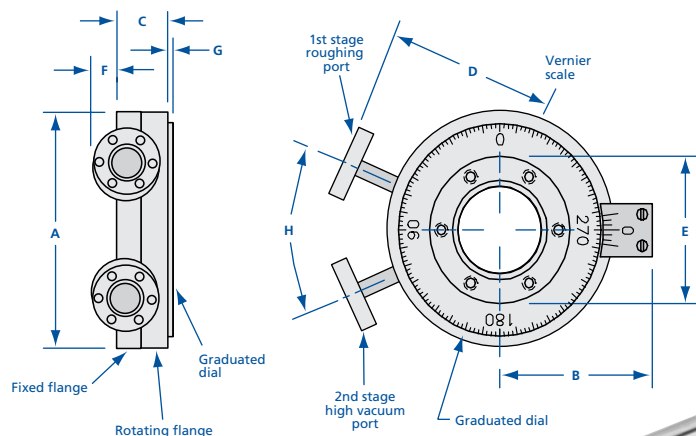
Differentially pumped rotary seals provide 360° of continuous rotation through the vacuum wall of a UHV system. They have two stages of differential pumping isolated by graphite-impregnated, expanded, Teflon seals on special sealing surfaces. A pre-loaded ball bearing set accurately controls the rotating stage position, allowing the unit to be successfully used with manipulators and other precision positioning devices. For easier and more accurate angle adjustment, a worm drive fine adjust option is available. Rotary seals are also available with an anti-backlash stepping or synchronous motor drive. Sizes up to 4 inch (101.6mm) ID are standard, while larger sizes are available on request.

#### SPECIFICATIONS

- Construction**  
Flanges: CF, tapped holes, one rotational and one stationary  
T-wrench included for adjustment
- Motion:** 360° rotation, two stage, differentially pumped with 360° vernier scale
- Operating orientation:** Any
- Temperature**  
Maximum bakeout: 150°C  
Operating: 20°C (ambient)
- Vacuum range:**  $\geq 10^{-11}$  mbar (UHV)
- Readability:** Standard scale 1.0°, mechanical counter 0.1°, micro stepped motor drive required for maximum resolution
- Options:** Fine adjust worm drive "-W", digital counters, stepper motors and other sizes available

MODEL NUMBER	ID	NOMINAL OD	A	B	C	D	E	F	G	H	VERTICAL PAYLOAD*	HORIZONTAL PAYLOAD*
<b>RS-150</b>	1.53 (38.86)	2 <sup>3</sup> / <sub>4</sub> (69.85)	4.50 (114.30)	2.99 (75.95)	1.00 (25.40)	3.18 (80.77)	2.75 (69.85)	0.49 (12.45)	0.13 (3.30)	60°	54 (24.3)	30 (13.5)
<b>RS-150-W</b>	1.53 (38.86)	2 <sup>3</sup> / <sub>4</sub> (69.85)	5.13 (130.30)	3.38 (85.85)	1.00 (25.40)	4.95 (125.73)	2.75 (69.85)	0.49 (12.45)	0.37 (9.40)	60°	54 (24.3)	30 (13.5)
<b>RS-250</b>	2.53 (64.26)	4 <sup>1</sup> / <sub>2</sub> (114.3)	5.75 (146.05)	3.64 (92.46)	1.36 (34.54)	3.58 (90.93)	4.50 (114.30)	0.49 (12.45)	0.03 (0.76)	45°	90 (40.5)	38 (17.1)
<b>RS-250-W</b>	2.53 (64.26)	4 <sup>1</sup> / <sub>2</sub> (114.30)	6.38 (162.05)	4.20 (106.68)	1.36 (34.54)	6.11 (155.19)	4.50 (114.30)	0.49 (12.45)	0.41 (10.41)	45°	90 (40.5)	38 (17.1)
<b>RS-400</b>	4.03 (102.36)	6 (152.40)	7.75 (196.85)	4.57 (116.08)	1.68 (42.67)	4.34 (110.24)	6.02 (152.91)	0.37 (9.40)	0.06 (1.52)	45°	144 (64.8)	66 (29.7)
<b>RS-400-W</b>	4.03 (102.36)	6 (152.40)	8.50 (215.90)	8.25 (209.55)	1.68 (42.67)	9.28 (235.71)	6.02 (152.91)	0.37 (9.40)	0.54 (13.72)	45°	144 (64.8)	66 (29.7)

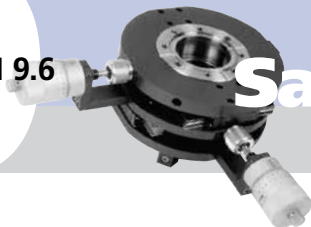
\*Note: Standard maximum payloads with center of gravity within 10% of the RS ID from the RS centerline when vertical, within one ID of the RS from the RS flange face when horizontal, and certain other size restrictions are met – consult factory.



Utility hat with a differentially pumped rotary seal and a rotary motion feedthrough

All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.





## SPECIFICATIONS

## Construction

Mounting flange: 2<sup>3</sup>/<sub>4</sub> (70mm) CF, clearance holes

Rotary probe: 3<sup>8</sup>/<sub>16</sub> inch (9.53mm)

Drive: Motor drive with controller, manual drive knob with position lock

Bearings: 4,000,000 revolutions before service

**Motion:** 360° continuous with variable speed

**Operating orientation:** Any

## Temperature

Maximum bakeout: 200°C, with drive removed

Operating: 20°C (ambient)

**Vacuum range:** ≥ 10<sup>-10</sup> mbar (UHV)

## Torque

Motor: 50 ounce-inches (.353 Nm)

Feedthrough: 150 ounce-inches (1.059 Nm)

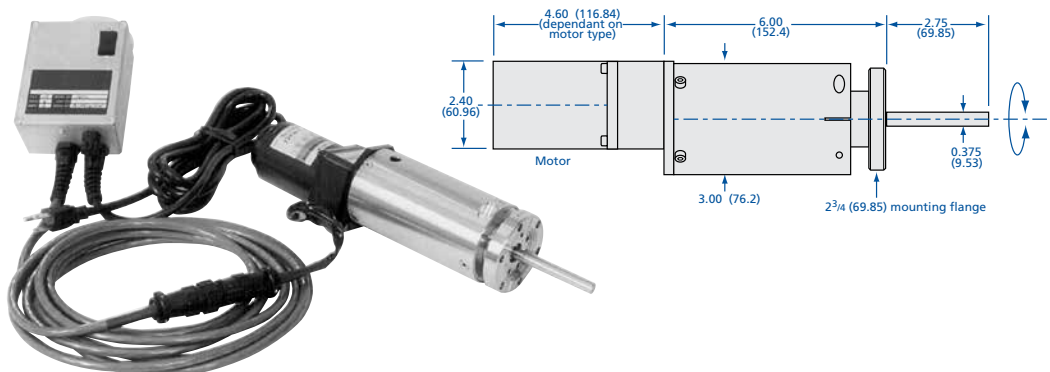
**Speed:** 5 to 95 RPM

**Options:** Higher torque motors, different speed ranges

## Motorized Rare Earth Magnetic Rotary Motion Feedthrough

The rare earth magnetic series rotary drives are designed to provide exceptional, long life performance. They are UHV compatible and are an excellent option to conventional bellows sealed and other rotary devices. They can be adapted to pulsed laser deposition (PLD) target clocking and continuous rotation of targets and substrates, as well as applications that require small profiles and high performance. There are no sliding seals or magnets in vacuum and stray magnetic fields are virtually nonexistent. The in-vacuum armature is made of paramagnetic materials with stainless steel and silicon nitride bearings and is capable of repeated bake-out to 200°C with magnets removed. Out-of-vacuum bearings are accessible for lubrication and the magnet drive is easily removable.

MODEL NUMBER	FLANGE TYPE	SHAFT OD	SHAFT LENGTH
MRRE-275-038	2.75 CF	0.375 (9.53)	2.75 (69.85)



## SPECIFICATIONS

## Construction

Mounting flange: 1<sup>1</sup>/<sub>3</sub> or 2<sup>3</sup>/<sub>4</sub> (34 or 70mm) CF, clearance holes

Rotary shaft: 1<sup>4</sup>/<sub>16</sub> inch (6.35mm)

Drive: Manually actuated

Attachment: 8-32 tapped hole

**Motion:** 360° continuous, with 360° graduations on knob and locking screw

**Operating orientation:** Any

**Temperature range:** -20°C to 150°C

**Vacuum range:** ≥ 10<sup>-10</sup> mbar (UHV)

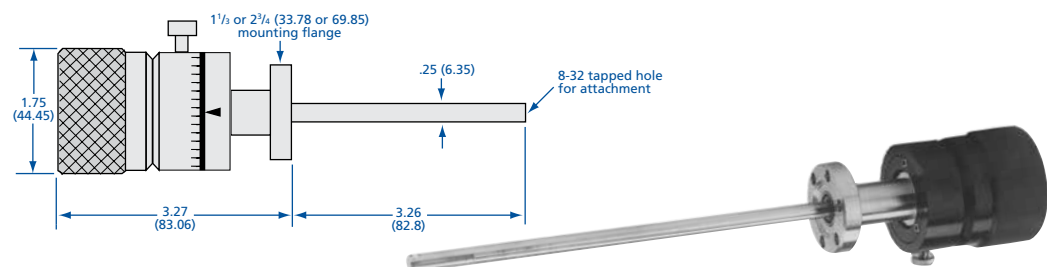
**Torque:** 50 ounce-inches (.353 Nm)

**Options:** Tapped holes, special lengths

## 1/4 Inch Precision Rotary Motion Feedthroughs

Precision rotary feedthroughs provide 360° continuous rotation and may be used to define a polar axis for a sample or probe or to actuate a mechanical device, such as a shutter, inside the vacuum chamber. Typically used for polar rotation on top of an XYZ manipulator.

MODEL NUMBER	FLANGE TYPE	SHAFT OD	SHAFT LENGTH
PRM-133	1.33 CF	0.25 (6.35)	3.26 (82.80)
PRM-275	2.75 CF	0.25 (6.35)	3.26 (82.80)



## SPECIFICATIONS

## Construction

Bellows: Welded stainless steel

Mounting flange: 2<sup>3</sup>/<sub>4</sub> (70mm) CF, clearance holes

Rotary shaft: 3<sup>8</sup>/<sub>16</sub> inch (9.53mm)

Drive: Manually actuated

**Motion:** 360° continuous, 0.10° resolution (1° graduations on dial), maximum run-out 0.005 inches (.13mm)

**Operating orientation:** Any

## Temperature

Maximum bakeout: 200°C

Operating: 20°C (ambient)

**Vacuum range:** ≥ 10<sup>-10</sup> mbar (UHV)

**Torque:** 1,100 ounce-inches (7.768 Nm)

**Options:** Custom shaft lengths: 9 to 23 inches (228.6 to 584.2mm).

Change model number suffix "-24"

Additional charges will apply. Example:

PRM-275-038-12 (indicates 12 inch

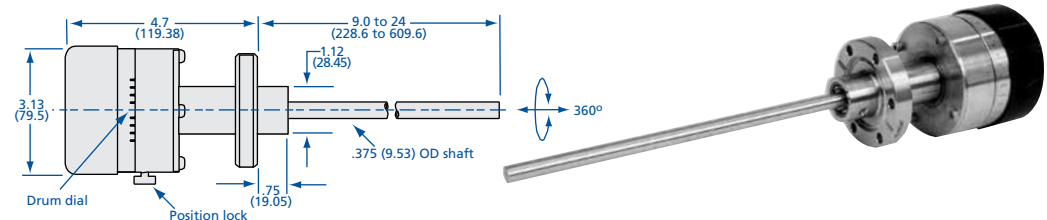
(304.8mm) shaft), field-mountable shaft

extensions, fine adjust and motor drives

## 3/8 Inch Precision Rotary Motion Feedthrough

Precision rotary feedthroughs are commonly used to define a polar axis for a sample or probe. They provide 360° continuous rotation and are mounted on top of XYZ manipulators and other stages. They are also used separately where precision angular orientation is needed.

