

SYGEF® PVDF Piping Systems

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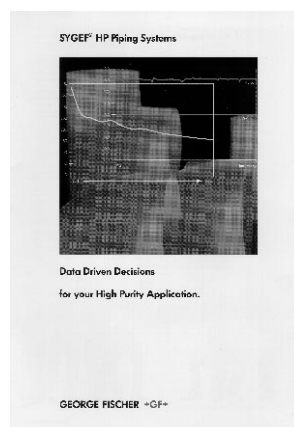


- **SYGEF® and SYGEF® HP**
- **Pipe, Valves, Fittings, and Flow Control**
- **Sizes 16 mm (3/8") through 225 mm (9")**
- **BCF®, IR Plus™/Butt, and Socket Fusion Joining**

Additional Publications on SYGEF HP PVDF

Data Driven Decisions

Outlines the high purity manufacturing processes and standards for SYGEF HP PVDF



Life Sciences Validation Guide

Consultant's engineering report outlining the acceptance of SYGEF HP PVDF for pharmaceutical and biotech applications

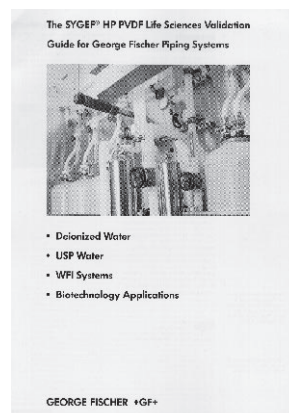


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SYGEF® PVDF (Polyvinylidene Fluoride) Piping Systems



George Fischer is a manufacturer and supplier of high purity PVDF piping components sold worldwide under the trade name SYGEF® HP. The following section explains the general properties of the PVDF material as well as an explanation of the proprietary George Fischer IR Plus™ (Infrared), Bead and Crevice Free (BCF), and socket fusion methods.

PVDF is a thermoplastic fluoropolymer with a melt point of 352°F (178°C) and a wide service temperature range from -40°F/°C to 284°F (140°C). The PVDF polymer chain is very linear and similar to PTFE Teflon® except it is not fully fluorinated and contains 3% hydrogen by weight. PVDF materials are ideal for use in ultrapure water systems since they are basically inert, have high strength, and are readily weldable into system components. PVDF raw material is commonly available under the trade names Solef®, supplied by Solvay Fluoropolymers, and Kynar®, supplied by Atofina Chemicals.

George Fischer produces SYGEF HP PVDF piping system components under cleanroom conditions at state of the art

high purity manufacturing facilities in Switzerland. The entire production process is designed, dedicated and operated to produce high purity PVDF components of consistent high quality.

George Fischer's Infrared fusion technology is a substantial improvement over older fusion methods such as contact butt fusion and socket fusion. IR fusion is accomplished by use of a revolutionary infrared heat source and computerized installer guidance program ensuring high quality, reproducible fusion welds of high mechanical strength. Completing the system are SYGEF HP PVDF butt fusion fittings and valves specifically designed for use with the IR-63 Plus and IR-225 Plus fusion machines.

For the unique demands of today's ultrapure water systems, the George Fischer SYGEF HP PVDF piping and IR Plus™ (Infrared) fusion systems offer the highest degree of repeatability and confidence available today.

General Description of SYGEF-PVDF

Material

PVDF is a thermoplastic fluorocarbon polymer with the general formula $(CH_2 - CF_2)_n$.

PVDF compared with other plastics

Its special features compared with other plastics are a unique combination of:

- better corrosion and solvent resistance
- better resistance to weathering and aging
- resistance to ambient uv, beta and gamma rays
- can be used over a wide range of temperatures (-40°F to above 282°F/-40°C to above 140°C)
- flame retardant, self-extinguishing with a Limiting Oxygen Index of 44
- low coefficient of friction and high abrasion resistance
- excellent insulating and dielectric properties.

PVDF differs from other fluorocarbon polymers

It differs from other fluorocarbon polymers in the following points:

- excellent resistance to mineral acids and halogens
- high strength
- excellent welding characteristics
- can be molded like other thermoplastic materials
- high purity – no additives whatsoever.

Advantages over PVC, PP and stainless steel

It has the following advantages over PVC, PP, and stainless steel piping:

- suitable for all-round general use
- requires little maintenance
- long service life
- easy to install
- very inert with very low extractibles

Applications for SYGEF-PVDF

The great versatility of the material, with its unique combination of physical and chemical properties, as well as the simple installation process of pipe, fittings and valves, make it the piping system of choice for ultrapure and chemical applications.

Products

One of the principal features of PVDF is that it can be extruded like an ordinary thermoplastic material to form without the use of any processing additives,

- pipes 16–160 mm (3/8"–6") diameter with a nominal pressure rating of 232 psi (16 bar), and 160–225 mm (5"–9") diameter with a nominal pressure rating of 150 psi (10 bar) or 232 psi (16 bar)
- special purpose pipes up to 250 mm (10") diameter

Injection molded to form:

- fittings 16–160 mm (3/8"–6") diameter with a nominal pressure rating of 232 psi (16 bar), and 160–225 mm (5"–9") diameter with a nominal pressure rating of 150 psi (10 bar) or 232 psi (16 bar)

The material can be extruded and compression molded to produce:

- blocks up to 80 mm (3.15") thick
- rods up to 200 mm

Extruded and laminated to form:

- sheets with stretchable fabric backing for thermoforming and/or reinforcement with FRP (polyester, vinylester and epoxy resin systems) for UPS storage tank construction

These products can be fabricated by the methods normally used for thermoplastics, namely:

- by machining (turning, milling, drilling, sawing, cutting and punching)
- by non-cutting techniques (welding, thermoforming, beveling, bending)

To form:

- pipeline systems
- wet bench equipment and apparatus components
- tanks

General Description of Properties

Physical Properties

PVDF has very good impact resistance properties even at low temperatures. Its abrasion resistance is excellent, the values being comparable to those of a polyamide. Aging tests with ultraviolet as well as gamma rays revealed excellent results. SYGEF piping systems are therefore also suitable for installations exposed to sunlight.

The long-term behavior of SYGEF pipes and fittings to internal pressure is shown in Diagram 1. CPVC, polypropylene (PP), and PB curves are shown for comparison. Diagram 2 shows the long-term strength curves for SYGEF pipe at various temperatures. Further characteristics are shown in the table below.

Chemical Resistance

PVDF is resistant against most of the inorganic acids and bases. It is further resistant against aliphatic and aromatic hydrocarbons, organic acids, alcohols

and halogenated solvents. It is also resistant to elemental halogens except fluorine.

PVDF is similar in chemical resistance to PTFE with the following exceptions for which it is not recommended:

1. Metallic hydroxides (pH over 11 not recommended without consultation)
2. Strong basic primary amines
3. Polar or aprotic solvents
4. Hot fuming concentrated acids

The basis of approval of SYGEF-PVDF in chemical applications is based on rigorous test procedures involving pipe samples and immersion coupons. Screening for chemical resistance is conducted via measurements of changes in tensile strength, weight gain or loss, and elongation. This screening is based on immersion tests carried out with flat test coupon pieces over a period of 7 to 60 days. An alternate improved test consists of a method which measures the change in mechanical properties of pipe after placing the test pipe in the aggressive chemical media.

Mechanical long term behavior of plastics is influenced by environmental media, similar to stress corrosion cracking metals. Therefore, chemical resistance must be determined by long term tests involving both mechanical and chemical loading. In Europe (Journal of Materials Technology 7/429-437/1975) a test method has been used over the last 22 years which shows changes in the time to failure of pipe specimens loaded internally by pressure after being filled with the media in question and compared with water. The various pipe specimens have a minimum diameter of 8 mm (0.315") with a wall thickness of 1 mm (0.040") and range up to 63 mm (2") with a wall thickness of 3 mm (0.120").

Property	ASTM Method	SYGEF-PVDF
Specific Gravity	D792	1.78
Melting point, °F	DSC	352
Ultimate tensile strength, psi	D638	8200
Ultimate elongation, %	D638	≥ 20
Flexural modulus, psi	D790	320,000
Tensile modulus, psi	D638	285,000
Compressive modulus, psi	D695	311,000
Tensile creep, % at 2000 psi, 1000 hrs.	–	1.5
at 3000 psi, 1000 hrs.	–	2.5
Water absorption, % @ 73°F	D570	< 0.04
Radiation resistance, Roentgens	–	10 ⁸
Hardness, Shore D	D676	79
Heat deflection temperature, °F @ 66 psi	D648	302
Specific heat, BTU/lb °F	–	0.23
Thermal expansion coefficient inch/inch °F	D696	6.7 x 10 ⁻⁵
Friction coefficient static	1894	0.4
dynamic	1894	0.3