MODEL NUMBER	FLANGE TYPE	SHAFT OD	SHAFT LENGTH
PRM-275-038-24	2.75 CF	3 <sup>8</sup> / <sub>16</sub> (9.53)	24.00 (609.60)



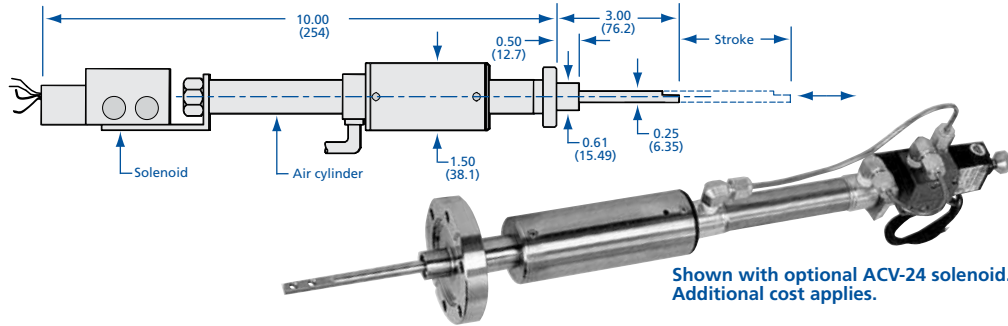


### Pneumatically Actuated Linear Motion Feedthrough

Commonly used as positioning devices for shutters and beam stoppers.

MODEL NUMBER	FLANGE TYPE	SHAFT OD	TRAVEL
ALM-133-2	1.33 CF	0.25 (6.35)	2 (50.80)
ALM-133-4	1.33 CF	0.25 (6.35)	4 (101.60)

#### AVC-24 Solenoid



#### SPECIFICATIONS

**Construction**  
 Bellows: Welded stainless steel, sealed  
 Mounting flange: 1 1/3 (34mm) CF, clearance holes  
 Linear probe: 1/4 inch (6.35mm) OD  
 Cylinder: 3/4 inch (19.05mm) ID  
 Bushing: Macor

**Motion**  
 Linear: 2 to 4 inch (50.8 to 101.6mm) travel, pneumatically actuated  
 Operating air pressure: 50 to 150 psi

**Operating orientation:** Any

**Temperature**  
 Maximum bakeout: 200°C  
 Operating: 20°C (ambient)

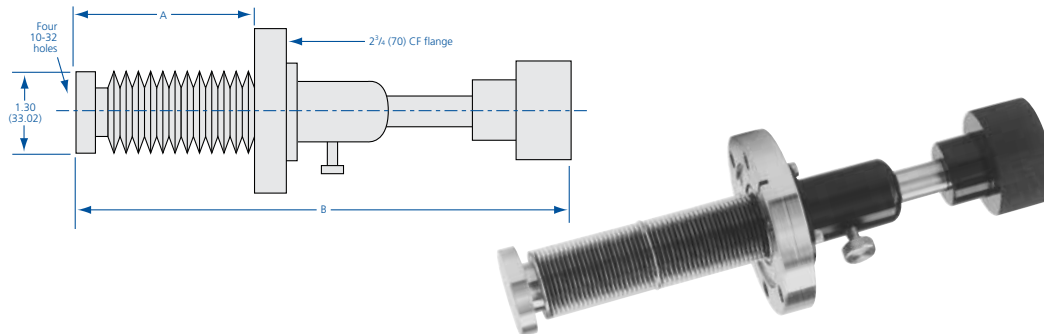
**Vacuum range:** ≥ 10<sup>-10</sup> mbar (UHV)

**Options:** 2 3/4 inch (69.85) OD flange, solenoid 24VDC or per customer requirements

### Heavy-Duty Push-Pull Linear Motion Feedthroughs

Manually operated linear motion positioning device designed for UHV applications.

MODEL NUMBER	FLANGE TYPE	TRAVEL	MINIMUM - MAXIMUM A	B
HLM-275-2	2.75 CF	2 (50.80)	1.1 - 3.1 (27.94 - 78.74)	6.75 (171.45)
HLM-275-3	2.75 CF	3 (76.20)	1.4 - 4.4 (35.56 - 111.76)	8.07 (204.98)
HLM-275-4	2.75 CF	4 (101.60)	1.7 - 5.7 (43.18 - 144.78)	9.38 (238.25)



#### SPECIFICATIONS

**Construction**  
 Bellows: Welded stainless steel, sealed  
 Mounting Flange: 2 3/4 (70mm) CF, clearance holes

**Motion:** 2, 3 and 4 inch (50.8, 76.2 and 101.6mm) linear travel with

**Operating orientation:** Any

**Temperature range:** -20°C to 250°C

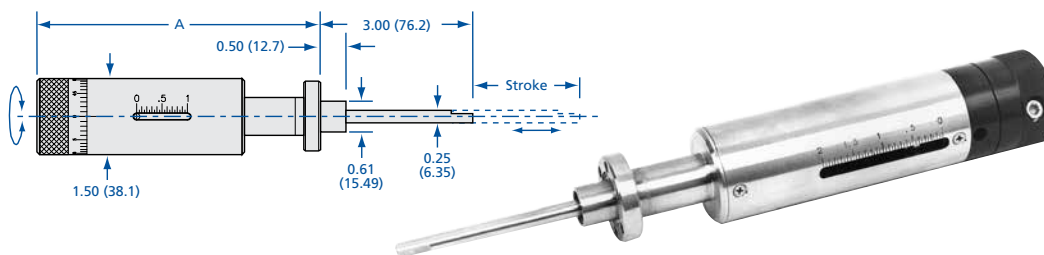
**Vacuum range:** ≥ 10<sup>-10</sup> mbar (UHV)

**Maximum lateral load:** 20 pounds

### Linear Vacuum Feedthrough

Manually operated linear motion positioning device with rotary actuation.

MODEL NUMBER	FLANGE TYPE	LINEAR TRAVEL	SHAFT OD
RLM-133-2	1.33 CF	2 (50.80)	0.25 (6.35)
RLM-133-4	1.33 CF	4 (101.60)	0.25 (6.35)
RLM-275-2	2.75 CF	2 (50.80)	0.25 (6.35)
RLM-275-4	2.75 CF	4 (101.60)	0.25 (6.35)



#### SPECIFICATIONS

**Construction**  
 Bellows: Welded stainless steel, sealed  
 Mounting flange: 1 1/3 or 2 3/4 (34 or 70mm) CF, clearance holes  
 Linear shaft: 1/4 inch (6.35mm) OD  
 Drive: All ball bearing

**Motion:** 2 or 4 inch (50.8 or 101.6mm) linear travel, 20 turns/inch (25.4) rotary actuation, position indicator

**Operating orientation:** Any

**Temperature**  
 Maximum bakeout: 200°C  
 Operating: 20°C (ambient)

**Vacuum range:** ≥ 10<sup>-10</sup> mbar (UHV)

**Options:** Longer strokes

All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.

## SPECIFICATIONS

## Construction

Mounting flange: 2<sup>3</sup>/<sub>4</sub> (70mm) CF, clearance holes  
 Probe: 1/2 inch (12.7mm) OD stainless steel tubular probe  
 Drive: Removable neodymium iron boron magnet  
 Bearings: 8 stainless steel

## Motion

Linear: 24 and 36 inch (609.6 and 914.4mm), adjustable stops  
 Rotary: 360° continuous rotation, with 0° to 360° indication

Operating orientation: Horizontal

## Maximum temperature:

200°C with drive removed

Vacuum range:  $\geq 10^{-10}$  mbar (UHV)

Linear force: 4 pounds (1.8 kg)

Torque: 150 ounce-inches (1.059 Nm)

Options: Light-touch magnet (-LT)

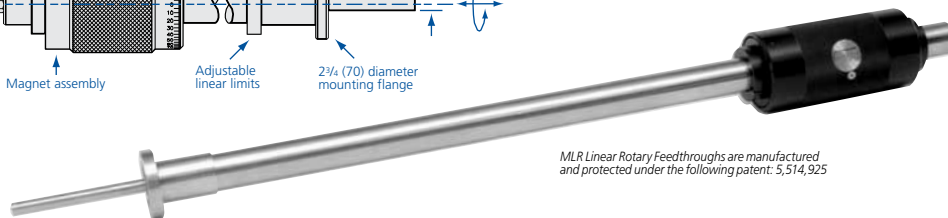
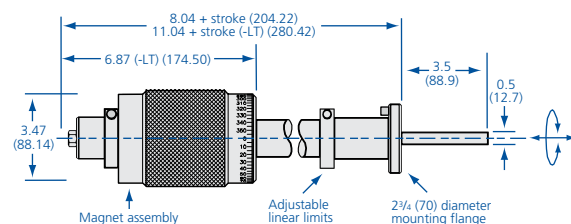
## Magnetic Linear/Rotary Feedthrough

Magnetically coupled feedthroughs offer exceptional linear/rotary motion for short to medium stroke sample introduction and transfer of light loads. The standard magnetic driver package provides more than 150 ounce-inches (1.059 Nm) of torque and four pounds of linear force. The inside traveler has no magnets, but it is made of magnetically permeable material.

## LIGHT-TOUCH MAGNET ASSEMBLY OPTION (-LT)

- Utilizes dynamically loaded full-bearing support to increase tactile feedback
- Heavy-duty linear magnet driver increases linear force to 15 pounds (6.75 kg)

MODEL NUMBER	DESCRIPTION
MLR-275-050-24	24 inch (609.6) stroke
MLR-275-050-36	36 inch (914.4) stroke
-LT	Light-touch magnet assembly option (Add -LT to the model number)



MLR Linear Rotary Feedthroughs are manufactured and protected under the following patent: 5,514,925

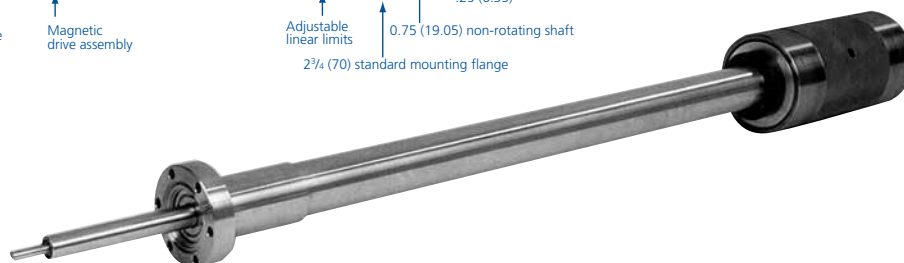
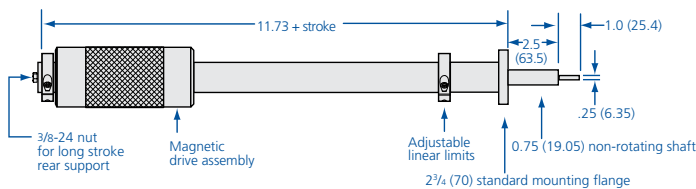
## Coaxial Magnetic Linear/Rotary Feedthrough

Magnetically-coupled linear/rotary feedthroughs offer unparalleled smooth rotary motion for medium to long stroke sample introduction and transfer of light loads. The coaxial design features a 3/4 inch (19.05mm) linear support tube with rotary bearing in the tip to guide the 1/4 inch (6.35mm) rotary probe. In addition to rotary motion, the design includes a linear driver, for additional axial force and tactile feedback.

## SOFT-TOUCH MAGNET ASSEMBLY OPTION (-ST)

Soft touch magnet assembly utilizes dynamically loaded full-bearing support to increase tactile feedback.

MODEL NUMBER	DESCRIPTION
MLRC-275-36	36 inch (914.4) stroke
MLRC-275-42	42 inch (1066.8) stroke
MLRC-275-48	48 inch (1219.2) stroke
-ST	Soft-touch magnet assembly option (Add -ST to model number)

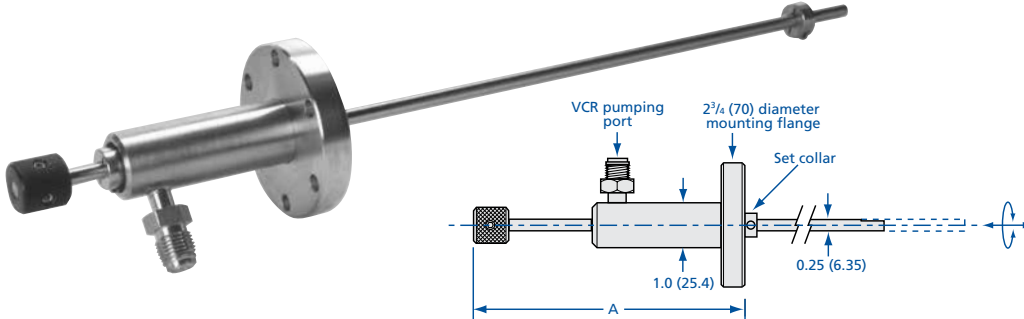


All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.



### Differentially Pumped Linear/Rotary Motion Feedthrough

MODEL NUMBER	SEAL	DESCRIPTION	MAXIMUM A
OLR-275-10	Viton	Manually operated, for medium vacuum applications	15.20 (386.08)



#### SPECIFICATIONS

**Construction**  
 Feedthrough: stainless steel  
 Mounting flange: 2<sup>3</sup>/<sub>4</sub> (70mm) CF, clearance holes  
 Probe: 1/4 inch (6.35mm) OD  
 Seal: Differentially pumped Viton O-ring  
 Body insert: Teflon

**Motion**  
 Linear: 24 inch (609.6mm), clamp type stop collar  
 Rotary: 360° continuous rotation

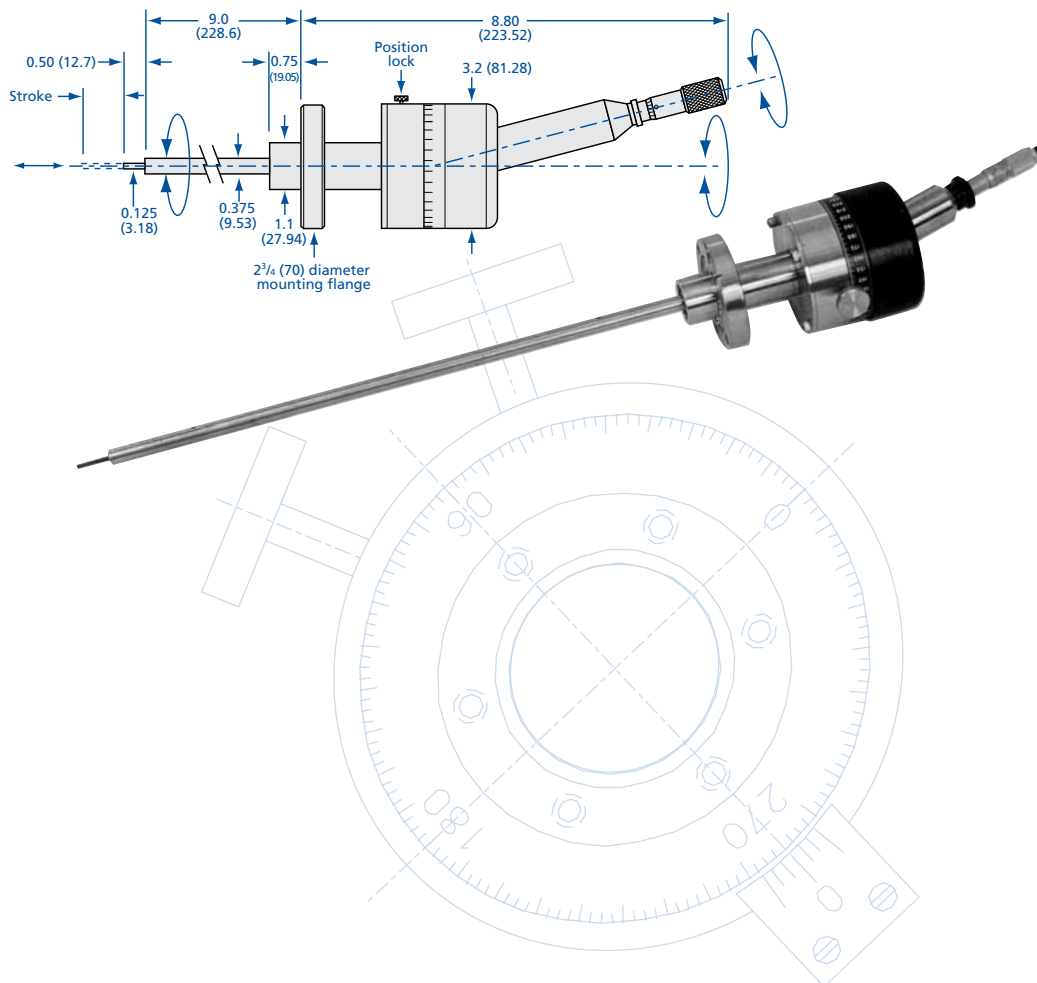
**Operating orientation:** Any

**Temperature range:** -20°C to 150°C

**Vacuum range:** ≥ 10<sup>-5</sup> mbar (Medium vacuum)

### Precision Linear/Rotary Motion Feedthrough

MODEL NUMBER	DESCRIPTION	STROKE
PLR-275-050	Stand-alone device or used when coupled with a gearbox to control polar and azimuthal rotation of a sample	1/2 (12.70)



#### SPECIFICATIONS

**Construction**  
 Mounting flange: 2<sup>3</sup>/<sub>4</sub> (70mm) CF, clearance holes  
 Linear probe: 1/8 inch (3.18mm) OD  
 Rotary tube: 3/8 inch (9.53mm) OD, 9 inch (228.6mm) length  
 Bearings: Precision internal guide

**Motion**  
 Linear: 1/2 inch (12.7mm), micrometer adjusted  
 Rotary: 360° continuous, 0.1° resolution in 1.0° graduations with position lock

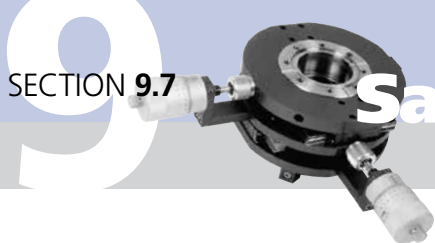
**Operating orientation:** Any

**Temperature**  
 Maximum bakeout: 200°C  
 Operating: 20°C (ambient)

**Vacuum range:** ≥ 10<sup>-8</sup> mbar (UHV)

*All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.*





# Sample Transfer & Manipulation

## Wobble Sticks

### Wobble Sticks

WBL wobble sticks offer a simple means of positioning samples in vacuum by permitting Z-axis and tilt movements. All stainless steel construction designed for use in high vacuum or UHV environments.

#### SPECIFICATIONS

##### Construction

Bellows: Welded stainless steel  
Mounting flange: CF or NW  
Shaft OD: 1/8 or 1/4 inch (3.18 or 6.35mm)  
Drive: Manually actuated

**Motion:**  $\pm 22^\circ$  or  $\pm 30^\circ$  tilt

**Operating orientation:** Any

##### Temperature range

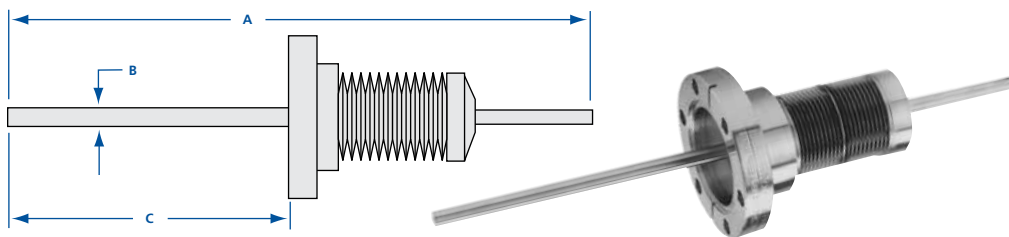
Metal seal: 450°C  
Elastomer seal: 200°C

##### Vacuum range

Metal seal:  $\geq 10^{-10}$  mbar (UHV)  
Elastomer seal:  $\geq 10^{-8}$  mbar (High Vacuum)

MODEL NUMBER	FLANGE TYPE	FLEX ANGLE*	A	B	MIN. - MAX. C
WBL-133	1.33 CF	$\pm 22^\circ$	6 (152.40)	0.12 (3.05)	3 - 3 1/2 (76.20 - 88.90)
WBL-275	2.75 CF	$\pm 30^\circ$	10 (254.00)	0.25 (6.35)	3 3/4 - 6 (95.25 - 152.40)
WBL-NW-16	NW-16	$\pm 22^\circ$	6 (152.40)	0.12 (3.05)	3 - 3 1/2 (76.20 - 88.90)
WBL-NW-40	NW-40	$\pm 30^\circ$	10 (254.00)	0.25 (6.35)	3 3/4 - 6 (95.25 - 152.40)

\* Mating flange may restrict flexible angle



### Rotary Wobble Sticks

RWS wobble sticks provide Z-axis, polar rotation, and polar axis tilt to allow tip positioning inside a vacuum chamber. They offer an inexpensive alternative for sample introduction and manipulation.

#### SPECIFICATIONS

##### Construction

Bellows: Welded stainless steel, independent for Z and theta  
Mounting flange: 2 3/4 (70mm) CF, clearance holes  
Tip: Pre-fitted with hook  
Drive: Manually actuated

##### Motion

Rotary: 360° probe rotation via rotary motion feedthrough  
Linear: 4 or 8 inch (101.6 or 203.2mm) stroke  
Tilt:  $\pm 22^\circ$

**Operating orientation:** Any

##### Temperature

Maximum bakeout: 200°C  
Operating: 20°C (ambient)

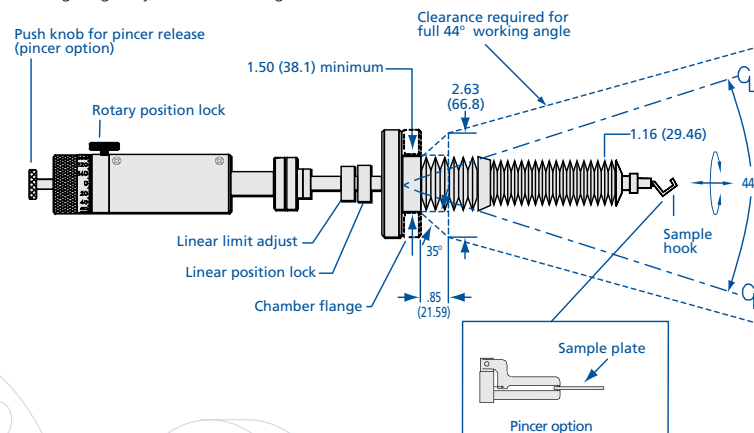
**Vacuum range:**  $\geq 10^{-10}$  mbar (UHV)

**Options:** Single-jaw pincer (add "-PS" to model number), double-jaw Omicron and other pincers upon request

MODEL NUMBER	FLANGE TYPE	FLEX ANGLE*	Z STROKE
RWS-275-4	2.75 CF	$\pm 22^\circ$	4 (101.60)
RWS-275-8	2.75 CF	$\pm 22^\circ$	8 (203.20)

-PS Single Jaw Pincer Option Add -PS to model number

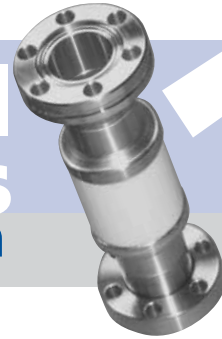
\* Mating flange may restrict flexible angle



All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.

# Liquid & Electrical Feedthroughs

## Section Ten



# 10



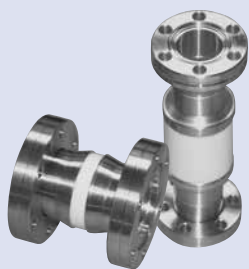
<b>10.1</b>	General Information	<b>210</b>
<b>10.2</b>	Liquid Feedthroughs	<b>211</b>
<b>10.3</b>	High Voltage Insulators	<b>213</b>
<b>10.4</b>	Electric Feedthroughs	<b>214</b>

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### New Products



#### High Voltage Insulators

Vacuum insulators electrically isolate one component or system from another. Nor-Cal's ceramic insulators provide UHV compatible isolation. Our insulators are available in  $\frac{3}{4}$  and  $1\frac{1}{2}$  inch (19.05 and 38.1mm) tube diameters, 3KV to 15KV ratings, with either CF or NW flanges.



#### Liquid Feedthroughs

Nor-Cal's product line of liquid and liquid nitrogen feedthroughs includes the most commonly required for medium, high and ultrahigh vacuum applications. Tubing is .25 and .375 (6.35 and 9.53mm) inch OD, 304 stainless steel with CF or NW flanges. They are available without fittings or terminated with industry standard Swagelok or Cajon VCR fittings. Maximum bakeout with CF flanges is 450°C and 200°C with NWs. Vacuum ranges are  $10^{-10}$  mbar and  $10^{-8}$ , respectively.

Liquid feedthroughs are a cost-effective and reliable way to introduce water into a vacuum system. The .035 inch (.89mm) single wall tube construction is designed for the transport of water as a cooling agent.