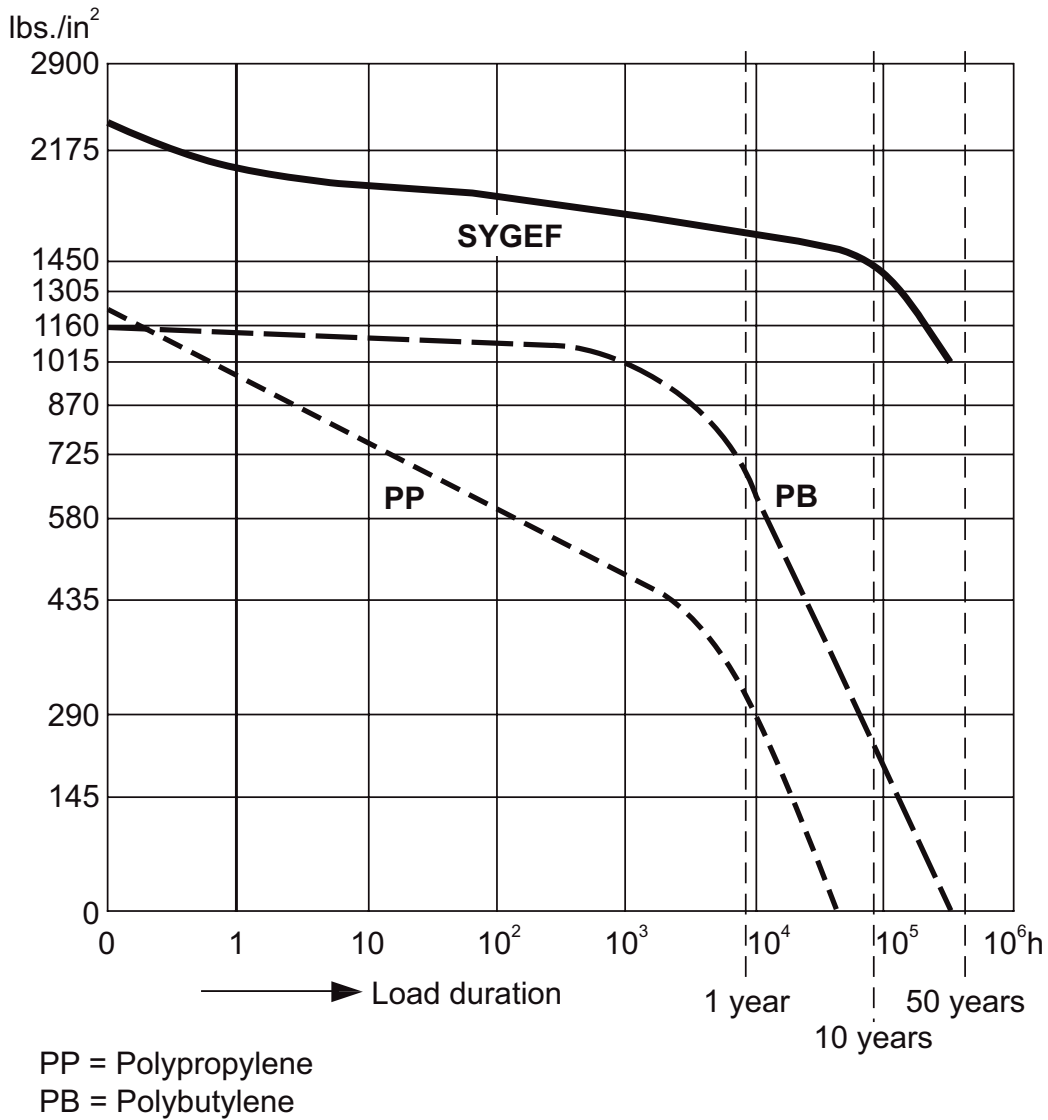
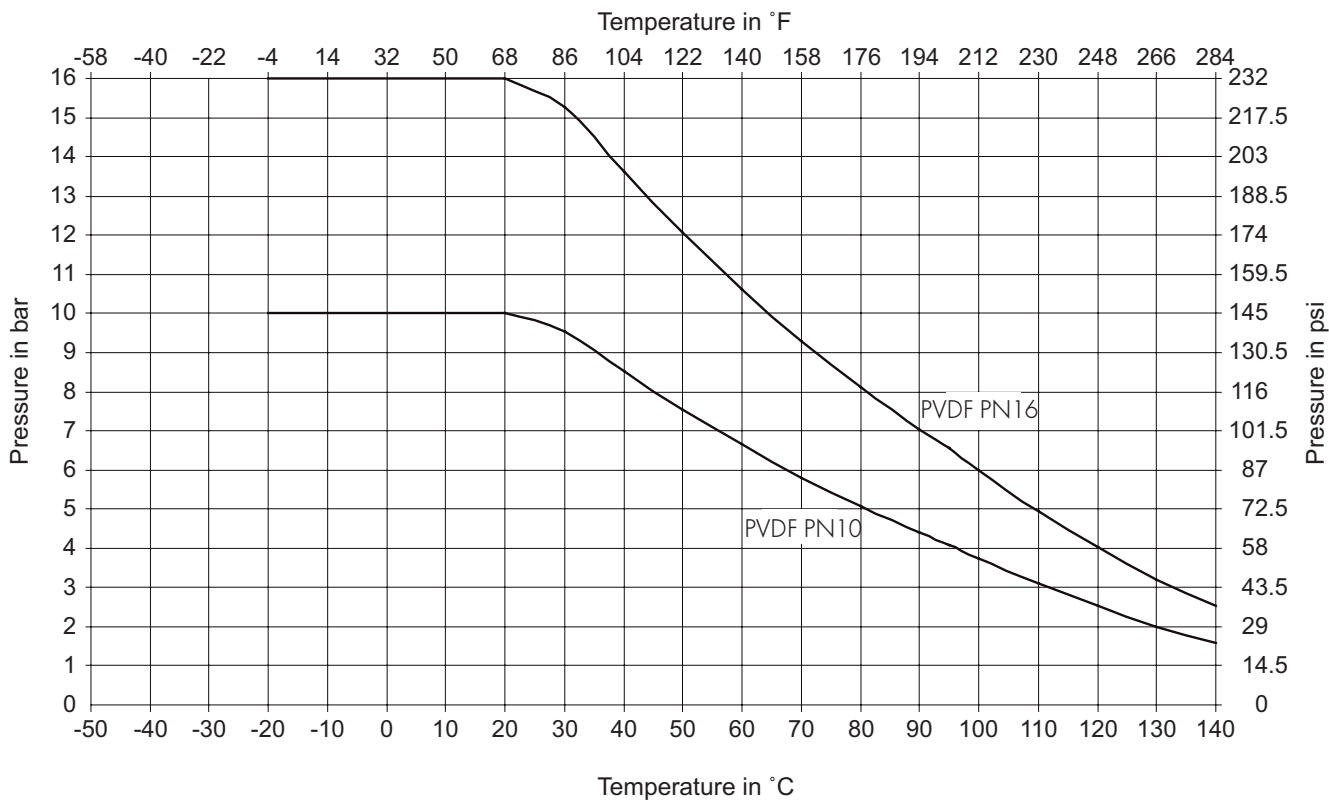
Diagram 1**Long-term behavior of SYGEF pipe in comparison to Polypropylene (PP) and PB pipes at 212°F**

Diagram 2
Application Limits of Pipes and Fittings Made of SYGEF®-PVDF
(25 years operation with safety factor incorporated)



Chemical Resistance (continued)

For detailed information consult the Chemical Resistance Section or our website.

The ISO working Group 6 (Plastic Pipes and Fittings for Industrial Applications) deals with the above mentioned test procedure. 38 different media in various concentrations have been included in this test program. Although the material PVDF has not yet been included in the ISO program, George Fischer is already using this test method. Results are available with respect to sulfuric acid, chromic acid, nitric acid, chlorides, sodium hypochlorite, ethylene glycol, triethanolamine, dioctylphthalate, etc.

The results are used to qualify the excellent chemical resistance of high crystalline SYGEF pipes. These tests allow precise information to be given as to the actual and the expected service life, as well as the possibilities of application. This method also allows rapid and reliable tests with special media, as actually used in the chemical processing industries.

This type of testing supports years of trouble-free industrial installations and clearly demonstrates the remarkable pressure, temperature, and chemical resistance of SYGEF piping materials.

Data on this subject have been accumulated over a number of years, both from field trials and from laboratory experiments, and are the basis of the information contained in the George Fischer Chemical Resistance Guide. It lists the resistance of SYGEF to over 400 chemical substances in various concentrations and temperatures. It also lists the resistance of elastomeric materials used in seals and diaphragms, since it is important to know the chemical resistance of every component in a piping system which is likely to come into contact with the line fluid.

Physiological properties

PVDF is non-toxic. It satisfies the requirements of the Food and Drug Administration (FDA) for use as food packaging and in articles which come into contact with food.

Resistance against Ozone

The resistance of SYGEF against ozone in aqueous solutions for permanent ozonization in concentrations of up to 0.2 ppm has been verified in field trials as well as in laboratory tests.

At the point of injection of the ozone into the piping system, special care needs to be taken.

Exposure to Ionizing Radiation

If SYGEF is subjected to radiation of Co^{60} , various effects can be observed. Up to about 20 Mrad, alpha-type crystallinity remains constant, and above that level a small fraction of β -type crystallinity appears. The melting point is also slightly lower, falling from 352°F (178°C) and to 336°F (169°C) after 100 Mrad. There is no noticeable change in the latent heat of fusion in the crystalline fraction. The polymer cross-links at 10 Mrad, particularly if a thick test sample is being utilized in order to avoid the retarding effect of the oxygen in the air on cross-linking.

The same effects can be observed if test specimens are exposed to accelerated electrons at 3 MeV.

Cross-linkage is almost complete at 100 kGy. Measurements with accelerated electrons (6 MeV) and gamma rays have shown a rapid decrease in impact strength at loading of 50 Mrd and higher. The tensile strength is unaffected up to 300 Mrd.

Electrical Properties

SYGEF is non-conducting. Surface resistivity is higher than $10^{13}\Omega$. This has to be taken into consideration for certain applications.

Permeability and Water

Absorption

The resistance of SYGEF to permeation as compared to other plastics such as PFA, FEP, PTFE, PP, and PE is superior, and it is equivalent in resistance to PVC and CPVC.

SYGEF has average impermeability to small molecules such as CO₂, N₂, O₂, H₂O, and nitrous oxide NO₂, as shown in the table below and the graphs on the next pages. These figures, however, do not reflect the polymer's excellent impermeability towards larger molecules of perfumes, aromatics, etc.

ASTM procedure D 1434-63 T, 73.4°F (23°C)

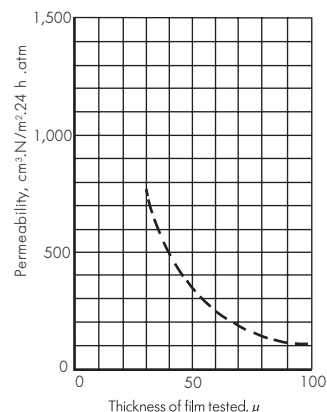
Medium	Cast PVDF film thickness in micron	Permeability cm ³ .N/ m ² . day.atm
Freon 12	Cast film, 25 μm	6.3
Freon 114	Cast film, 25 μm	10
Freon 115	Cast film, 25 μm	4
Freon 318	Cast film, 25 μm	7
Nitrous oxide	Cast film, 25 μm	900
H ₂ S	Cast film, 25 μm	60
SO ₂	Cast film, 25 μm	60
NH ₃	Cast film, 100 μm	65
He	Cast film, 100 μm	850
Cl ₂	Cast film, 100 μm	12
H ₂	Cast film, 100 μm	210

Consultation with the Technical Services Group is recommended when chemical permeation is a consideration. In a solid piping system, due to normal pipe wall thickness, the permeation of chemicals is low enough to disregard and may be considered inconsequential. If there is notable permeation and/or weight gain of a chemical through SYGEF, the chemical resistance rating will have been already lowered to reflect the condition.

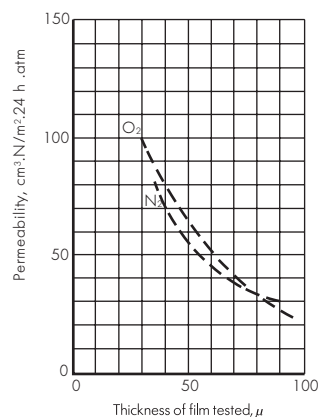
Elevated temperatures may complicate the choice of thermoplastic liner thickness for tank applications. For some chemicals, the permeation rate through thermoplastics will double for each 20°F rise in operating temperature.

The water absorption, measured according to ASTM D 570, is very low: less than 0.4% at 73°F.

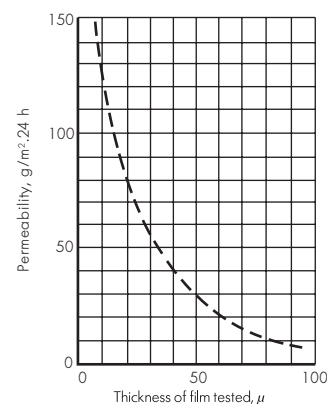
Permeability to CO₂ 73.4°F (23°C), ASTM D 1434-66