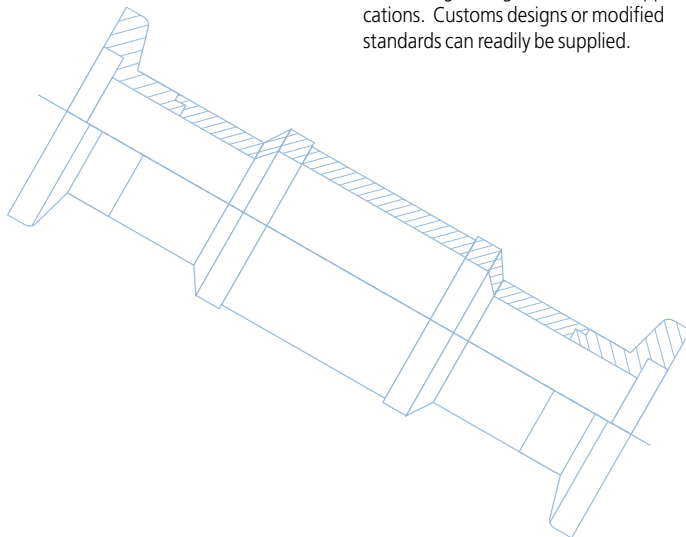
Liquid nitrogen feedthroughs are constructed with single and dual coaxial tube geometries. This thermal barrier effectively reduces condensation and ice buildup on the atmosphere side of the feedthrough around the mounting flange interface, protecting the seal's integrity. This is necessary because of the extreme thermal gradients encountered with liquid nitrogen.

Swagelok stainless steel tube compression fittings provide a leakproof, torque-free vacuum seal by swaging the stainless steel tube to which they are mated. These fittings require no gaskets.

Cajon VCR stainless steel compression fittings provide a quick and efficient means of vacuum system assembly. These zero clearance fittings make them the perfect installation solution when space is limited. Compression of a removable copper gasket creates a vacuum seal between the air and process sides.

#### Electrical Feedthroughs

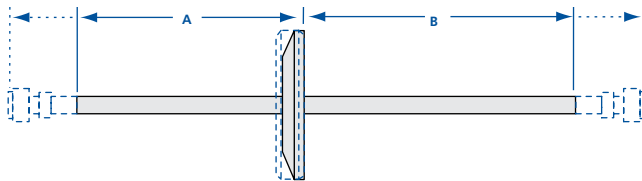
Nor-Cal's extensive line of electrical feedthroughs are manufactured from ultra-high vacuum grade materials such as high alumina ceramic insulators, OFHC copper or nickel conductors, and 304 stainless steel flanges. These robust ceramic to metal feedthroughs have electrical ratings for operation with one side in dry atmosphere while the opposite end is in a stable vacuum. They are used in UHV systems with CF flanges or high vacuum systems with NW flanges. CF feedthroughs can be baked to 450°C and NWs to 200°C. Our product line consists of the most commonly required feedthroughs for general vacuum applications. Custom designs or modified standards can readily be supplied.



All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.

### Single Liquid Feedthroughs

MODEL NUMBER	FLANGE	TUBE FITTINGS	TUBE OD	A	B
LFT-NW-16-1-025	NW-16	None	0.250 (6.35)	3.00 (76.20)	4.00 (101.60)
LFT-NW-25-1-025	NW-25	None	0.250 (6.35)	3.00 (76.20)	4.00 (101.60)
LFT-NW-25-1-025-2SW	NW-25	2 Swagelok	0.250 (6.35)	4.01 (101.85)	5.01 (127.25)
LFT-NW-25-1-025-2MVCR	NW-25	2 MVCR	0.250 (6.35)	4.03 (102.36)	5.03 (127.76)
LFT-NW-40-1-025	NW-40	None	0.250 (6.35)	3.00 (76.20)	4.00 (101.60)
LFT-NW-40-1-025-2SW	NW-40	2 Swagelok	0.250 (6.35)	4.01 (101.85)	5.01 (127.25)
LFT-NW-40-1-025-2MVCR	NW-40	2 MVCR	0.250 (6.35)	4.03 (102.36)	5.03 (127.76)
LFT-NW-40-1-038	NW-40	None	0.375 (9.53)	3.00 (76.20)	4.00 (101.60)
LFT-NW-50-1-025	NW-50	None	0.250 (6.35)	3.00 (76.20)	4.00 (101.60)
LFT-NW-50-1-025-2SW	NW-50	2 Swagelok	0.250 (6.35)	4.01 (101.85)	5.01 (127.25)
LFT-NW-50-1-025-2MVCR	NW-50	2 MVCR	0.250 (6.35)	4.03 (102.36)	5.03 (127.76)
LFT-NW-50-1-038	NW-50	None	0.375 (9.53)	3.00 (76.20)	4.00 (101.60)
LFT-075-1-025	1.33 CF	None	0.250 (6.35)	3.00 (76.20)	4.00 (101.60)
LFT-075-1-038	2.75 CF	None	0.375 (9.53)	3.00 (76.20)	4.00 (101.60)
LFT-150-1-025	2.75 CF	None	0.250 (6.35)	3.00 (76.20)	4.00 (101.60)
LFT-150-1-025-2SW	2.75 CF	2 Swagelok	0.250 (6.35)	4.01 (101.85)	5.01 (127.25)
LFT-150-1-025-2MVCR	2.75 CF	2 MVCR	0.250 (6.35)	4.03 (102.36)	5.03 (127.76)
LFT-150-1-038	2.75 CF	None	0.375 (9.53)	3.00 (76.20)	4.00 (101.60)



#### SPECIFICATIONS

##### Materials

Flange: 304 stainless steel

##### Vacuum range

Metal seal:  $\geq 10^{-10}$  mbar (UHV)

Elastomer seal:  $\geq 10^{-8}$  mbar (High vacuum)

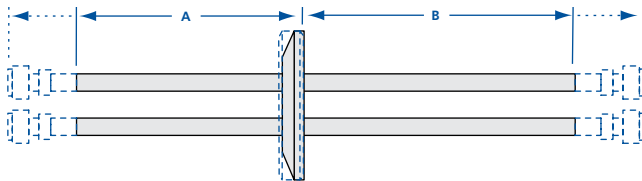
##### Temperature range

Metal seal: -270°C to 450°C

Elastomer seal: -20°C to 200°C

### Dual Liquid Feedthroughs

MODEL NUMBER	FLANGE	TUBE FITTINGS	TUBE OD	A	B
LFT-NW-40-2-025	NW-40	None	0.250 (6.35)	3.00 (76.20)	4.00 (101.60)
LFT-NW-40-2-025-4SW	NW-40	4 Swagelok	0.250 (6.35)	4.01 (101.85)	5.01 (127.25)
LFT-NW-40-2-025-4MVCR	NW-40	4 MVCR	0.250 (6.35)	4.03 (102.36)	5.03 (127.76)
LFT-NW-50-2-025	NW-50	None	0.250 (6.35)	3.00 (76.20)	4.00 (101.60)
LFT-NW-50-2-025-4SW	NW-50	4 Swagelok	0.250 (6.35)	4.01 (101.85)	5.01 (127.25)
LFT-NW-50-2-025-4MVCR	NW-50	4 MVCR	0.250 (6.35)	4.03 (102.36)	5.03 (127.76)
LFT-150-2-025	2.75 CF	None	0.250 (6.35)	3.00 (76.20)	4.00 (101.60)
LFT-150-2-025-4SW	2.75 CF	4 Swagelok	0.250 (6.35)	4.01 (101.85)	5.01 (127.25)
LFT-150-2-025-4MVCR	2.75 CF	4 MVCR	0.250 (6.35)	4.03 (102.36)	5.03 (127.76)
LFT-150-2-038	2.75 CF	None	0.375 (9.53)	3.00 (76.20)	4.00 (101.60)



#### SPECIFICATIONS

##### Materials

Flange: 304 stainless steel

##### Vacuum range

Metal seal:  $\geq 10^{-10}$  mbar (UHV)

Elastomer seal:  $\geq 10^{-8}$  mbar (High vacuum)

##### Temperature range

Metal seal: -270°C to 450°C

Elastomer seal: -20°C to 200°C

All dimensions for optional fittings are referenced from the seal face

All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.







## SPECIFICATIONS

## Materials

Flange: 304 stainless steel

## Vacuum range

Metal seal:  $\geq 10^{-10}$  mbar (UHV)Elastomer seal:  $\geq 10^{-8}$  mbar (High vacuum)

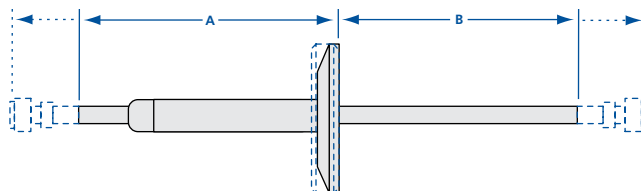
## Temperature range

Metal seal: -270°C to 450°C

Elastomer seal: -20°C to 200°C

## Single Liquid Nitrogen Feedthroughs

MODEL NUMBER	FLANGE	TUBE FITTINGS	TUBE OD	A	B
LNF-NW-16-1-025	NW-16	None	0.250 (6.35)	5.50 (139.70)	4.50 (114.30)
LNF-NW-25-1-025	NW-25	None	0.250 (6.35)	5.50 (139.70)	4.50 (114.30)
LNF-NW-25-1-025-2SW	NW-25	2 Swagelok	0.250 (6.35)	6.51 (165.35)	5.51 (139.95)
LNF-NW-25-1-025-2MVCR	NW-25	2 MVCR	0.250 (6.35)	6.53 (165.86)	5.53 (140.46)
LNF-NW-40-1-025	NW-40	None	0.250 (6.35)	5.50 (139.70)	4.50 (114.30)
LNF-NW-40-1-025-2SW	NW-40	2 Swagelok	0.250 (6.35)	6.51 (165.35)	5.51 (139.95)
LNF-NW-40-1-025-2MVCR	NW-40	2 MVCR	0.250 (6.35)	6.53 (165.86)	5.53 (140.46)
LNF-NW-40-1-038	NW-40	None	0.375 (9.53)	5.50 (139.70)	4.50 (114.30)
LNF-NW-50-1-025	NW-50	None	0.250 (6.35)	5.50 (139.70)	4.50 (114.30)
LNF-NW-50-1-025-2SW	NW-50	2 Swagelok	0.250 (6.35)	6.51 (165.35)	5.51 (139.95)
LNF-NW-50-1-025-2MVCR	NW-50	2 MVCR	0.250 (6.35)	6.53 (165.86)	5.53 (140.46)
LNF-NW-50-1-038	NW-50	None	0.375 (9.53)	5.50 (139.70)	4.50 (114.30)
LNF-075-1-025	1.33 CF	None	0.250 (6.35)	5.50 (139.70)	4.50 (114.30)
LNF-075-1-038	1.33 CF	None	0.375 (9.53)	5.50 (139.70)	4.50 (114.30)
LNF-150-1-025	2.75 CF	None	0.250 (6.35)	5.50 (139.70)	4.50 (114.30)
LNF-150-1-025-2SW	2.75 CF	2 Swagelok	0.250 (6.35)	6.51 (165.35)	5.51 (139.95)
LNF-150-1-025-2MVCR	2.75 CF	2 MVCR	0.250 (6.35)	6.53 (165.86)	5.53 (140.46)
LNF-150-1-038	2.75 CF	None	0.375 (9.53)	5.50 (139.70)	4.50 (114.30)



## Dual Liquid Nitrogen Feedthroughs

## SPECIFICATIONS

## Materials

Flange: 304 stainless steel

## Vacuum range

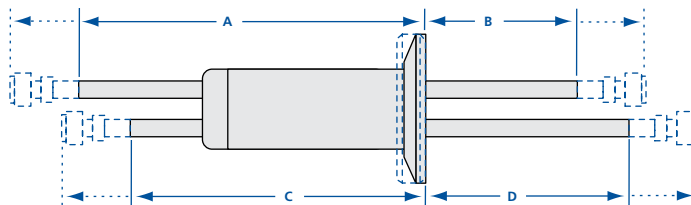
Metal seal:  $\geq 10^{-10}$  mbar (UHV)Elastomer seal:  $\geq 10^{-8}$  mbar (High vacuum)

## Temperature range

Metal seal: -270°C to 450°C

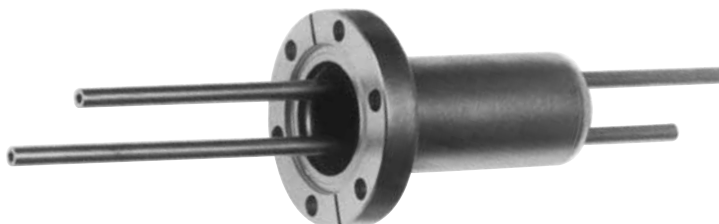
Elastomer seal: -20°C to 200°C

MODE NUMBER	FLANGE	TUBE FITTINGS	TUBE	A	B	C	D
LNF-NW-40-2-025	NW-40	None	0.250 (6.35)	6.50 (165.10)	3.50 (88.90)	5.50 (139.70)	4.50 (114.30)
LNF-NW-40-2-025-4SW	NW-40	4 Swagelok	0.250 (6.35)	7.51 (190.75)	4.51 (114.55)	6.51 (165.35)	5.51 (139.95)
LNF-NW-40-2-025-4MVCR	NW-40	4 MVCR	0.250 (6.35)	7.53 (191.26)	4.53 (115.06)	6.53 (165.86)	5.53 (140.46)
LNF-NW-50-2-025	NW-50	None	0.250 (6.35)	6.50 (165.10)	3.50 (88.90)	5.50 (139.70)	4.50 (114.30)
LNF-NW-50-2-025-4SW	NW-50	4 Swagelok	0.250 (6.35)	7.51 (190.75)	4.51 (114.55)	6.51 (165.35)	5.51 (139.95)
LNF-NW-50-2-025-4MVCR	NW-50	4 MVCR	0.250 (6.35)	7.53 (191.26)	4.53 (115.06)	6.53 (165.86)	5.53 (140.46)
LNF-150-2-025	2.75 CF	None	0.250 (6.35)	6.50 (165.10)	3.50 (88.90)	5.50 (139.70)	4.50 (114.30)
LNF-150-2-025-4SW	2.75 CF	4 Swagelok	0.250 (6.35)	7.51 (190.75)	4.51 (114.55)	6.51 (165.35)	5.51 (139.95)
LNF-150-2-025-4MVCR	2.75 CF	4 MVCR	0.250 (6.35)	7.53 (191.26)	4.53 (115.06)	6.53 (165.86)	5.53 (140.46)
LNF-150-2-038	2.75 CF	None	0.375 (9.53)	6.50 (165.10)	3.50 (88.90)	5.50 (139.70)	4.50 (114.30)



All dimensions for optional fittings are referenced from the seal face

All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.





Vacuum insulators (also known as vacuum breaks and isolators) are used to electrically isolate one component or system from another. Nor-Cal uses a ceramic insulator with 95% minimum aluminum oxide content, which is silver brazed to two Kovar sleeves, creating a UHV compatible insulator. The insulator is then welded to the appropriate vacuum flange. Standard vacuum insulators are available in two tube diameters, 3/4 and 1 1/2 inches (19.05 and 38.1mm). The 3/4 inch (19.05mm) size is rated up to 10KV, while the 1 1/2 inch (38.1mm) size is offered in two voltage ratings (3KV and 15KV). All three voltage ratings are available with either two NW (ISO-KF) flanges for high vacuum applications or with one non-rotatable and rotatable CF (Conflat) flange for ultra-high vacuum applications. Other sizes, current ratings and flange combinations are available on request.

### SPECIFICATIONS

#### Materials

Flanges: 304 stainless steel  
 Sleeve: Kovar  
 Insulator: Ceramic  
 (95% aluminum oxide content)  
 Magnetic: Yes

#### Vacuum range

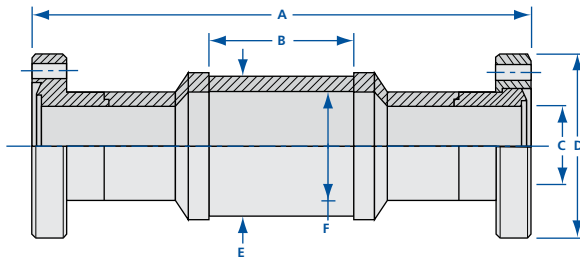
Metal seal:  $\geq 10^{-13}$  mbar (UHV)  
 Elastomer seal:  $\geq 10^{-8}$  mbar (High vacuum)

#### Temperature range

Metal seal:  $\leq 450^{\circ}\text{C}$   
 Elastomer seal:  $\leq 150^{\circ}\text{C}$  sustained,  
 $\leq 200^{\circ}\text{C}$  intermittent  
 Gradient:  $25^{\circ}\text{C}/\text{minute}$  maximum

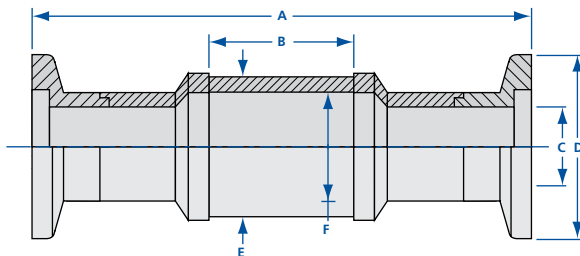
### CF High Voltage Insulators

MODEL NUMBER	TUBE OD	MAX. VOLTAGE (KV)	A	B	C	D	E	F
HVI-075-10	3/4 (19.05)	10	3.62 (91.95)	1.00 (25.40)	0.63 (16.00)	1.33 (33.78)	1.04 (26.42)	0.75 (19.05)
HVI-150-3	1 1/2 (38.10)	3	2.65 (67.31)	0.25 (6.35)	1.37 (34.80)	2.73 (69.34)	1.66 (42.16)	1.25 (31.75)
HVI-150-15	1 1/2 (38.10)	15	4.20 (106.68)	2.00 (50.80)	1.37 (34.80)	2.73 (69.34)	1.66 (42.16)	1.25 (31.75)



### NW High Voltage Insulators

MODEL NUMBER	TUBE OD	MAX. VOLTAGE (KV)	A	B	C	D	E	F
HVI-NW-16-10	3/4 (19.05)	10	3.62 (91.95)	1.00 (25.40)	0.63 (16.00)	1.18 (29.97)	1.04 (26.42)	0.75 (19.05)
HVI-NW-40-3	1 1/2 (38.10)	3	2.28 (57.91)	0.25 (6.35)	1.37 (34.80)	2.16 (54.86)	1.66 (42.16)	1.25 (31.75)
HVI-NW-40-15	1 1/2 (38.10)	15	4.03 (102.36)	2.00 (50.8)	1.37 (34.80)	2.16 (54.86)	1.66 (42.16)	1.25 (31.75)



All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.



## SPECIFICATIONS

## Materials

Flange: 304 stainless steel  
Conductors: OFHC copper  
Insulator: Alumina ceramic

## Electrical

Voltage: 5 KVDC  
Current: 150 Amps

**Connector:** Use with vacuum connector  
MCF-VC (see page 216)

## Vacuum range

Metal seal:  $\geq 10^{-10}$  mbar (UHV)  
Elastomer seal:  $\geq 10^{-8}$  mbar (High vacuum)

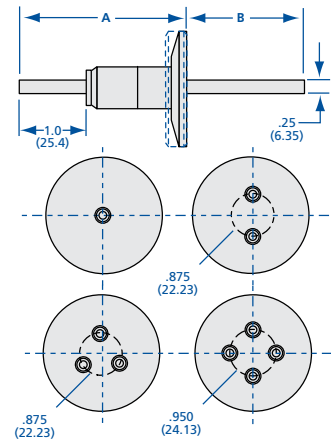
## Temperature range

Metal seal: -270°C to 450°C  
Elastomer seal: -20°C to 200°C

## Medium Current Copper Feedthroughs

These electrical feedthroughs transmit either high voltage, high current or a combination of both. They are used for sample heating, in-vacuum coating, electron beam evaporation, sputtering and other high vacuum applications. High-purity, high-strength, low-loss alumina ceramic surfaces maximize strike and creep distances. The air-side ceramic surfaces have a high temperature glass coating which reduces surface roughness and contamination.

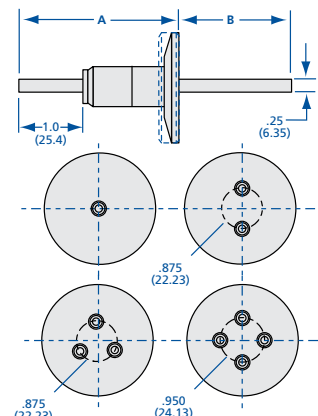
MODEL NUMBER	FLANGE	NUMBER OF FEEDTHROUGHS	A	B
MCF-NW-16-1	NW-16	1	3.23 (82.04)	4.03 (102.36)
MCF-NW-25-1	NW-25	1	3.23 (82.04)	4.03 (102.36)
MCF-NW-40-1	NW-40	1	3.13 (79.50)	4.13 (104.90)
MCF-NW-40-2	NW-40	2	3.23 (82.04)	4.03 (102.36)
MCF-NW-40-3	NW-40	3	3.23 (82.04)	4.03 (102.36)
MCF-NW-40-4	NW-40	4	3.23 (82.04)	4.03 (102.36)
MCF-NW-50-1	NW-50	1	3.13 (79.50)	4.13 (104.90)
MCF-NW-50-2	NW-50	2	3.23 (82.04)	4.03 (102.36)
MCF-NW-50-3	NW-50	3	3.23 (82.04)	4.03 (102.36)
MCF-NW-50-4	NW-50	4	3.23 (82.04)	4.03 (102.36)
MCF-075-1	1.33 CF	1	3.21 (81.53)	4.05 (102.87)
MCF-150-1	2.75 CF	1	3.18 (80.77)	4.08 (103.63)
MCF-150-2	2.75 CF	2	3.18 (80.77)	4.08 (103.63)
MCF-150-3	2.75 CF	3	3.18 (80.77)	4.08 (103.63)
MCF-150-4	2.75 CF	4	3.18 (80.77)	4.08 (103.63)



## Medium Current Nickel Feedthroughs

The nickel rod conductors on these electrical feedthroughs offer an alternative to copper for use in environments and processes that attack copper surfaces.

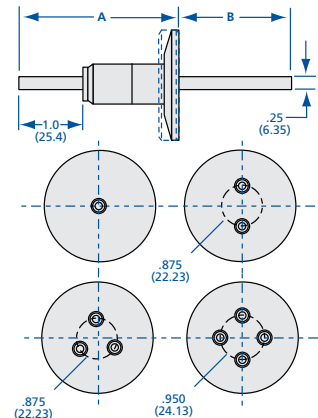
MODEL NUMBER	FLANGE	NUMBER OF FEEDTHROUGHS	A	B
MCF-NW-16-1N	NW-16	1	3.23 (82.04)	4.03 (102.36)
MCF-NW-25-1N	NW-25	1	3.23 (82.04)	4.03 (102.36)
MCF-NW-40-1N	NW-40	1	3.13 (79.50)	4.13 (104.90)
MCF-NW-40-2N	NW-40	2	3.23 (82.04)	4.03 (102.36)
MCF-NW-40-3N	NW-40	3	3.23 (82.04)	4.03 (102.36)
MCF-NW-40-4N	NW-40	4	3.23 (82.04)	4.03 (102.36)
MCF-NW-50-1N	NW-50	1	3.13 (79.50)	4.13 (104.90)
MCF-NW-50-2N	NW-50	2	3.23 (82.04)	4.03 (102.36)
MCF-NW-50-3N	NW-50	3	3.23 (82.04)	4.03 (102.36)
MCF-NW-50-4N	NW-50	4	3.23 (82.04)	4.03 (102.36)
MCF-075-1N	1.33 CF	1	3.21 (81.53)	4.05 (102.87)
MCF-150-1N	2.75 CF	1	3.18 (80.77)	4.08 (103.63)
MCF-150-2N	2.75 CF	2	3.18 (80.77)	4.08 (103.63)
MCF-150-3N	2.75 CF	3	3.18 (80.77)	4.08 (103.63)
MCF-150-4N	2.75 CF	4	3.18 (80.77)	4.08 (103.63)



## Water Cooled Medium Current Copper Feedthroughs

These water cooled electrical feedthroughs transmit power and coolants simultaneously. They conduct higher current loads than solid rod conductors of equal size when properly cooled. Grounding of system is necessary for safety.