Permeability to Nitrogen and Oxygen 73.4°F (23°C), ASTM D 1434-66



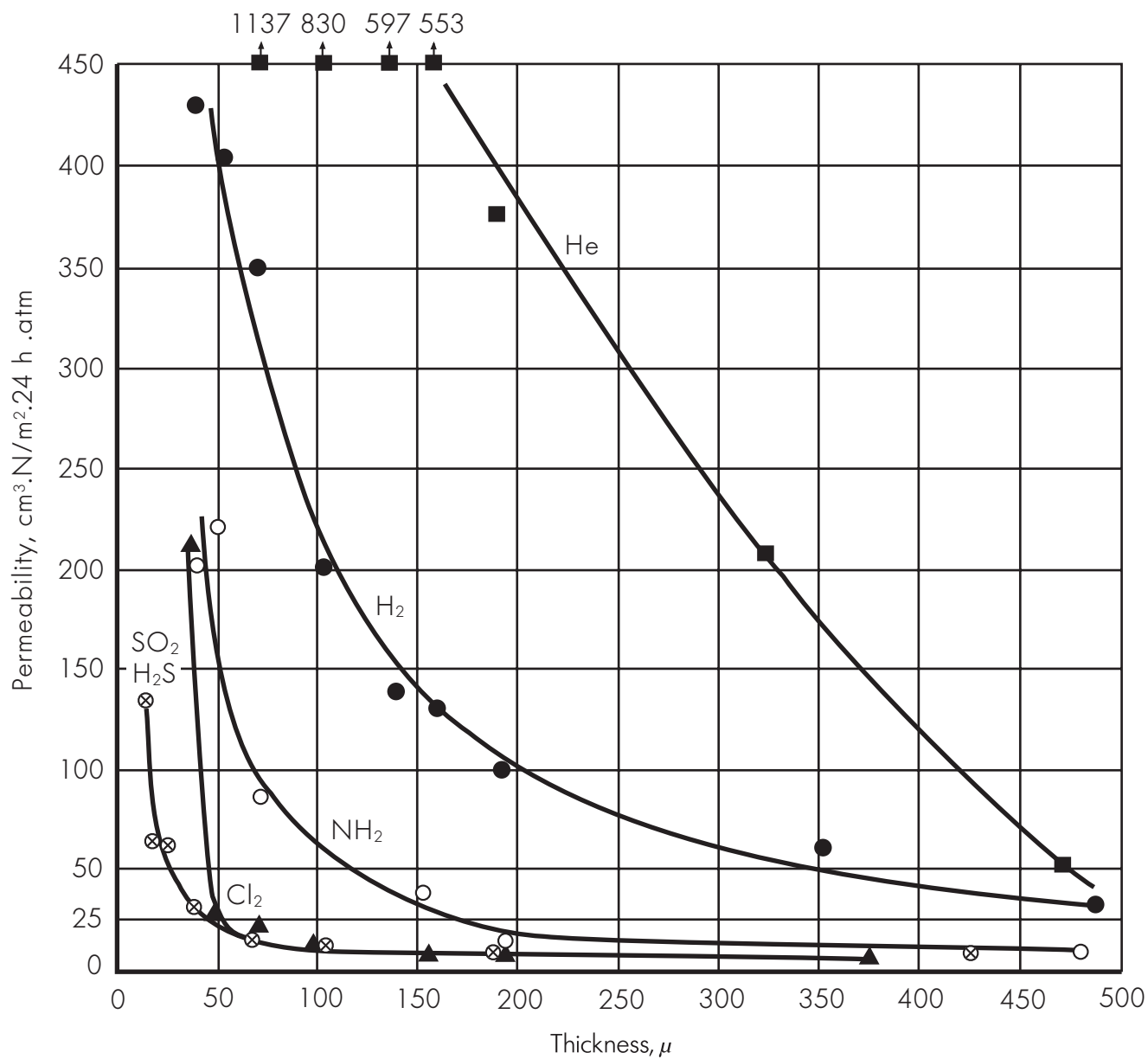
Permeability to Water Vapor 100.4°F (38°C), ASTM E 96-66-Proc. E



Permeability to various gases at 73°F (23°C)

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- Permeability H₂ acc. to ASTM D 1434-66
- Permeability NH₃ acc. to ASTM D 1434-66
- ▲ Permeability Cl₂ acc. to ASTM D 1434-66
- Permeability He acc. to ASTM D 1434-66
- ⊗ Permeability SO₂ or H₂S acc. to ASTM D 1434-66



Flammability

SYGEF is very difficult to ignite and will not burn in a normal atmosphere. The oxygen index may be used as a measure of its behavior in case of fire.

Oxygen index

The oxygen index is the minimum volume of oxygen contained in an atmosphere, expressed in %, in which the material could burn.

Comparative oxygen indices

PMMA	17.3	PC	27
PE	17.4	PA 6.6	29
PP	17.4	ETFE	30
		SYGEF	43,7
PIB	17.7	PVC	45
PS	18.1	PTFE	95

Test method according to ASTM D 635
The end of a test specimen is held horizontally, for 30 seconds, in the flame of a Bunsen burner, the narrow side of the specimen being inclined at an angle of 45°.

SYGEF stops burning immediately if the flame is removed. By way of comparison, unplasticised PVC also stops burning immediately, while self-extinguishing polyester continues to burn for 2 seconds after the source of ignition has been removed.

The HOOKER HLT 15 flame test
This method of test is much more stringent than the ASTM D 635 test. The test permits the classification of non-flammable products into various categories.

A test specimen prepared according to ASTM D 635 is clamped vertically and is then periodically exposed to the Bunsen flame, using the following rhythm:

Duration

5 seconds	1st contact with flame
10 seconds	flame removed
7 seconds	2nd contact with flame
14 seconds	flame removed
10 seconds	3rd contact with flame
20 seconds	flame removed
15 seconds	4th contact with flame
30 seconds	flame removed
25 seconds	5th contact with flame
50 seconds	flame removed

The test specimen must have stopped burning at any rate before the flame is applied again.

SYGEF will withstand four contact cycles with the flame. After the fifth contact it melts, but without burning.

ISO R 181 test according to SCHRAMM

A flat test specimen in horizontal position is pressed for 3 min. against a rod heated to 1742°F (950°C). The loss in weight p in mg is then determined, together with the longitudinal shrinkage L in cm and assessed according to the following equation:

$$Lg = \frac{100,000}{pL} \quad \text{in degrees SCHRAMM}$$

For SYGEF, the result is 2.2 degrees SCHRAMM. By way of comparison, unplasticised PVC shows 2.2 degrees SCHRAMM also, and self-extinguishing polyester 2.5 degrees SCHRAMM.

Toxicological Properties

SYGEF is absolutely non-toxic. In the USA it may be used according to the Food and Drug Administration for food packing and for objects in contact with food. We recommend the rinsing or boiling of fluoride plastics prior to initial usage, as is usual with other materials. SYGEF is just as poor a nutrient for microorganisms as glass. This has been confirmed in tests carried out by the Centre d'Enseignement et de Recherches des Industries Alimentaires et Chimiques (CERIA, Brussels).

Abrasion Resistance

SYGEF is extremely abrasion resistant, ranking with UHMW PE and nylon as the most abrasion resistant as measured by Taber abrasion test methods. SYGEF is five to ten times more abrasion resistant than stainless steel and 50 to 100 times more abrasion resistant than PTFE. In sand slurry tests lasting 30 days, the abrasion losses of mild steel were 10 to 30 times greater than with SYGEF.

Taber Abrasion Test

Abrasion resistance of thermoplastics and steel, according to Taber CS17 tests with load of 1kg, 1000 cycles (weight loss from solid plates):

SYGEF	7 - 10 mg
Polyamide (nylon)	4 - 7
UHMW PE	4 - 7
PVC (Irigid)	12
Polypropylene	18 - 24
CTFE	25
High Density PE	25
304 Stainless Steel	50
Steel	100 - 300
PTFE	500 - 1000

Solvay Sand Slurry Test

A pump forces a 300 gram/liter (30%) sand suspension in water through a loop made with SYGEF pipe and fittings. The average flow speed is between 10 - 13 feet per second. Temperature was ambient, and the test was performed for one month. Thickness decreases as measured were:

- For 90° elbow, 1/2" diameter- 7 microns per year.
- For 45° elbow, 1/2" diameter- 4 microns per year.

As a comparison, a similar loop made with steel showed losses equal to 10 - 30 times larger.

Solvay Agitator Test

An agitator shaft with PVDF blades (size: 3/4" x 2 1/2") fixed at a 45° angle to the shaft is rotated at 2500 RPM in a 10% sand slurry. Sand size was 80 to 150 microns (100 to 200 mesh passage), and temperature was held at 185° for a 96 hour duration.

Weight Loss

SYGEF Pipe Grade	3.86%
SYGEF Fitting Grade	3.16%
SYGEF Block Grade	2.18%
Mild Carbon Steel	10.9%
Titanium	0.92%
Uranus B6 (Cr-Mo-Ni-Cu)	3.0%
Stainless Steel	

Appearance

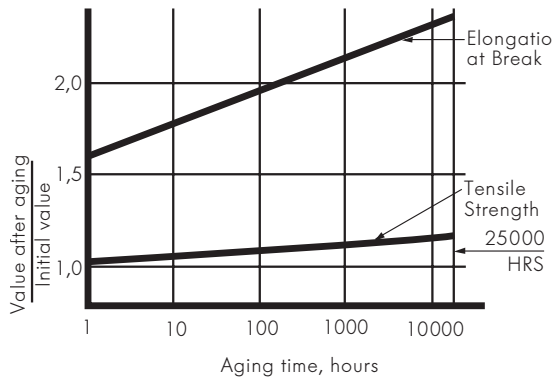
SYGEF pipe, fittings and valves are supplied in an opaque natural color. The individual components are slightly translucent. The excellent properties of the material and especially its chemical resistance are fully retained by avoiding the use of color pigmentation.

Aging Tests

SYGEF-PVDF is one of the few natural thermoplastics which shows no deterioration of physical properties via Weather-O-Meter tests, environmental aging, heat aging, or Xeno-Tests. For instance, the tensile mechanical properties of SYGEF were followed, along with evolution of yield strength, tensile strength, and elongation properties, in a Weather-O-Meter for 7200 hours, whereafter the test was discontinued due to measurements which showed less than 10% variation compared to initial values. The Xeno-Test was discontinued after 500 hours; outside aging tests were stopped after 5 years duration as both tests showed no degradative alteration in properties. SYGEF is also inert to incidental radiation such as high intensity UV light and gamma radiation. After forced bombardment with radiation, initial minor effects of gamma radiation can be noticed at about 10 Mrad, with no change in polymeric crystallinity observed until up to about 20 Mrad.

An improvement in the physical properties of SYGEF can be measured after heat aging is performed. This represents a tempering or annealing of the semi crystalline PVDF, wherein the material improves in tensile strength but does not lose any of its fracture toughness. It gains elasticity and requires less strain to cause a given amount of plastic deformation. The degree of tensile property improvement is shown in the following graph.

Tensile Properties at 73°F (23°C) after Aging at 329°F (165°C)



Discoloration Phenomena

PVDF exhibits a more intense degree of color change due to heat history and chemical effects when compared to other thermoplastics. Due to an absence of additives, changes in coloration of PVDF are exhibited far more readily than otherwise expected.

Coloration changes can vary from beige to dark brown. It is important to recognize that even a major discoloration (brown) does not always relate to a degradation of the polymer. Such discoloration is common for PVDF materials operating in hot ultrapure water systems operating at 70°C to 80°C and is the result of a double bonding of carbon along the PVDF linear molecule chain.

According to a 1993 report by Solvay Polymers, the theoretical effects of such discoloration of PVDF are outlined as follows:

- PVDF becomes completely black when only (1) in (1000) of PVDF monomer ($-\text{CH}_2-\text{CF}_2-$) transform to a ($-\text{CH}=\text{CF}-$) molecule
- In a (1) meter length of d 63mm (2") pipe there are about 1800 sq. cm of surface area
- When the discoloration affects 1mm of the surface (entire pipe appears black), this volume is 180 cubic cm.

- PVDF has a density of $\sim 1.8\text{g}/\text{cubic cm.}$, therefore, 180cubic cm. Weights $\sim 320\text{g}$
 - Since 59% of the ($-\text{CH}_2-\text{CF}_2-$) monomer is F_2 , the loss of 1 atom of F per 1000 results in 0.094 g F being removed from the 1 meter of pipe material; $(320\text{g} \times 59\%/2 \times 1/1000) = 0.094\text{g}$
 - There are 6.02×10^{23} atoms per 18.99g F; hence, 0.094g is equivalent to 2.98×10^{21} atoms
 - If a d63mm (2") pipe has a velocity of 1.5m/sec., then the flow is approximately 230 liters/min.
 - Because brown discoloration occurs within 2 weeks time in a hot UPW system, the amount of H_2O passing through this 1 meter of pipe is about 5×10^6 liters.
 - Therefore, this 0.094g is diluted to levels challenging detection capabilities even when the PVDF appears black
- $0.094\text{g}/5 \times 10^6 \text{ liters} = \sim 19\text{ppt}$
- If a conservative factor of 1000 is used to demonstrate the difference between the first signs of discoloration (brown) and the 1 per 1000 rule (black) the value is easily $<0.019\text{ppt}$ F

Summary

- Each meter length of d 63mm (2") PVDF pipe contributes about 19ppt F when the pipe appears completely black.
- Brown discoloration probably occurs at levels 1/1000 of this (0.019ppt).