MODEL NUMBER	FLANGE	NUMBER OF FEEDTHROUGHS	A	B
MCF-NW-16-1W	NW-16	1	3.23 (82.04)	4.03 (102.36)
MCF-NW-25-1W	NW-25	1	3.23 (82.04)	4.03 (102.36)
MCF-NW-40-1W	NW-40	1	3.13 (79.50)	4.13 (104.90)
MCF-NW-40-2W	NW-40	2	3.23 (82.04)	4.03 (102.36)
MCF-NW-40-3W	NW-40	3	3.23 (82.04)	4.03 (102.36)
MCF-NW-40-4W	NW-40	4	3.23 (82.04)	4.03 (102.36)
MCF-NW-50-1W	NW-50	1	3.13 (79.50)	4.13 (104.90)
MCF-NW-50-2W	NW-50	2	3.23 (82.04)	4.03 (102.36)
MCF-NW-50-3W	NW-50	3	3.23 (82.04)	4.03 (102.36)
MCF-NW-50-4W	NW-50	4	3.23 (82.04)	4.03 (102.36)
MCF-075-1W	1.33 CF	1	3.21 (81.53)	4.05 (102.87)
MCF-150-1W	2.75 CF	1	3.18 (80.77)	4.08 (103.63)
MCF-150-2W	2.75 CF	2	3.18 (80.77)	4.08 (103.63)
MCF-150-3W	2.75 CF	3	3.18 (80.77)	4.08 (103.63)
MCF-150-4W	2.75 CF	4	3.18 (80.77)	4.08 (103.63)



## SPECIFICATIONS

## Materials

Flange: 304 stainless steel  
Conductors: OFHC copper tube  
Insulator: Alumina ceramic

## Electrical

Voltage: 12 KVDC

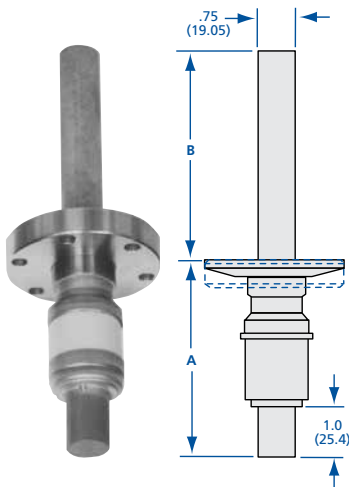
## Vacuum range

Metal seal:  $\geq 10^{-10}$  mbar (UHV)  
Elastomer seal:  $\geq 10^{-8}$  mbar (High vacuum)

## Temperature range

Metal seal: -270°C to 450°C  
Elastomer seal: -20°C to 200°C

All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.



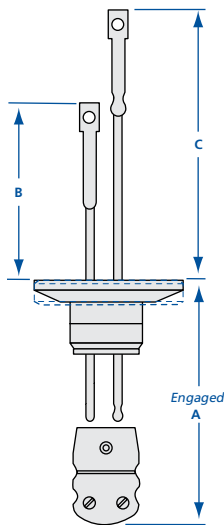
### Single High Current Copper Feedthroughs

These electrical power feedthroughs accommodate a higher electrical current due to the size of the copper rod.

MODEL NUMBER	FLANGE	CURRENT	A	B
HCF-NW-40-1	NW-40	600 Amps	3.85 (97.79)	3.40 (86.36)
HCF-NW-50-1	NW-50	600 Amps	3.85 (97.79)	3.40 (86.36)
HCF-150-1	2.75 CF	600 Amps	3.90 (99.06)	3.35 (85.09)

### Single Water Cooled High Current Copper Feedthroughs

MODEL NUMBER	FLANGE	A	B
HCF-NW-40-1W	NW-40	3.85 (97.79)	3.40 (86.36)
HCF-NW-50-1W	NW-50	8.85 (224.79)	3.40 (86.36)
HCF-150-1W	2.75 CF	3.90 (99.06)	3.35 (85.09)



### Thermocouple Feedthroughs

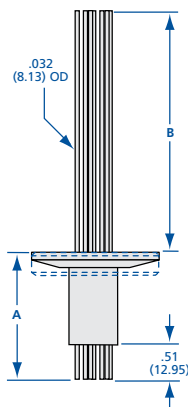
Thermocouple feedthroughs carry instrumentation signals while providing electrical isolation and hermetic sealing. They are leak free in high and ultra high vacuum environments and are composed of only inorganic materials. The insulators are made of high purity, high strength, low-loss alumina ceramic.

MODEL NUMBER	FLANGE	A	B	C
TC-NW-16-1	NW-16	2.40 (60.96)	3.00 (76.20)	4.00 (101.60)
TC-NW-25-1	NW-25	2.02 (51.31)	3.38 (85.85)	4.38 (111.25)
TC-NW-40-1	NW-40	1.90 (48.26)	3.50 (88.90)	4.50 (114.30)
TC-NW-50-1	NW-50	1.90 (48.26)	3.50 (88.90)	4.50 (114.30)
TC-075-1	1.33 CF	2.40 (60.96)	3.00 (76.20)	4.00 (101.60)
TC-150-1	2.75 CF	1.95 (49.53)	3.45 (87.63)	4.45 (113.03)

### 8-Pin Instrumentation Feedthroughs

Multipin instrumentation feedthroughs are typically used to transmit signal voltages and currents. Applications such as electron beam evaporation, electron microscopy and surface science analysis utilize these feedthroughs to control processes.

MODEL NUMBER	FLANGE	A	B
IFT-NW-16-8P	NW-16	1.32 (33.53)	1.18 (29.97)
IFT-NW-25-8P	NW-25	0.92 (23.37)	1.58 (40.13)
IFT-NW-40-8P	NW-40	0.82 (20.83)	1.68 (42.67)
IFT-NW-50-8P	NW-50	0.82 (20.83)	1.68 (42.67)
IFT-075-8P	1.33 CF	1.32 (33.53)	1.18 (29.97)
IFT-150-8P	2.75 CF	0.87 (22.10)	1.63 (41.40)



#### SPECIFICATIONS

**Materials**  
 Flange: 304 stainless steel  
 Conductors: OFHC copper  
 Insulator: Alumina ceramic

**Electrical**  
 Voltage: 3 KVDC peak

**Vacuum Range**  
 Metal Seal:  $\geq 10^{-10}$  mbar (UHV)  
 Elastomer Seal:  $\geq 10^{-8}$  mbar (High vacuum)

**Temperature Range**  
 Metal seal: -270°C to 450°C  
 Elastomer seal: -20°C to 200°C

#### SPECIFICATIONS

**Materials**  
 Flange: 304 stainless steel  
 Conductors: Chromel/Alumel  
 Insulator: Alumina ceramic

**Connectors**  
 Plug color: Yellow  
 Thermocouple: Type K

**Included hardware:** Plugs, screws and nuts for vacuum and atmosphere lead attachment

**Vacuum range**  
 Metal seal:  $\geq 10^{-10}$  mbar (UHV)  
 Elastomer seal:  $\geq 10^{-8}$  mbar (High vacuum)

**Temperature range**  
 Metal seal: -270°C to 450°C  
 (plug disconnected)  
 Elastomer seal: -20°C to 150°C

#### SPECIFICATIONS

**Materials**  
 Flange: 304 stainless steel  
 Conductors: 0.032 OD nickel wire  
 Insulator: Alumina ceramic

**Electrical**  
 Voltage: 500 VDC  
 Current: 2 Amps

**Connector:** Use with vacuum connector IFT-VC (see page 216)

**Vacuum range**  
 Metal seal:  $\geq 10^{-10}$  mbar (UHV)  
 Elastomer seal:  $\geq 10^{-8}$  mbar (High vacuum)

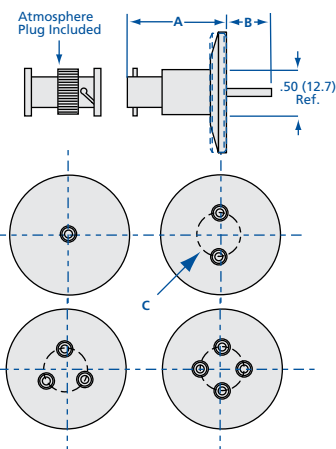
**Temperature range**  
 Metal seal: -270°C to 450°C  
 Elastomer seal: -20°C to 200°C





### BNC Coaxial Feedthroughs

The BNC (Bayonet Naval Connection) electrical feedthrough consists of two concentric conductor paths which are separated and insulated with high-purity alumina ceramic. It is commonly used in 50 to 70 ohm low power instrumentation lines.



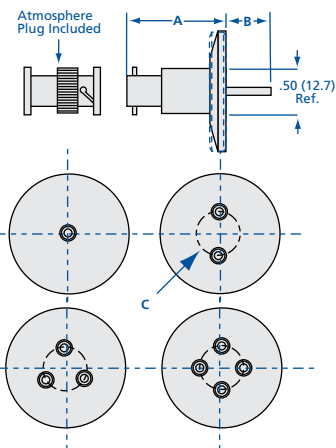
#### SPECIFICATIONS

<b>Materials</b>	Flange: 304 stainless steel Conductors: Stainless steel Insulator: Alumina ceramic
<b>Electrical</b>	Voltage: 500 VDC @10 <sup>-4</sup> mbar Current: 3 Amps
<b>Connector:</b>	Use with vacuum connector BNC-VC (see below), atmosphere connector included
<b>Vacuum range</b>	Metal seal: ≥10 <sup>-10</sup> mbar (UHV) Elastomer seal: ≥10 <sup>-8</sup> mbar (High vacuum)
<b>Temperature range</b>	Metal seal: -270°C to 450°C Elastomer seal: -20°C to 200°C

MODEL NUMBER	FLANGE	NUMBER OF FEEDTHROUGHS	A	B	C
BNC-NW-16-1	NW-16	1	1.43 (36.32)	0.32 (8.13)	-
BNC-NW-25-1	NW-25	1	1.43 (36.32)	0.32 (8.13)	-
BNC-NW-40-1	NW-40	1	1.33 (33.78)	0.42 (10.67)	-
BNC-NW-40-2	NW-40	2	1.33 (33.78)	0.42 (10.67)	0.75 (19.05)
BNC-NW-40-3	NW-40	3	1.33 (33.78)	0.42 (10.67)	0.75 (19.05)
BNC-NW-40-4	NW-40	4	1.43 (36.32)	0.32 (8.13)	0.90 (22.86)
BNC-NW-50-1	NW-50	1	1.33 (33.78)	0.42 (10.67)	-
BNC-NW-50-2	NW-50	2	1.33 (33.78)	0.42 (10.67)	0.75 (19.05)
BNC-NW-50-3	NW-50	3	1.33 (33.78)	0.42 (10.67)	0.75 (19.05)
BNC-NW-50-4	NW-50	4	1.33 (33.78)	0.42 (10.67)	0.90 (22.86)
BNC-075-1	1.33 CF	1	1.41 (35.81)	0.34 (8.640)	-
BNC-150-1	2.75 CF	1	1.38 (35.05)	0.37 (9.40)	-
BNC-150-2	2.75 CF	2	1.38 (35.05)	0.37 (9.40)	0.95 (24.13)
BNC-150-3	2.75 CF	3	1.38 (35.05)	0.37 (9.40)	0.95 (24.13)
BNC-150-4	2.75 CF	4	1.38 (35.05)	0.37 (9.40)	0.95 (24.13)

### MHV Coaxial Feedthroughs

The MHV (Miniature High Voltage or High Voltage BNC) electrical feedthroughs operate in medium to high power with higher voltage requirements. MHV and BNC feedthroughs look similar but are very different in electrical rating. They should never be cross-mated since their electrical ratings are not compatible.



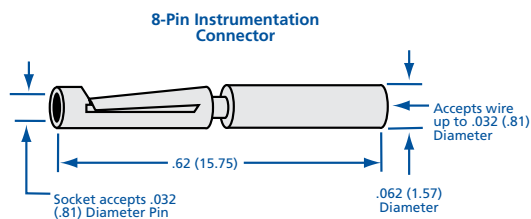
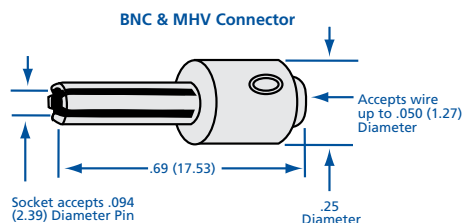
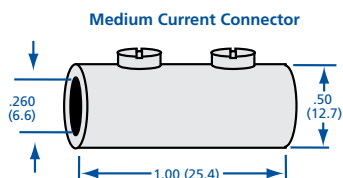
#### SPECIFICATIONS

<b>Materials</b>	Flange: 304 stainless steel Conductors: Stainless steel Insulator: Alumina ceramic
<b>Electrical</b>	Voltage: 5 KV Current: 3 Amps
<b>Connector:</b>	Use with vacuum connector MCF-VC (see below), atmosphere connector included
<b>Vacuum range</b>	Metal seal: ≥10 <sup>-10</sup> mbar (UHV) Elastomer seal: ≥10 <sup>-8</sup> mbar (High vacuum)
<b>Temperature range</b>	Metal seal: -270°C to 450°C Elastomer seal: -20°C to 200°C