Safety factors are important in several areas, such as:

- resistance to water hammer/pressure surge failures
- assuring that long term creep rates do not jeopardize the safety of a piping system (protection against creep rupture)
- accommodate weaknesses due to aging tendencies
- when high stresses due to compressive or contractive forces occur

1 MPa (Mega Pascal) =
1 N/mm² (Newton/mm²) =
145.05 psi

Engineering Design

Safety Factors

The SYGEF piping system has been designed with a safety factor of no less than 200%.

Calculating Effective Safety Factors and Permissible Operating Pressures

Pressures

To calculate the safety factor and permissible operating pressure it is necessary to know the long term rupture stress of material (see Diagram).

This diagram allows the long term rupture stress K to be read depending on the desired operating life and working temperature. Since George Fischer fittings and valves are generally designed to withstand higher operating pressures than pipe of the equivalent

pressure rating, all calculations can be based on the outside diameter and wall thickness of the pipe.

The effective safety factor is given by the following formula:

$$C = \frac{K \cdot 20 \cdot e}{p \cdot (d - e)}$$

where:

- C = safety factor (2 for PVDF)
- K = long-term creep strength in psi
- e = wall thickness in inch of pipe of a given pressure rating
- d = outside diameter of pipe in inch
- p = working pressure in psi
- 20 = constant

Example:

Intended operating life: 20 years

Max. operating temp.: 176°F

Max. operating pressure: 101.5 psi

Material: SYGEF-PVDF

Pressure rating: 232 psi

Pipe dimension: up to 3.543" (4" diameter) x 0.169"

K₂₀ from Diagram: 275.5 psi

$$C = \frac{275.5 \cdot 20 \cdot 0.169}{101.5 \cdot (3.543 - 0.169)} = 2.7 > 2$$

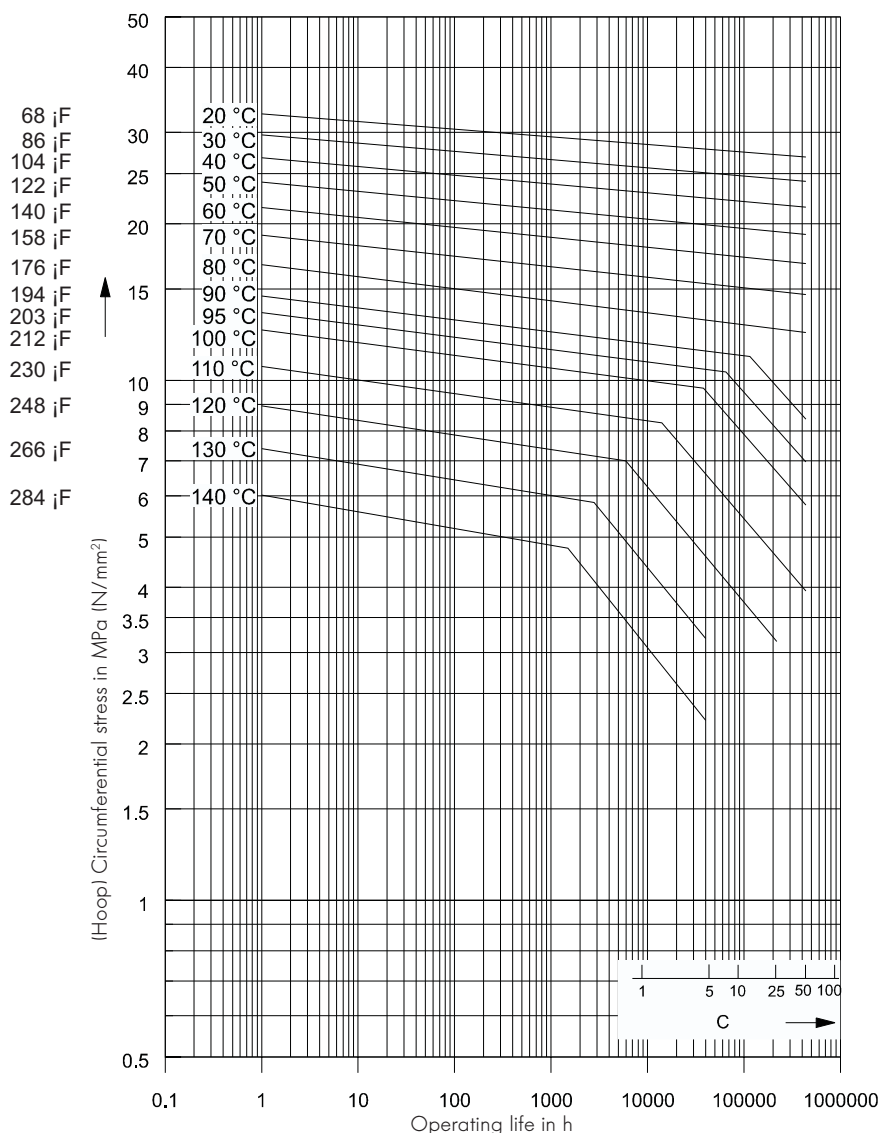
Similarly, the permissible operating pressure is given by rewriting the formula above as:

$$p = \frac{20 \cdot e \cdot \frac{K}{C}}{d - e}$$

For the sake of clarity, the calculations are carried out using the example above, but using the usual minimum safety factor for PVDF instead of the one calculated.

$$p = \frac{20 \cdot 0.169 \cdot \frac{275.5}{2}}{3.543 - 0.169} = 138 \text{ psi}$$

Long Term Strength of SYGEF-PVDF (LTHS)



Safety Consideration

The safety of a piping system in any kind of service may only be as good as the integrity of the joining method and joint design itself.

For a safe, trouble free installation it's recommended to only work with trained and certified installers. Please contact your local George Fischer representative for a training session on state of the art welding technology and equipment.

Before putting a piping system into operation a hydraulic pressure test is strongly recommended. In section "Final Testing" a procedure for hydraulic testing is described.

Should during testing or during operation of the piping system the SYGEF pipe be overpressured hydraulically to the point of forced failure, the physical nature of the failure is that a relatively small blister or bubble forms, followed by a small slit forming at a right angle to the run of the pipe. Should other factors contribute to the failure, such as compressed air entrapped in the system, water hammer, incorrect designed support or hangers, miscalculated allowance for thermal expansion/contraction, etc. the mode of failure may change.

Joint Strength

Several tests have been performed to test the ultimate SYGEF joint strength. The degree of safety factor found in SYGEF pipe is enhanced by an equally high degree of safety factor in the socket fusion joint, as evidenced by the following test results at 68°F/20°C:

Quick Burst

Joints are resistant to damage from 940 psi up to 1700 psi, varying with fitting diameter.

Pulsation Shock Test

Fully resistant beyond 500,000 cycles of pressure shock, with pulses from 60 psi to 232 psi, at a rate of one cycle per second.

Adherence to recommended joining procedures, with attention to good alignment of pipe and fitting will assure this same degree of joint strength in industrial installations.

Pressure Ratings

Operating temperature		Operating pressure for the following pressure ratings:			
		150 psi/10 bar		232 psi/16 bar	
°F	°C	psi	bar	psi	bar
-40	-40	150	10.0	232	16.0
68	20	150	10.0	232	16.0
104	40	117	8.1	190	13.1
140	60	96	6.6	152	10.5
176	80	75	5.2	117	8.1
212	100	58	4.0	90	6.2
248	120	42	2.9	67	4.6
284	140	27	1.9	13	3.0

CAUTION

Remaining air in the system is to be avoided under any circumstances; it may lead to a potentially dangerous situation should system failure occur. Testing with gaseous media or any other introduction of compressed gaseous media must not be done.

Resistance to Creep

When a plastic is subjected to a constant static load, it deforms a certain amount quickly and then continues to deform at a lower rate indefinitely. If the loads is high enough, rupture will occur. This phenomenon, which occurs commonly in soft metals but also in structurally hard metals at high temperatures, is called creep. SYGEF exhibits an extremely low degree of creep which is virtually zero at full pressure ratings and loads. However, this is not so with other common thermoplastics. SYGEF exhibits such a low degree of creep even at high loads that it is difficult to find a basis for comparison to other fluoropolymers such as PTFE, FEP and PFA, since these materials exhibit such a high degree of creep. For example, at room temperature, at an applied stress of 3000 psi/207 bar, the degree of creep after 100 hours for FEP is 81%, whereas SYGEF measures 1.9%. This difference is also noticeable at higher temperatures, where a 500 psi/35 bar tensile load at 212°F/100°C will result in a creep rate of 20% for FEP, and just 3% for PVDF.

The practical importance of creep must be considered in terms of these points:

1. A solid piping system should not be manufactured out of a plastic which exhibits a high degree of creep. Unexpected long term burst failures could otherwise occur.
2. Safety factors are not predictable with materials of high creep rates.
3. A solid piping system manufactured from high creep rate materials could be rated only at a very low pressure.
4. The creep rate of the piping material at elevated temperatures should be tested and noted if exceedingly high. External piping reinforcement would be needed in such an application.

Final Testing

The completed system or section of piping should be hydrostatically tested before being put in service. Project specifications usually have a written procedure for testing. The generally accepted practice is to fill the system from the lowest point through a 1" or smaller line. The system should be completely vented to relieve entrapped air at the highest point. Once the test pressure is achieved the system should remain pressurized for at least 1 hour. The test pressure should not exceed the maximum operating pressure of the lowest rated system component.

A pressure drop in the course of the test due to elongation is to be expected. If constancy of pressure throughout the test is important, we recommend a preliminary test with the same test pressure for at least as long a duration as the test itself. The main test must follow the preliminary test immediately.

The approximate rate of drop in pressure induced by elongation of PVDF pipes is 0.8 bar/h during a leak test without preliminary test.

A written record should be kept of the leak test.

Operational Test

When the pipeline contains valves with actuators, and when measuring, control or inspection equipment is also installed, the equipment must be checked to ensure that it operates correctly as designed.

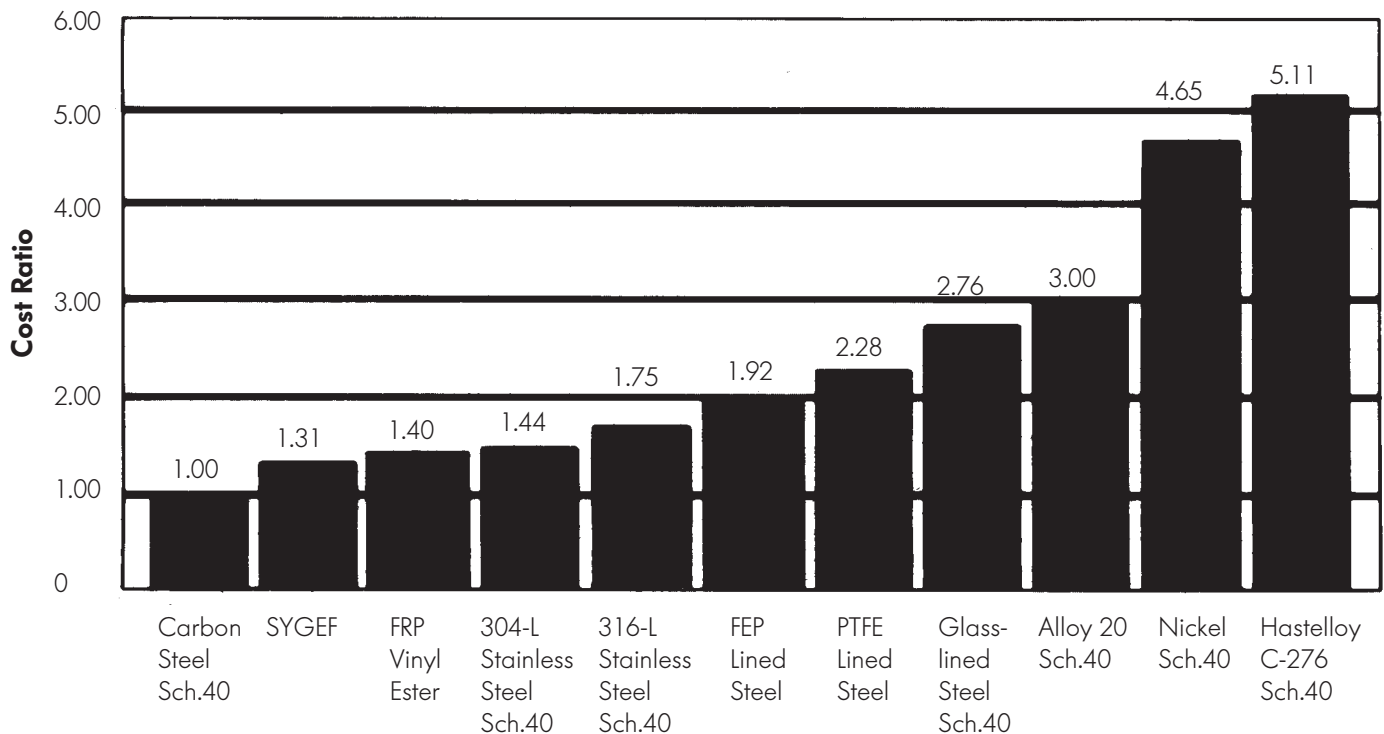
We further recommend that an inspection to ensure that the installation of the pipe system is planned and the materials specified be incorporated in the turnover procedure. Special attention should be paid to check that expansion and contraction can take place unimpeded, that compensators have been correctly installed and that pipe supports have been properly placed.

Cost Analysis

The installed cost of a SYGEF HP PVDF piping system compares favorably with other industrial piping systems. This information is shown on a ratio basis (with Schedule 40 carbon steel having a factor of 1.0) in the graph below.

The basis of this cost comparison is a small, somewhat complex installation typical of an industrial piping application. The installation cost factors included all labor, pipe supports and equipment rental requirements. From time to time this comparison has been reviewed and has shown to be fairly consistent with an overall variance of only a few percentage points.

Comparison of Installed Costs: SYGEF versus Other Piping Systems



Guidelines for the Installation of SYGEF Pipes, Fittings and Valves

Calculation of Length Changes

Length changes which occur in SYGEF can be calculated in the usual manner, taking into consideration the coefficient of linear expansion (δ) for SYGEF as given in the adjacent formula

$$\Delta L = L \cdot \Delta T \cdot \delta$$

(inch) = (inch) (°C) (inch/inch °C)

Rule of thumb is
"about 1" growth per
100' per 10°F ΔT "

where

ΔL = difference in length in inches

L = original length of pipe or pipe section where length change is to be calculated in inches

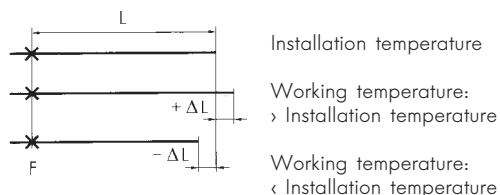
ΔT = difference between installation temperature and max. or min. working temperature in °C

δ = coefficient of linear expansion of the pipe material in inches per inch and °C

δ SYGEF Stand. = .00012 · inch/inch °C

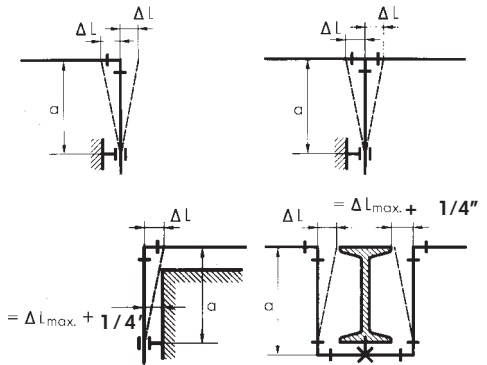
δ SYGEF HP = .00014 · inch/inch °C

Important: If the working temperature is higher than the installation temperature the pipe becomes longer. If, on the other hand, the working temperature is lower, the pipe becomes shorter. For this reason: both **max. and min.** working temperatures must be taken into account.



The simplest method is to take up length changes at changes in direction and/or at branches by flexible movement of specially chosen pipeline sections. The length of this so-called flexible section a is calculated on the basis of the pipe diameter d and the extent of the length change ΔL to be compensated. In order to simplify the calculation, the third influencing factor, the pipe wall temperature is not as a rule taken into account, as in this case the temperature dependence of the shearing modulus would also have to be included.

The pipeline must be installed in such a way that movement of the flexible section a caused by length change ΔL is not impeded in the area concerned by too tightly mounted brackets, jutting brickwork, steel girders or similar.

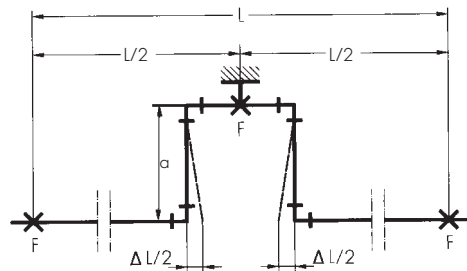


The length changes ΔL to be compensated by specific lengths of flexible section a , dependent upon the pipe diameter d , can be seen from the table at the top of the next page, whereas optional intermediate values can be taken from the diagram at the top of page 4.22.

Determining Length of Flexible Section "a" as a Function of Change in Length ΔL

Ø of deflecting pipe d in mm	closest inch	Length change ΔL in inches										
		1.30	2.95	5.24	8.15	11.77	15.98	20.91	26.46	32.68	39.53	47.05
16	3/8	1.30	2.95	5.24	8.15	11.77	15.98	20.91	26.46	32.68	39.53	47.05
20	1/2	1.06	2.36	4.17	6.54	9.41	12.80	16.73	21.18	26.14	31.61	37.64
25	3/4	.83	1.89	3.35	5.24	7.52	10.24	13.39	16.93	20.91	25.28	30.12
32	1	.67	1.46	2.60	4.09	5.87	7.99	10.43	13.23	16.34	19.76	23.50
40	1 1/4	.51	1.18	2.09	3.27	4.69	6.42	8.35	10.59	13.07	15.83	18.82
50	1 1/2	.43	.95	1.65	2.60	3.78	5.12	6.69	8.47	10.43	12.64	15.04
63	2	.32	.75	1.34	2.09	2.99	4.06	5.32	6.73	8.31	10.04	11.93
75	2 1/2	.28	.63	1.10	1.73	2.52	3.43	4.45	5.63	6.97	8.43	10.04
90	3	.24	.51	.95	1.46	2.09	2.84	3.70	4.69	5.79	7.01	8.35
110	4	.20	.43	.75	1.18	1.69	2.32	3.03	3.86	4.76	5.75	6.85
125	4 1/2	.16	.39	.67	1.06	1.50	2.05	2.68	3.39	4.17	5.04	6.02
140	5	.16	.35	.59	.95	1.34	1.81	2.40	3.03	3.74	4.53	5.39
160	6	.12	.28	.51	.83	1.18	1.61	2.09	2.64	3.27	3.94	4.69
200	8	.12	.24	.43	.67	.95	1.30	1.65	2.13	2.60	3.15	3.78
225	9	.08	.20	.35	.59	.83	1.14	1.50	1.89	2.32	2.80	3.35
Length of flexible section a in inches		19.92	29.89	39.84	49.80	59.76	69.72	79.68	89.64	99.60	109.56	119.52

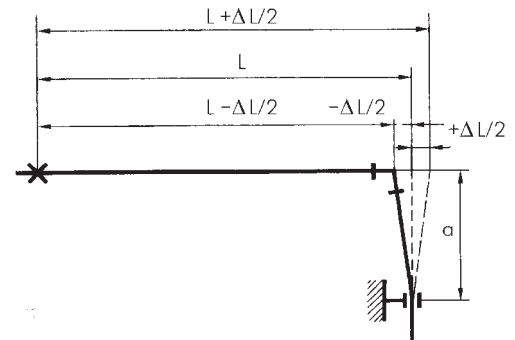
In the case of long straight sections of pipework where there is a considerable difference between the installation and working temperatures, it may be necessary to take up the length changes by the inclusion of additional expansion loops.



Under particularly unfavorable conditions it may also be necessary to include expansion joints. However, the only suitable types are those which have a low intrinsic resistance, and also the same chemical resistance as the pipeline material.



If the working temperatures are almost constantly much higher than the installation temperature it can be of advantage to pre-stress the pipeline during installation. In this process the pipe is shorter than the so-called zero-position when installed. To simplify matters, the amount of the reduction is as a rule as follows:



$$\Delta L/2 = L \cdot \frac{T_{\max.} - T_{\text{inst.}}}{2} \cdot \delta$$

i.e. the length change ΔL to be expected over the whole range of working temperatures is distributed with $\Delta L/2$ on each side of the zero-position, thus achieving a reduction of the flexible section required against the previously described methods.

Distance Between Pipe Brackets

The distance between the pipe brackets depends upon the pipe diameter as well as the maximum working and ambient temperatures. Media with a specific weight difference from that of water ($\delta > \text{g/cm}^3$) also influence the spacing of the brackets.

At very high working temperatures it may be of advantage to provide small diameter horizontal pipework with a continuous support. For SYGEF pipes the following bracket spacing is shown in the table below:

Pipe Diameter - O.D.		*Distance in inches between brackets for SYGEF Pipe							
mm	inch								
20	1/2	37.40	35.43	31.50	29.53	27.56	25.50	23.63	
25	3/4	39.37	37.40	35.43	33.46	31.50	29.50	27.50	
32	1	43.31	39.37	37.40	35.43	33.46	31.50	29.50	
40	1 1/4	49.21	45.28	43.30	39.37	37.40	35.50	31.50	
50	1 1/2	55.12	51.18	47.24	45.28	43.30	39.38	37.38	
63	2	59.06	55.12	51.18	47.24	45.25	41.38	39.38	
75	2 1/2	64.96	61.02	55.12	51.18	49.25	45.25	43.25	
90	3	70.87	64.96	61.02	57.09	53.13	49.25	47.25	
110	4	78.74	72.83	68.90	62.99	61.00	55.13	51.13	
125	4 1/2	82.68	76.77	72.83	66.93	62.99	59.06	55.12	
140	5	88.58	82.68	76.77	70.87	66.93	62.99	59.06	
160	6	94.49	88.58	82.68	76.77	72.84	66.93	62.99	
200	8	100.39	94.49	88.58	82.68	78.75	72.84	68.90	
225	9	106.30	100.39	94.49	88.58	84.65	78.74	74.80	
Operating temperature		20°C 68°F	40°C 104°F	60°C 140°F	80°C 176°F	100°C 212°F	120°C 248°F	140°C 284°F	

* Spacing based on a fluid specific gravity of 1.000

Pipe bracket spacing are based on a maximum permissible deflection of 0.25 cm (0.098") between two brackets.

Note: Hot ultrapure water systems operating at elevated temperatures (such as 70°C) should be continuously supported.