MODEL NUMBER	FLANGE	NUMBER OF FEEDTHROUGHS	A	B	C
MHV-NW-16-1	NW-16	1	1.43 (36.32)	0.25 (6.35)	-
MHV-NW-25-1	NW-25	1	1.43 (36.32)	0.25 (6.25)	-
MHV-NW-40-1	NW-40	1	1.33 (33.78)	0.35 (8.89)	-
MHV-NW-40-2	NW-40	2	1.33 (33.78)	0.35 (8.89)	0.75 (19.05)
MHV-NW-40-3	NW-40	3	1.33 (33.78)	0.35 (8.89)	0.75 (19.05)
MHV-NW-40-4	NW-40	4	1.43 (36.32)	0.25 (6.35)	0.90 (22.86)
MHV-NW-50-1	NW-50	1	1.33 (33.78)	0.35 (8.89)	-
MHV-NW-50-2	NW-50	2	1.33 (33.78)	0.35 (8.89)	0.75 (19.05)
MHV-NW-50-3	NW-50	3	1.33 (33.78)	0.35 (8.89)	0.75 (19.05)
MHV-NW-50-4	NW-50	4	1.33 (33.78)	0.35 (8.89)	0.90 (22.86)
MHV-075-1	1.33 CF	1	1.41 (35.81)	0.27 (6.86)	-
MHV-150-1	2.75 CF	1	1.38 (35.05)	0.30 (7.62)	-
MHV-150-2	2.75 CF	2	1.38 (35.05)	0.30 (7.62)	0.95 (24.13)
MHV-150-3	2.75 CF	3	1.38 (35.05)	0.30 (7.62)	0.95 (24.13)
MHV-150-4	2.75 CF	4	1.38 (35.05)	0.30 (7.62)	0.95 (24.13)

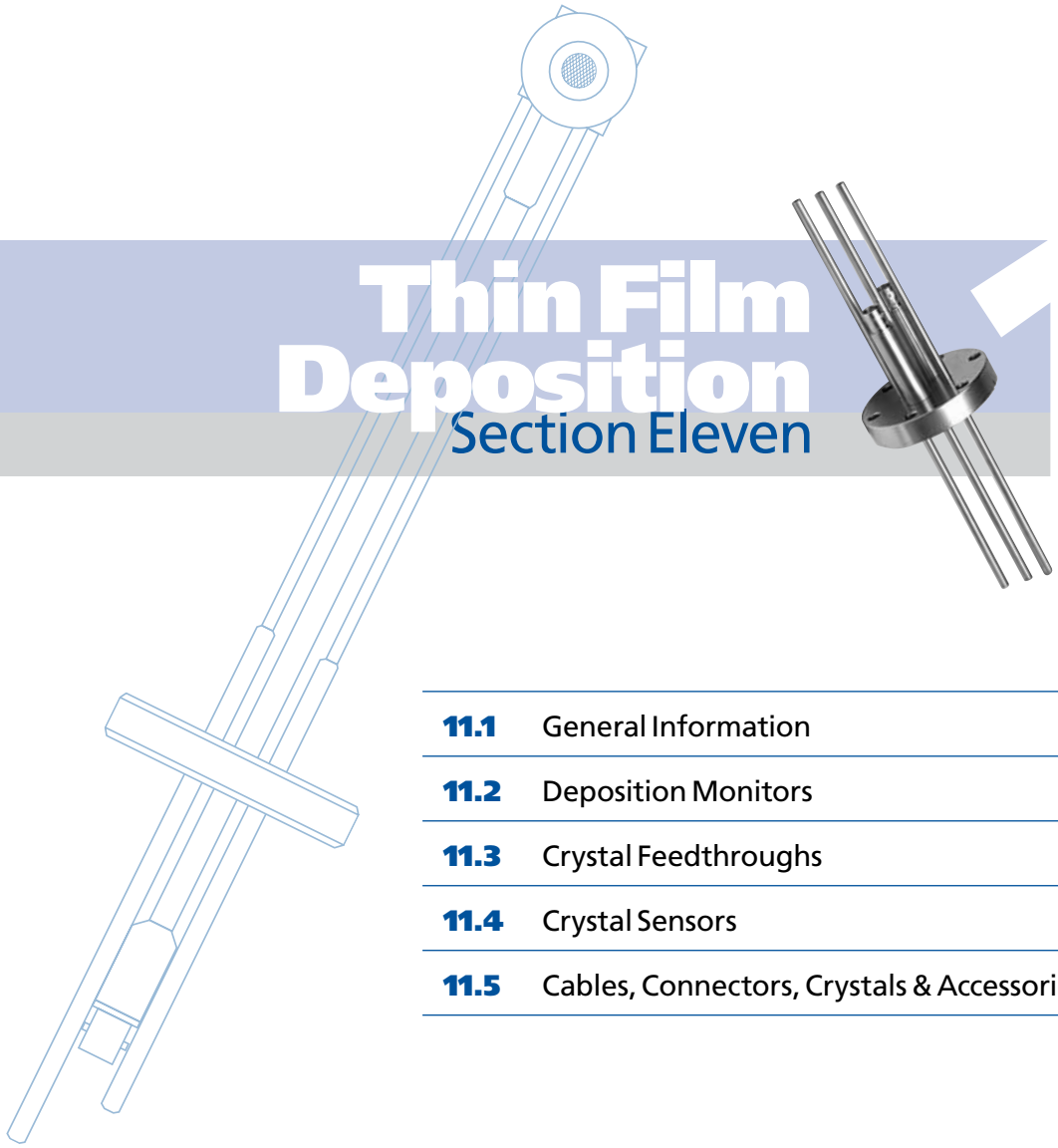
### Electrical Feedthrough Connectors

MODEL NUMBER	USE WITH	MATERIAL	MAXIMUM CURRENT (AMPS)	QUANTITY
MCF-VC	Medium Current	Beryllium Copper with SS Screws	100	10 per Pkg.
BNC-VC	BNC and MHV	Beryllium Copper with SS Screws	15	10 per Pkg.
IFT-VC	8-Pin Instrumentation	Beryllium Copper	10	10 per Pkg.





# Thin Film Deposition Section Eleven



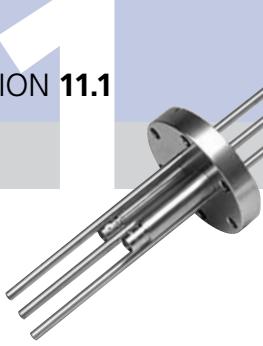
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# Thin Film Deposition General Information



Nor-Cal offers an extensive selection of commonly used quartz crystal feedthroughs, sensors and multi-channel monitors, cables, quartz crystals, accessories and replacement parts for use in semiconductor, optical and industrial thermal deposition processes. Custom feedthroughs are available with a variety of flanges in all sizes.

Our coating instrumentation products support one of the more popular methods of thin film measurement and rate control - the crystal monitor, which utilizes the piezo-electric properties of a quartz crystal.

The electrical characteristics of the crystal, which is held in place by the sensor, change during deposition. Single sensors are generally used for short deposition runs, whereas, dual sensors allow for longer runs. Dual sensors require an air line to operate a pneumatic shutter which covers one crystal at a time. The sensor is either welded to the feedthrough or attached with connectors. Most sensors are available with cooling lines.

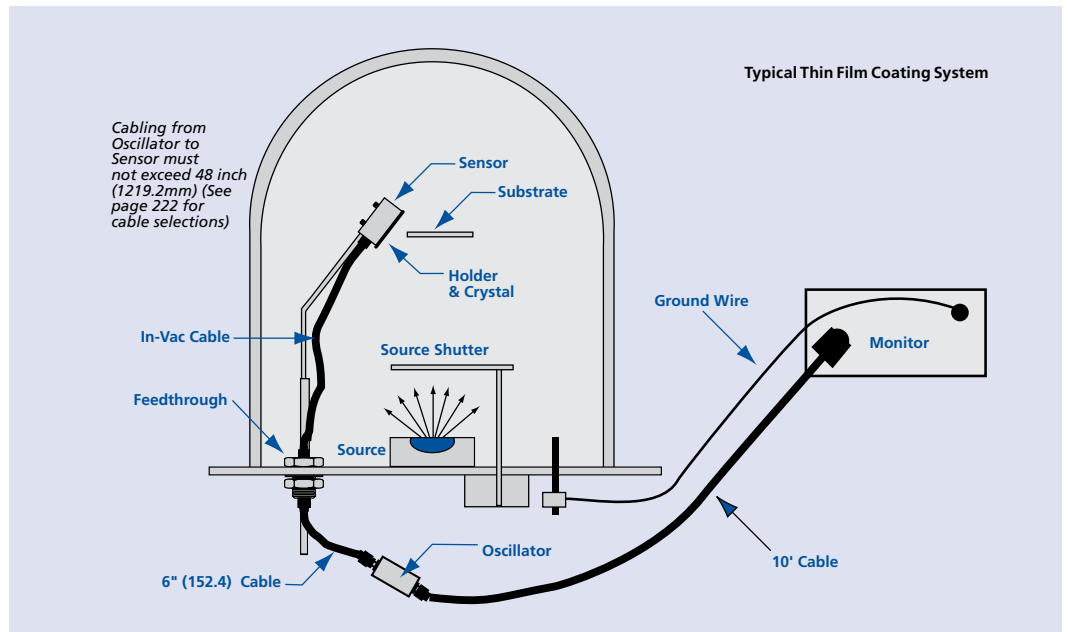
The application determines the correct choice of sensor. The sensor determines compatible feedthroughs and cabling. The chamber determines the appropriate feedthrough and flange. For application temperatures up to 150°C, electrical



connection between the sensor and feedthrough is accomplished with a vacuum coaxial cable. A bakeable, one piece sensor/feedthrough replaces the standard in-vac cable with a stainless steel high-temp coaxial line for high temperature applications up to 300°C.

The feedthrough is the air-to-vacuum connection between the sensor and the oscillator. The feedthrough transfers the quartz crystal's piezo-electric vibrations to the oscillator via a short coaxial cable. The oscillator conditions the signals

and transfers them to the monitor via another coaxial cable. The monitor then measures, interprets and displays the thickness, rate and frequency of deposition. Nor-Cal's thin film deposition monitors are available with up to six independent channels to read six sensors. Each sensors' rate, thickness and frequency can be read from the RS-232 port, and placed in a spreadsheet formatted file for later inspection. Each sensor requires its own cabling and oscillator. Contact our sales staff for help with your system configuration.



All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.



### Deposition Monitors

Our deposition monitors measure film thickness/rate or frequency using crystals as the sensor device. Independent channels monitor different films or average different sensors together to provide a more uniform deposition measurement. These monitors are Class 1 Equipment CE approved. Included are a RS-232 cable and Windows software. This software will allow you to change the monitor's parameters, save process readings in Excel formatted files, and operate the monitor remotely. Mounting brackets are included, rack-mount extenders are available on request

MODEL NUMBER	CRYSTAL INPUTS	POWER INPUT	TEMPERATURE RANGE	FREQUENCY RANGE
CM-2	2	120/240 VAC, 20 VA	0° to 50°C	6.0 to 4.0 MHz
CM-6	6	120/240 VAC, 20 VA	0° to 50°C	6.0 to 4.0 MHz

### SPECIFICATIONS

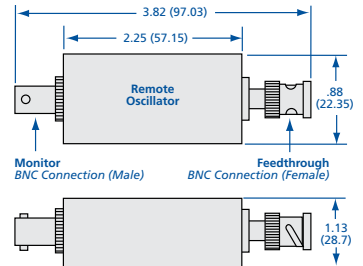
- Dimensions:** 8.38 x 3.50 x 7.75 inches (212.85 x 88.9 x 196.85mm)
- Connections**
  - Inputs: 4 digital, 2 or 6 sensor
  - Outputs: 4 relay, analog rate & thickness
  - PC: RS-232 port
- Display:** Alphanumeric LED
- Frequency:** 6.0 to 4.0 MHz, programmable
- Rate averaging:** 1 to 20 readings
- Frequency resolution:** 0.1 Hz
- Thickness resolution:** 1 Å
- Rate resolution:** 0.1 or 0.01 Å/s selectable
- Measurement rate:** 0.15 to 2 seconds



### Remote Oscillators

Oscillators condition the signal from the crystal sensor to the controller. They are housed in a die-cast aluminum body. BNC connectors are used to interface with the monitor and sensor. Refer to the diagram on this page for installation and to page 222 of the catalog for cabling and accessories. In-vacuum oscillators are available. Call for information and pricing.