Pipe Bracket Spacing in the case of Fluids with Specific Gravity

> 1 g/cm³

Where fluids with a specific gravity exceeding 1 g/cm³ are to be conveyed, the pipe bracket spacing given in the above table must be multiplied by the factors given in the second column of the following table, resulting in shorter distances between the supports.

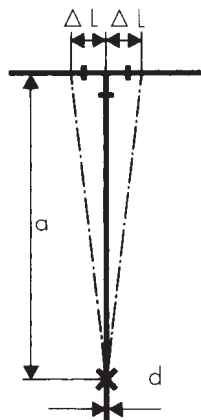
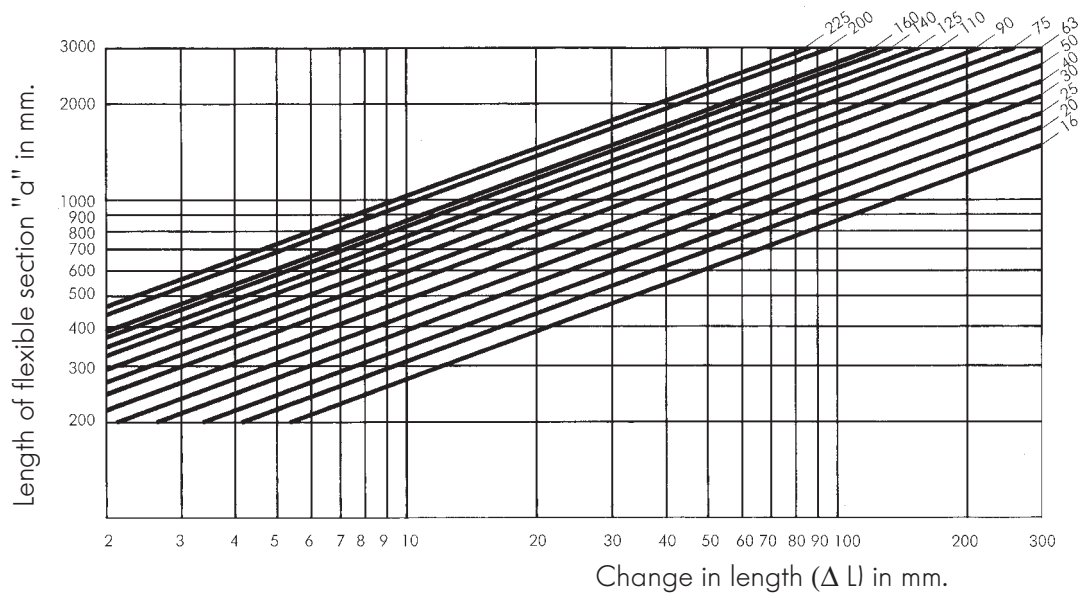
Spec. gravity of medium in g/cm ³	Factors for pipe bracket spacing in the case of spec. gravities > 1 g/cm ³
1.25	0.9
1.5	0.83
1.75	0.77
2.0	0.70
2.25	0.64
2.5	0.57
2.75	0.50
3.0	0.44

Installation of Closely Spaced Pipe Brackets

A continuous support may be more advantageous and economical than pipe brackets for small diameter horizontal pipework, especially in a higher temperature range. Installation in a "V" – or "U" – shaped support made of metal or heat-resistant plastic material has proven satisfactory.



Determination of Flexible Section "a", Dependent Upon Thermal Expansion ΔL For SYGEF Pipes



Calculation of flexible section "a".

$$a = 21.7 \sqrt{d \Delta L}$$

(all measurements in mm.)

Thermal Displacement

SYGEF-PVDF vs Schedule Pipe Dimensions

SYGEF			O.D.			I.D.			cross section area			area ratio		inch size
OD	ID	area	SYGEF	Sch 40	Sch 80	SYGEF	Sch 40	Sch 80	SYGEF	Sch 40	Sch 80	SYGEF	SYGEF	
mm	mm	cm ²	inch	inch	inch	inch	inch	inch	inch ²	inch ²	inch ²	Sch 40	Sch 80	
16	13.0	1.33	.630	.675	.675	.512	.493	.423	.206	.191	.141	1.079	1.461	3/8
20	16.2	2.06	.787	.840	.840	.638	.622	.546	.320	.304	.234	1.053	1.368	1/2
25	21.2	3.53	.984	1.050	1.050	.835	.824	.742	.548	.533	.432	1.028	1.269	3/4
32	27.2	5.81	1.260	1.315	1.315	1.071	1.049	.957	.901	.864	.719	1.043	1.253	1
40	35.2	9.73	1.575	1.660	1.660	1.386	1.380	1.278	1.509	1.496	1.283	1.009	1.176	1-1/4
50	44.0	15.2	1.969	1.900	1.900	1.732	1.610	1.500	2.356	2.036	1.767	1.157	1.333	1-1/2
63	57.0	25.5	2.480	2.375	2.375	2.244	2.067	1.939	3.955	3.356	2.953	1.178	1.339	2
75	67.8	36.1	2.953	2.875	2.875	2.669	2.469	2.323	5.595	4.788	4.238	1.169	1.320	2-1/2
90	81.4	52.0	3.543	3.500	3.500	3.205	3.068	2.900	8.068	7.393	6.605	1.091	1.221	3
110	99.4	77.6	4.331	4.500	4.500	3.913	4.026	3.826	12.026	12.731	11.497	.945	1.046	4
125	117.2	107.8	4.921	*	*	4.614	*	*	16.721	*	*	*	*	*
140	131.2	135.2	5.512	5.563	5.563	5.163	5.047	4.813	20.955	20.005	18.193	1.05	1.15	5
160**	150.2	177.1	6.300	6.625	6.625	5.913	6.065	5.761	27.464	28.890	26.066	.950	1.05	6
200**	187.6	276.4	7.874	8.625	8.625	7.386	7.981	7.625	42.844	50.027	45.663	.856	.938	8
225**	211.0	350.0	8.858	*	*	8.307	*	*	54.198	*	*	*	*	9

*no metal equivalent

**dimensions are for 150 psi rated piping

Friction Loss through Fittings in Equivalent Length of Pipe, Feet

Pipe outside diameter	3/8" 16 mm	1/2" 20 mm	3/4" 25 mm	1" 32 mm	1-1/4" 40 mm	1-1/2" 50 mm	2" 63 mm	2-1/2" 75 mm	3" 90 mm	4" 110 mm	6" 160 mm	8" 200 mm	9" 225 mm
90° elbow	0.9	1.5	2.0	2.7	3.5	4.2	5.5	7.0	8.0	11.0	16.0	20.0	22.5
45° elbow	0.5	0.8	1.0	1.3	1.7	2.1	2.7	3.5	4.0	5.5	8.0	10.0	11.2
Tee with flow through run	0.6	1.0	1.4	1.7	2.3	2.7	4.3	5.1	6.3	8.3	13.0	16.5	18.6
Tee with flow through branch	1.8	4.0	5.1	6.0	6.9	8.1	12.0	14.3	16.3	22.1	32.0	40.0	45.0
Reducer bushing (one reduction)	—	1.0	1.1	1.2	1.4	1.7	2.6	3.6	4.4	5.2	7.0	10.0	11.2
Male/female adapter	0.5	1.0	1.3	1.6	2.2	2.6	3.5	—	—	—	—	—	—

Flow Rate versus Friction Loss - SYGEF pipe

Flow Rate (GPM)	V	ΔH	ΔP	V	ΔH	ΔP	V	ΔH	ΔP	V	ΔH	ΔP	V	ΔH	ΔP	Flow Rate (GPM)
	16mm			20mm			25mm			32mm			40mm			
1	1.56	2.57	1.11	1.00	0.88	0.38	0.59	0.24	0.10	0.36	0.07	0.03			1	
2	3.11	9.26	4.01	2.00	3.18	1.37	1.17	0.86	0.37	0.71	0.26	0.11	0.42	0.07	0.03	2
5	7.78	50.6	21.9	5.01	17.3	7.50	2.93	4.68	2.03	1.78	1.39	0.60	1.06	0.40	0.17	5
7	10.9	94.3	40.8	7.02	32.3	14.0	4.10	8.73	3.78	2.49	2.60	1.13	1.49	0.74	0.32	7
10				10.02	62.6	27.1	5.85	16.9	7.31	3.56	5.03	2.18	2.12	1.44	0.62	10
15							8.78	35.8	15.5	5.34	10.7	4.62	3.19	3.04	1.32	15
20							11.7	61.0	26.4	7.11	18.2	7.87	4.25	5.18	2.24	20
25										8.89	27.5	11.9	5.31	7.83	3.39	25
30										10.7	38.5	16.7	6.37	11.0	4.75	30
35													7.43	14.6	6.32	35
40													8.50	18.7	8.10	40
45													9.56	23.3	10.1	45
50													10.6	28.3	12.2	50

Flow Rate (GPM)	V	ΔH	ΔP	V	ΔH	ΔP	V	ΔH	ΔP	V	ΔH	ΔP	V	ΔH	ΔP	Flow Rate (GPM)
	50mm			63mm			75mm			90mm			110mm			
1																1
2	0.27	0.02	0.01													2
5	0.68	0.13	0.06	0.41	0.04	0.02										5
7	0.95	0.25	0.11	0.57	0.07	0.03	0.40	0.03	0.01			7				
10	1.36	0.48	0.21	0.81	0.14	0.06	0.57	0.06	0.03			0				1
15	2.04	1.03	0.45	1.22	0.29	0.13	0.86	0.13	0.05	0.60	0.05	0.02			5	1
20	2.72	1.75	0.76	1.62	0.50	0.22	1.15	0.21	0.09	0.79	0.09	0.04	0.53	0.03	0.01	20
25	3.40	2.65	1.15	2.03	0.75	0.33	1.43	0.32	0.14	0.99	0.13	0.06	0.67	0.05	0.02	25
30	4.08	3.71	1.61	2.43	1.05	0.46	1.72	0.45	0.20	1.19	0.19	0.08	0.80	0.07	0.03	30
35	4.76	4.94	2.14	2.84	1.40	0.61	2.00	0.60	0.26	1.39	0.25	0.11	0.93	0.09	0.04	35
40	5.44	6.33	2.74	3.24	1.79	0.78	2.29	0.77	0.33	1.59	0.32	0.14	1.07	0.12	0.05	40
45	6.12	7.87	3.41	3.65	2.23	0.97	2.58	0.96	0.42	1.79	0.39	0.17	1.20	0.15	0.06	45
50	6.80	9.56	4.14	4.05	2.71	1.17	2.86	1.17	0.50	1.99	0.48	0.21	1.33	0.18	0.08	50
60	8.16	13.4	5.80	4.86	3.80	1.64	3.44	1.63	0.71	2.38	0.67	0.29	1.60	0.25	0.11	60
70	9.52	17.8	7.72	5.67	5.06	2.19	4.01	2.18	0.94	2.78	0.89	0.39	1.87	0.34	0.15	70
80	10.9	22.8	9.89	6.48	6.48	2.80	4.58	2.79	1.21	3.18	1.14	0.49	2.13	0.43	0.19	80
90				7.29	8.06	3.49	5.15	3.46	1.50	3.57	1.42	0.62	2.40	0.54	0.23	90
100				8.10	9.79	4.24	5.73	4.21	1.82	3.97	1.73	0.75	2.66	0.65	0.28	100
125				10.1	14.8	6.41	7.16	6.37	2.76	4.96	2.61	1.13	3.33	0.98	0.43	125
150							8.59	8.92	3.86	5.96	3.66	1.59	4.00	1.39	0.60	150
175							10.0	11.9	5.14	6.95	4.87	2.11	4.66	1.86	0.80	175
200							11.4	15.2	6.58	7.94	6.24	2.70	5.33	2.36	1.02	200
250										9.93	9.43	4.08	6.66	3.57	1.55	250
300										11.9	13.2	5.72	7.98	5.01	2.17	300
350													9.33	6.66	2.88	350
400													10.7	8.53	3.69	400

V = Fluid Velocity, Ft/Sec

ΔH = Head Loss, Ft. H₂O Per 100 ft. pipe

ΔP = Head Loss, psi per 100 ft. pipe

C = 150*

Hazen and Williams Equation

$$\Delta H = .2083 \left(\frac{100}{C} \right)^{1.852} \left(\frac{\text{GPM}}{ID^{4.8655}} \right)^{1.852}$$

$$\Delta P = \Delta H / 2.31$$

$$V = \frac{4 Q (1.337)}{60\pi \left(\frac{D}{12} \right)^2}$$

*This is a generally accepted and conservative number for all plastic piping. Due to the smooth surface of PVDF, some engineers have chosen to use a more aggressive value of 160 (or higher).

Flow Rate versus Friction Loss – SYGEF-PVDF Pipe

Flow Rate (GPM)	V ΔH ΔP			V ΔH ΔP			V ΔH ΔP			V ΔH ΔP			V ΔH ΔP			Flow Rate (GPM)
	125 mm			140 mm			160 mm*			200 mm*			225 mm*			
25	.48	.02	.01	.38	.01	.01	.29	.01	.00							25
50	.96	.08	.04	.77	.05	.02	.58	.02	.01	.37	.01	.00				50
100	1.92	.29	.13	1.53	.17	.07	1.17	.08	.04	.75	.03	.01	.59	.02	.01	100
150	2.88	.62	.27	2.30	.36	.16	1.75	.19	.08	1.12	.06	.03	.89	.04	.02	150
200	3.84	1.05	.46	3.07	.61	.26	2.34	.32	.14	1.50	.11	.05	1.18	.06	.03	200
260	4.99	1.71	.74	3.98	.99	.43	3.04	.51	.22	1.95	.17	.08	1.54	.10	.04	260
300	5.76	2.23	.97	4.60	1.29	.56	3.51	.67	.29	2.25	.23	.10	1.78	.13	.06	300
360	6.91	3.13	1.36	5.52	1.81	.79	4.21	.94	.41	2.70	.32	.14	2.13	.18	.08	360
400	7.68	3.81	1.65	6.13	2.20	.95	4.67	1.14	.49	3.00	.39	.17	2.37	.22	.09	400
450	8.64	4.73	2.05	6.90	2.74	1.19	5.26	1.42	.61	3.37	.48	.21	2.66	.27	.12	450
500	9.60	5.75	2.49	7.66	3.33	1.44	5.84	1.72	.75	3.74	.58	.25	2.96	.33	.14	500
550	10.56	6.87	2.97	8.43	3.97	1.72	6.43	2.05	.89	4.12	.70	.30	3.26	.39	.17	550
600	11.51	8.07	3.49	9.20	4.67	2.02	7.01	2.41	1.04	4.49	.82	.35	3.55	.46	.20	600
700				10.73	6.21	2.69	8.18	3.21	1.39	5.24	1.09	.47	4.14	.61	.27	700
800				12.26	7.95	3.44	9.35	4.11	1.78	5.99	1.39	.60	4.74	.79	.34	800
900							10.52	5.11	2.21	6.74	1.73	.75	5.33	.98	.42	900
1000							11.69	6.21	2.69	7.49	2.11	.91	5.92	1.19	.52	1000
1200										8.99	2.95	1.28	7.10	1.67	.72	1200
1400										10.48	3.93	1.70	8.29	2.22	.96	1400
1600													9.47	2.84	1.23	1600
1800													10.66	3.53	1.53	1800
2000													11.84	4.29	1.86	2000

* flow rates are noted for 150 psi rated piping, information regarding flow rates for 232 psi rated, large diameter PVDF is available upon request

George Fischer Custom Products



Application: Pharmaceutical Industry

4

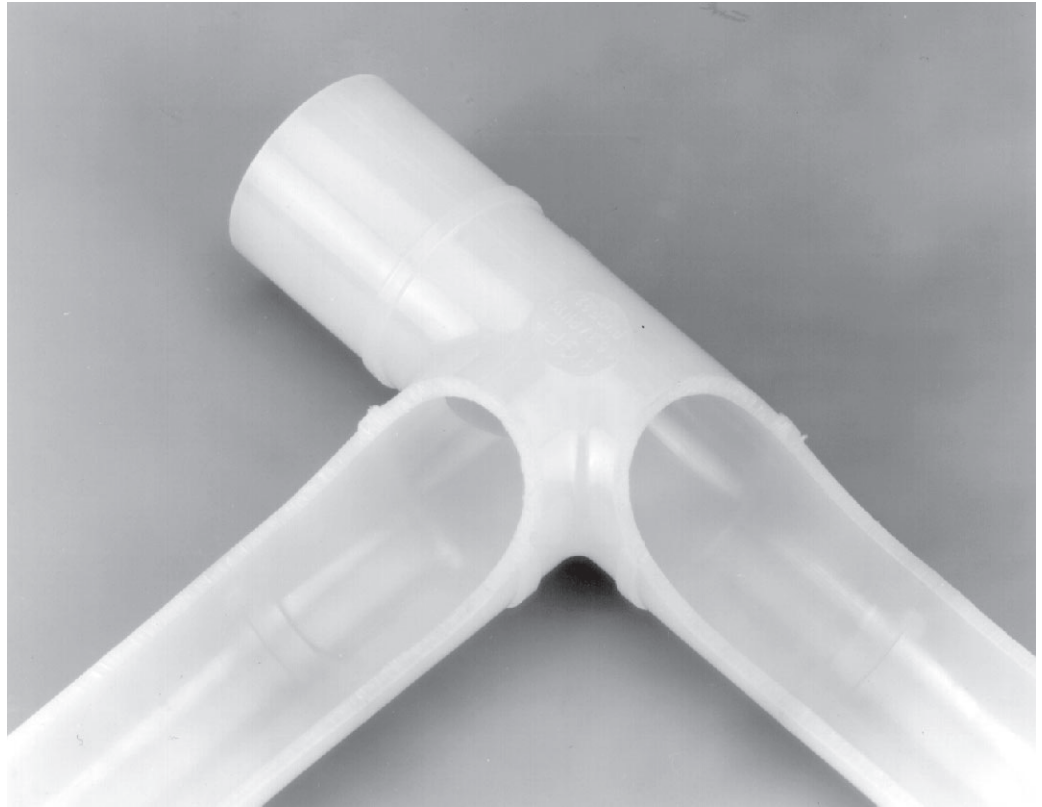


Ultrapure SYGEF®-PVDF HP BCF® (Bead and Crevice Free) pipe, valves, and fittings for USP WFI and USP PW water systems.

SYGEF®-PVDF HP BCF® (Bead & Crevice Free) Joining Technology

With BCF joining, a cross-section shows that the fusion area is just as smooth as the inner surface of the pipe.

SYGEF HP BCF — a safe, dependable pipe joining system to meet exact standards: very pure, smooth and safe.



For a complete guide to proper installation techniques, the George Fischer factory sponsored installer certification program is recommended. It teaches a basic understanding of plastics and fusion technology. For more information, contact your George Fischer representative.

The George Fischer SYGEF HP BCF (Bead and Crevice Free) joining system produces bead and crevice free joints for SYGEF-PVDF (polyvinylidene fluoride) piping. It is used where there is extreme concern about the presence of small beads or crevices in the piping system. Such applications can be found in the Semiconductor, Pharmaceutical, and Food and Beverage Industries.

The SYGEF HP BCF system is manufactured to conform to strict purity standards specified for ultra-pure water applications by both the FDA and the semiconductor industry. These stringent quality control standards apply to the piping system under actual operation and not merely for the raw material of the pipe and fittings. SYGEF HP BCF will not leach metal ions into ultra-pure water nor will joints corrode as metal piping does.

The SYGEF HP BCF joining machine automatically clamps and aligns the pipe and fitting, and produces the seamless joint by a proprietary heat-fusion method. The machine's electronic logic circuits provide temperature monitoring and heat sensing to automatically produce the proper weld for the particular pipe size. The SYGEF HP BCF system is offered in 20mm through 63mm (1/2" through 2-1/2" SS tube size) pipe diameters; with 90° elbows, T's, unions, diaphragm valves, zero static diaphragm valves, reducers (both concentric and eccentric), and flange adaptors.

Specification Guide for High Purity SYGEF® HP PVDF Piping System for WFI and USP Purified Water Distribution

Part 1 General

1.1 Work Included

- A. This section provides the requirements for high purity non-metallic materials, cleaning, fabrication, and installation of SYGEF® HP Bead & Crevice Free (BCF) piping systems intended for the transport of USP Water for Injection (WFI) or USP Purified Water (PW).
- B. This section establishes the requirements for work to be performed by the contractor in a pre-fab cleanroom whether on-site or performed in the permanent facility. Work shall be performed in a dedicated area for PVDF assembly within the cleanroom isolated from UHP stainless steel fabrication work.
- C. In the event of conflict regarding requirements for PVDF piping systems between this Section and any other section, the provisions of this Section shall govern.
- C. Manufacturer shall select at random a minimum of one pipe and one fitting per lot (or 10% whichever is greater) and test for interior/surface finish, dimensional tolerances, and inclusions.
- D. QAR acceptance of material shall be contingent on submitted SEM analysis confirming absence of porosity, defects, inclusions, or surface contamination and satisfactory tests as outlined above.
- E. Random samples from each lot may be selected by QAR or the owner for testing. Failure of test or inspection shall be grounds for rejection of entire lot.
- F. Results of quality assurance tests shall be stored by the supplier for a period of one year and made available to QAR or owner upon request.

1.2. Quality Assurance of Materials

- A. Any deviation from the materials, packaging and inspection requirements of this section must be approved in writing by QAR (Quality Assurance Representative) or the owner.
- B. Manufacturer shall 100% visually inspect all piping components prior to packaging for cleanliness and imperfections. If any defect or contamination is discovered, the material shall be tagged and rejected.

1.3 Installation Training

- A. The Contractor and his field personnel shall be certified by the manufacturer for the installation of the PVDF system for Ultra Pure Water. The certification shall be current (within one year of date of issue) and each welder shall display a laminated badge identifying the individual by name, date of certification and type of fusion machine for which certification is granted.

1.4 Submittals

- A. The Ultra Pure Water Contractor shall submit the following:
 - 1. A detailed description of the Contractor pre-fabrication cleanroom whether on-site, at the Contractor's site, or both, and conformance with current Federal Specifications.
 - 2. Contractor 's proposed protocol for all work to be performed by Contractor's personnel in the pre-fabrication cleanroom(s).
 - 3. Installation Quality Control and Field Quality Assurance procedures for review and approval by Facilities Engineering or QAR representative.
 - 4. Provide catalog and operating information for all equipment submitted.
 - 5. Documentation shall be submitted for the materials supplied to show their compliance with the attached Piping Specification Sheet. This shall include manufacturer's surface testing results as required in this specification.
 - 6. Contractor training plan for UPW material handling protocol for all contractor personnel involved in the installation of the UPW piping system.

Part 2 Products

2.1 General

- A. This specification is for the installation of pipe, fittings and valves required throughout the UPW system equipment and distribution system.
- B. Acceptable manufacturer of high purity pipe, valves and fittings is:
 - a) George Fischer's SYGEF® HP PVDF products or other products of equal quality manufactured under same clean room processes.