MODEL NUMBER	TEMPERATURE RANGE	FREQUENCY RANGE
CO-A	10° to 40°C	6.0 to 4.0 MHz



Thin film deposition systems

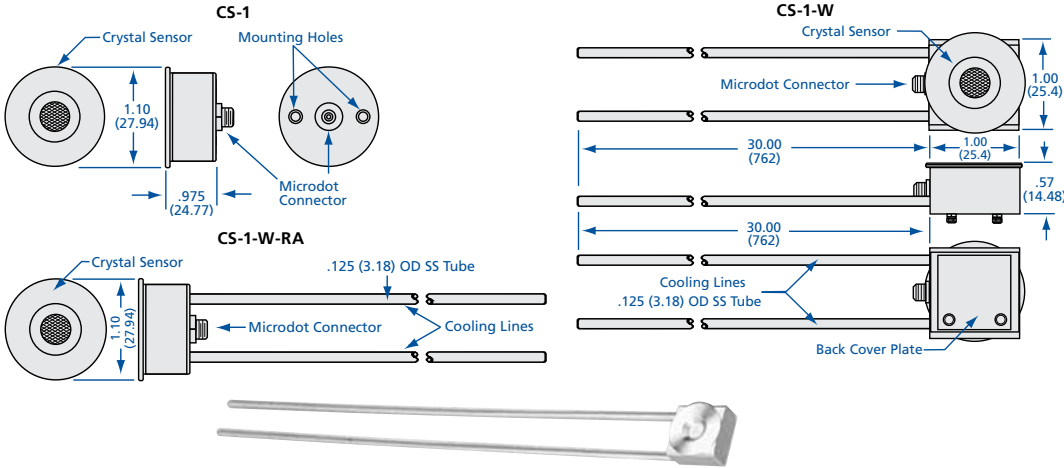
All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.





## Single Crystal Sensors

MODEL NUMBER	SENSORS	MOUNTING BRACKET	SENSOR ORIENTATION	WATER COOLED
CS-1	1	✓	0°	
CS-1-W	1		0°	✓
CS-1-W-RA	1		90°	✓



### SPECIFICATIONS

**Materials**  
 Body: 304 stainless steel  
 Crystals: 6 MHz gold and aluminum alloy

**Vacuum range:**  $\geq 1 \times 10^{-9}$  mbar (High Vacuum)

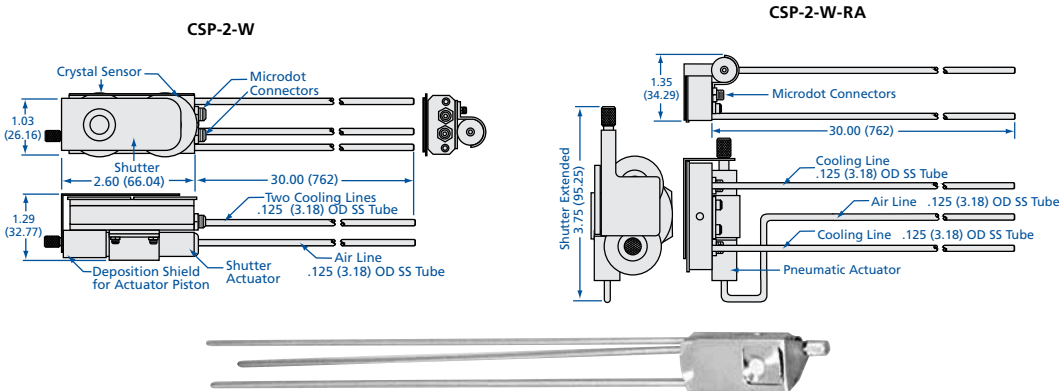
**Temperature range:**  $\leq 225^\circ\text{C}$

*Custom lengths and bends available for all sensors.*

*Cables, crystals and accessories are on page 222.*

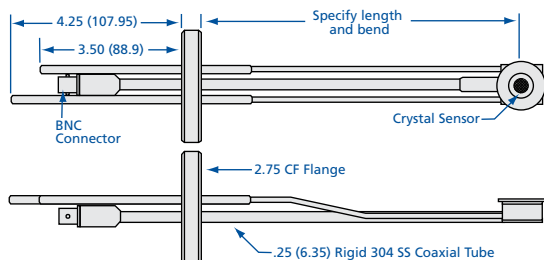
## Dual Crystal Sensors

MODEL NUMBER	SENSORS	SENSOR ORIENTATION	PNEUMATIC SHUTTER	WATER COOLED
CSP-2-W	2	0°	✓	✓
CSP-2-W-RA	2	90°	✓	✓



## Bakeable Crystal Sensors

MODEL NUMBER	FLANGE TYPE	DESCRIPTION	TEMPERATURE RANGE	WATER COOLED
CSH-275-1-W	2.75 CF	Single sensor with feedthrough	$\leq 300^\circ\text{C}$	✓



*All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.*

# Thin Film Deposition

## Cables, Connectors, Crystals & Accessories



### Cables and Connectors

MODEL NUMBER	DESCRIPTION	LENGTH
<b>CCV-MM-30*</b>	Microdot to Microdot in-vacuum coaxial cable, metal sheath. Connects feedthrough to sensor.	30.75* (781.05)
<b>CCV-MM-30T*</b>	Microdot to Microdot in-vacuum coaxial cable, Teflon coated metal sheath. Connects feedthrough to sensor.	30.75* (781.05)
<b>CCA-BB-6</b>	BNC to BNC cable (Male to Female). Connects feedthrough to oscillator.	6.00 (152.40)
<b>CCA-BM-6</b>	BNC to Microdot cable. Connects feedthrough to oscillator.	6.00 (152.40)
<b>CCA-BB-10</b>	BNC to BNC cable (Male to Male). Connects oscillator to monitor.	120.00 (3048)
<b>CRU-1</b>	Reducing union tube connector $\frac{3}{16}$ to $\frac{1}{8}$ . Connects cooling and air lines between feedthrough and sensor	Each

\*Additional charges will apply for Special Lengths



### Quartz Crystals and Accessories

MODEL NUMBER	DESCRIPTION	QUANTITY
<b>CQ-G</b>	6MHz gold, .550 (13.97) diameter	Pkg. of 10
<b>CQ-A</b>	6MHz aluminum alloy, .550 (13.97) diameter	Pkg. of 10
<b>CH-1</b>	Replacement crystal holder	Each



All dimensions are in inches (mm) & weights are in pounds (kg), unless otherwise noted.

# Index & Order Information

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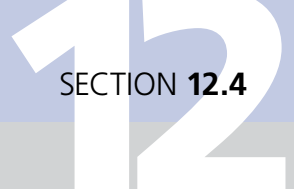
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# Order Information

## Order Information & Warranty

### Orders

To place an order, request catalogs or obtain information about our products and services call 800-824-4166 or 530-842-4457. You may also make requests from our website, [www.n-c.com](http://www.n-c.com).

### Minimum Orders

The minimum domestic order that will be processed is \$40.00. The minimum international order is \$100.00.

### Terms of Payment

Terms are net 30 days from the date of invoice once credit has been approved. Otherwise terms are COD. Visa, Mastercard or American Express charges are accepted.

### Establishing Credit

Contact our sales department to establish credit with Nor-Cal Products. You may download a credit application from our website under Customer Service.

### Discounts

OEM and quantity discounts are available to qualified customers.

### Shipment

Shipments will be UPS Surface, Prepay and Add, unless quoted otherwise.

### FOB Point

All shipments are FOB Yreka, California unless quoted otherwise.

### Pricing & Dimensions

In order to meet the changing needs of our customers we periodically make design revisions in our standard product line. As a result, the dimensions, pricing and specifications are subject to change without notice. International pricing may also vary.

### Return Policy

Merchandise may be returned at the sole discretion of Nor-Cal Products, but not more than 60 days after shipment. A fee may be charged for restocking the item. An RMA number must be obtained from Nor-Cal before returning any merchandise. RMA forms in printable PDF format can be downloaded from our website under Customer Support.

### Cancellations

Any request by customers for cancellation in total or part of any purchase order must be approved at the sole discretion of Nor-Cal Products and shall be subject to the following conditions:

1. Nor-Cal must receive written notice of Request for Cancellation, stating the reasons therefore.
2. Customer shall be liable for payment of the following charges to Nor-Cal in the event of cancellation.
  - A. For all charges incurred (including overhead, G&A, and profit) prior to the date that notice of cancellation is received by Nor-Cal for all parts peculiar to customer's requirements. Upon payment by customer of these charges such parts become the property of the customer, Nor-Cal will store said parts for a reasonable period of time pending the receipt of customer's instruction for disposition. Such storage is at the customer's risk and may be subject to storage charges if stored by Nor-Cal for longer than 30 days from the cancellation date; plus
  - B. Charges to convert modified standard parts for return to Nor-Cal's inventory; plus
  - C. A restocking charge

### Warranty

Products manufactured by Nor-Cal Products, Inc. (hereinafter referred to as "Nor-Cal") are warranted against defects in material and workmanship for a period of twelve (12) months from the date of shipment from Nor-Cal to the buyer. Any modification to the product by the buyer or their agent voids this warranty. Liability under this warranty is expressly, limited to replacement or repair (at Nor-Cal's option) of defective parts. Nor-Cal may at any time discharge its warranty as to any of its products by refunding the purchase price and taking back the products. This warranty applies only to parts manufactured, and labor provided, by Nor-Cal under valid warranty claims received by Nor-Cal within the applicable warranty period and shall be subject to the terms and conditions hereof.

Expendable items such as tubes, heaters, sources, bellows, etc., by their nature may not function for one year; if such items fail to give reasonable service for a reasonable period of time, as determined solely by Nor-Cal, they will be repaired or replaced by Nor-Cal at its election.

All warranty replacement or repair of parts shall be limited to equipment malfunctions which, in the sole opinion of Nor-Cal, are due or traceable to defects in original materials or workmanship. Malfunctions caused by abuse or neglect of the equipment are expressly not covered by this warranty. Nor-Cal expressly disclaims responsibility for any loss or damage caused by the use of its products other than in accordance with proper operating and safety procedures. Reasonable care must be taken by the user to avoid hazards.

In-warranty repaired or replacement parts are warranted only for the remaining unexpired portion of the original warranty period applicable to the parts which have been repaired or replaced.

After expiration of the applicable warranty period, the buyer shall be charged at Nor-Cal's then current prices for parts and labor plus transportation.

Except as stated herein, Nor-Cal makes no warranty, expressed or implied (either in fact or by operation of law), statutory or otherwise: and, except as stated herein, Nor-Cal shall have no liability for special or consequential damages of any kind or from any cause arising out of the sale, installation, or use of any of its products. Statements made by any person, including representatives of Nor-Cal, which are inconsistent or in conflict with the terms of this warranty shall not be binding upon Nor-Cal unless reduced to writing and approved by an officer of Nor-Cal.

#### **Nor-Cal Products, Inc. patents and trademarks:**

Genesis Modular Valves are manufactured under patent number 6289932  
Intellisys Pressure Control Products are manufactured under patent number 6612331  
Genesis is a trademark of Nor-Cal Products, Inc.  
Intellisys is a registered trademark of Nor-Cal Products, Inc.

#### **Other registered patents and trademarks:**

Magnetic Linear/Rotary Feedthroughs are manufactured under patent number 5514925  
Sample Transfer Systems are manufactured under patent number 5705128  
Alumel is a registered trademark of Hoskins Manufacturing Company  
Amp Mate-N-Lok is a registered trademark of the Amp Company  
AutoCAD is a registered trademark of AutoDesk Corporation  
Inventor is a registered trademark of AutoDesk Corporation  
Cajon is a registered trademark of The Cajon Company  
Chemraz is a registered trademark of Green Tweed Company  
Chromel is a registered trademark of Hoskins Manufacturing Company  
Conflat is a registered trademark of Varian Associates  
DeviceNet is a trademark of the Open DeviceNet Vendor Association (ODVA)  
Inconel is a registered trademark of Inco Alloys  
KF is a registered trademark of Leybold Vacuum Products  
Kalrez is a registered trademark of DuPont Dow Elastomers  
Kovar is a registered trademark of Westinghouse Electric Corporation  
Macor is a registered trademark of Corning, Inc.  
Mate-N-Lok is a registered trademark of AMP Company  
Microdot is a registered trademark of Microdot Corporation  
Modbus is a registered trademark of Schneider Automation Incorporated  
OFHC is a registered trademark of American Metals Climax, Inc.  
Omicron is a registered trademark of Omicron Corporation GmbH  
Penduroil is a registered trademark of V-Tex Corporation  
Perlast is a registered trademark of PPE Limited  
Pyrex is a registered trademark of Corning Glass Works  
SoftShut is a registered trademark of Thermo Vacuum Generators  
SolidWorks is a registered trademark of Dassault Systèmes SolidWorks Corp.  
Swagelok is a registered trademark of Crawford Fittings Company  
Teflon is a registered trademark of DuPont Dow Elastomers  
UL is a registered trademark of Underwriters Laboratories, Inc.  
VCR is a registered trademark of The Cajon Company  
Viton is a registered trademark of DuPont Dow Elastomers  
Windows is a registered trademark of Microsoft Corporation