2.2 Pipe, Fittings and Valves - Raw Material

- A. In general, all piping, fittings and valves shall be in accordance with these specifications and approved submittals. All materials shall be designed, fabricated and prepared for high purity installation.
- B. SYGEF® HP (PVDF) pipe shall be manufactured from "Kynar 740 SYGEF®" natural, unpigmented, virgin polyvinylidene fluoride (PVDF) homopolymer conforming to the standards of ASTM D-3222. SYGEF® High Purity (HP) PVDF valves and SYGEF® HP PVDF fittings shall be manufactured from Solef 1008 natural, unpigmented, virgin polyvinylidene fluoride (PVDF) homopolymer conforming to the standards of ASTM D-3222. This high purity PVDF material shall have a tensile strength of 6815 psi/470 bar and a flexural strength of 11165 psi/770 bar when tested at 73°F/23°C according to ASTM D-638 and ASTM D-790. Each lot of resin shall be inspected for proper melt flow index, color, and density: melting point per ASTM D3222; vicat softening per ASTM D1525. All raw material utilized for SYGEF® HP (PVDF) production shall be specially controlled regarding procurement, shipment, handling and storage prior to production to minimize contact with extraneous contamination.
- C. PVDF resins shall be handled in a clean room environment to prevent contamination from entering resin. Resin shall be gravity fed to processing equipment. Pneumatic conveyance of resin shall be prohibited.
- D. PVDF resin shall meet the testing requirements for impurities per Sematech 92010936B.

2.3 Pipe, Fittings and Valves - Dimensions and Pressure Rating

- A. Pipe and Fitting shall be extruded or molded in a class 10,000 cleanroom or better as defined by the current Federal Standard. SYGEF® HP (PVDF) pipe shall be a Standard Dimensions Ratio (SDR) series which defines the outer pipe diameter, wall thickness and tolerances. The pressure rating for all pipe sizes through 63mm (2 1/2" SS tubing size) diameter shall be 232 psi (16 bar) when measured at 68°F
- B. All PVDF diaphragm and butterfly valves shall have a minimum pressure rating of 150 psi at 68°F (10 bar at 23°C). Flanged valves shall have ANSI bolt pattern for Class 150 rating. All mechanical connections for sample ports, instrumentation or venting shall have either sanitary or approved threaded NPT connections.
- C. All high purity PVDF valves in sizes through 63mm (2 1/2" SS tubing size) shall be Type 314/315/319 Diaphragm Valves as manufactured by George Fischer. All diaphragm valves shall be weir style with PTFE Teflon® diaphragm seals backed with EPDM or FPM.

2.4 PVDF Pipe - Manufacturing

- A. Environment:
SYGEF® HP (PVDF) pipe shall be extruded in a dedicated high purity PVDF production line which is located in a Class 10,000 cleanroom or better, as defined by the current Federal Standard. All pipes shall be extruded on dedicated production equipment used exclusively for the production of high purity PVDF. Pipe dimensions and tolerances shall be continually monitored by use of ultra-sonic equipment.
- B. Stress Relieving:
Extrusion stresses shall be relieved by use of a continuous in-line annealing oven. Stress relief shall be measured and relate to a maximum 0.4% dimensional change when tested according to ISO Draft #10931-2
- C. Pipe Identification:
SYGEF® HP (PVDF) pipe shall be identified on the pipe outer surface with the production lot, pipe diameter and wall thickness. Pipe identification shall be accomplished by use of heat embossed lettering and without the use of any ink on the pipe surface. After packaging, each pipe length shall have a label adhered to the outside of the outer polyethylene bag. The label shall denote production lot, pipe diameter, wall thickness and surface quality.

(Specification Guide for High Purity SYGEF® HP PVDF Piping System for WFI and USP Purified Water Distribution continued)

- D. Surface Finish:
SYGEF® HP (PVDF) pipe shall have samples taken which are measured for micropore size and mean roughness of the interior pipe surface. Samples are examined by use of scanning electron microphotography (at 3500 magnification) for detection of micropores larger than 1 micron. Any pore shall be non-fragmented at the edge and smooth shouldered.

Using SEMASPEC 92010955B, SYGEF HP (PVDF) pipe surface defects shall be less than 40 total.

Using SEMASPEC 92010950B, SYGEF HP (PVDF) pipe, regardless of size, shall have profilometer mean roughness values, Ra, as follows:
Ra longitudinal: 0.15 micron or less
Ra diagonal: 0.20 micron or less

- E. SYGEF® HP (PVDF) pipe interior shall also be visually inspected for defects on a lighted table prior to fitting with protective polyethylene end caps and double bagged in heat sealed polyethylene liners immediately after production within the cleanroom.
- F. Pipe Dimensional tolerance (mm) shall be according to the following:

Size	Tolerance	Ovality	Wall	Tolerance
20	+0.3, -0.0	0.3	1.9	+0.4, -0.0
25	+0.3, -0.0	0.4	1.9	+0.4, -0.0
32	+0.3, -0.0	0.5	2.4	+0.5, -0.0
40	+0.3, -0.0	0.5	2.4	+0.5, -0.0
50	+0.3, -0.0	0.6	3.0	+0.6, -0.0
63	+0.4, -0.0	0.8	3.0	+0.6, -0.0
75	+0.4, -0.0	0.9	3.6	+0.6, -0.0
90	+0.4, -0.0	1.1	4.3	+0.7, -0.0
110	+0.5, -0.0	1.3	5.3	+0.8, -0.0
160	+1.0, -0.0	2.0	4.9	+0.8, -0.0
200	+1.2, -0.0	2.5	6.3	+0.9, -0.0
225	+1.4, -0.0	2.7	6.9	+0.9, -0.0

2.5 PVDF Fittings and Valves - Manufacturing

- A. Environment:
All high purity PVDF fittings and valves shall be manufactured on dedicated equipment in a Class 10,000 cleanroom as defined in the current Federal Standard. Any machined valve components shall be done in a Class 10,000 cleanroom with no coolant other than filtered air.
- B. Cleaning:
Fittings and valves (diaphragm and butterfly) shall be machined washed in a Class 100 cleanroom, as defined in the current Federal Standard, using DI water with non-ionic, phosphate free surfactant solution. After cleaning, the components shall be rinsed with hot (80°C) DI water, flushed with ambient DI water 15 meg-ohm (min.) resistivity and heat dried with HEPA filtered air or filtered nitrogen.

(Specification Guide for High Purity SYGEF® HP PVDF Piping System for WFI and USP Purified Water Distribution continued)

- C. DI Water Specification for Cleaning:
DI water for cleaning shall meet or exceed the quality water listed in the following table:
- | | |
|--------------------|------------------------|
| Resistivity (min.) | 15.0 meg-ohm/cm @ 25°C |
| TOC | 10 ppb |
| Particles | 0. 1/ml @ 0.1 micron |
| Bacteria | < 2 cfu/1 00ml |
| Copper | 0.1 ppb |
| Zinc | 0.5 ppb |
| Nickel | 0.1 ppb |
| Sodium | 0.5 ppb |
| Potassium | 2 ppb |
| Chloride | 1 ppb |
| Nitrate | 1 ppb |
| Phosphate | 1 ppb |
| Sulfate | 1 ppb |
- D. Nitrogen Specification for Drying Components:
Nitrogen used for drying shall be clean, dry, high purity nitrogen meeting the following requirements:
- | | |
|---------------------------|---------------------------------|
| Oxygen content | < 3 ppm |
| Hydrogen content | < 2 ppm |
| CO Content | < 5 ppm |
| CO ₂ Content | < 1 ppm |
| Moisture Content | < 1 ppm |
| Total Hydrocarbon Content | < 1 ppm |
| Particles | Filtered to 0.1 micron absolute |
- Nonionic surfactant shall be Triton X-100 or submitted and approved equal.
- E. Fitting/Valves Packaging:
After cleaning fittings and valves shall be immediately and individually heat sealed in PA6/PE double bags while in the cleanroom. Valves shall be assembled in a Class 100 environment without the use of lubricants on any wetted surface. No external markings or labeling shall be permitted except on the outer bag. The production label shall denote production lot, dimension and logistical information.
- F. Fitting/Valves Identification:
All high purity PVDF fittings and valves shall be molded with permanent identification to allow tractability to production lot and resin batch. In addition, all high purity PVDF fitting and valves labels shall have an identification code or numbering scheme on packaging that permits traceability back to the lot and batch cleaning of fittings or valves.
- G. Fabricated Components:
Production of PVDF fabricated items are to be done under a minimum Class 10,000 cleanroom as defined in the current Federal Standard. Machine components made from semi-finished PVDF block and rod used in this fabrication of parts or sub-assemblies shall be inspected, cleaned and packaged similar to fittings and valves. Final inspection is made prior to packaging by 100% visual inspection of every weld. Pressure test for welded assemblies as required. Surface finish for any machined component shall be: Ra = 0.62μ or better.
- H. Traceability of Machined Components:
Welding of sub-components shall only be done by manufacturers certified technicians. All factory welds shall be labeled using the manufacturers fusion machine printouts from actual welds. All finished parts and assemblies shall be heat embossed with a serial number for traceability which links incoming material, production dates, machines used and welding personnel.

(Specification Guide for High Purity SYGEF® HP PVDF Piping System for WFI and USP Purified Water Distribution continued)

2.6 Bead & Crevice Free (BCF) Fusion Equipment

- A. All SYGEF® HP Bead and Crevice Free Piping shall be joined by use of the George Fischer BCF fusion joining equipment as manufactured by George Fischer. The BCF fusion equipment shall control the fusion process by means of an integrated software program and allow for a printed output of fusion parameters through a standard parallel port interface.
- B. For ease of installation, all fusion equipment shall permit the use of remote or in-place fusion welding of all components up to 63 mm (2 1/2" SS tube size).

2.7 Fusion Training and Certification

- A. SYGEF® HP Bead and Crevice Free PVDF piping installation shall only be performed by factory trained and certified installers in accordance with the manufacturer's written procedures. Each installer shall complete the George Fischer Certification Course including written test examinations and submittal of fusion test welds to the manufacturer for evaluation and file.

- B. All PVDF pipe, valves and fittings shall be properly prepared in accordance with high purity standards and the manufacturer's written instructions. Each certified welder shall display at all times a permanent certification card showing name, type of fusion machine, certification number and date of certification.
- C. Installation practices, including support spacing and expansion considerations, shall be in compliance with the manufacturer's certification course and written recommendations.

2.8 Weld Inspection

- A. Inspection of BCF fusion welds shall be performed using a light source (such as a "D" cell "Maglite") capable of illuminating the fusion weld area to determine internal weld characteristics. The light source shall be directed opposite the viewing side of the weld to determine weld integrity. Every BCF weld shall be inspected around the circumference for visible cracks, dirt, voids and thinning of fusion zone. A properly fused BCF joint will appear uniform in color with little or no weld line and smooth internal surface characteristics similar to the pipe wall with no weld bead.
- B. For further inspection criteria refer to the Welder Certification Course.

(Specification Guide for High Purity SYGEF® HP PVDF Piping System for WFI and USP Purified Water Distribution cont.)

Part 3 Execution

3.1 Delivery, Storage and Handling

- A. Any material that becomes damaged and/or contaminated in transit handling or storage shall not be used. It will be rejected by the QAR representative and returned to the manufacturer/distributor.
- B. All material and equipment shall be handled and stored in an indoor location throughout the progress of the job in such a manner as to prevent damage and/or contamination. Room shall be maintained dry and dust free. Room shall be kept at a temperature between 60 and 85 degrees F.
- C. Piping, fittings, and valves shall be stored in their original factory sealed poly bags. Use nylon or polypropylene rope or soft strand for slings and tie-downs used to let, load, or transport pipe bundles. Do not stack pipe higher than 2 feet.
- D. All fabricated material shall be used within 48 hours of being removed from the storage site. All high-purity PVDF piping system components shall be inspected and approved by fabricator and installer upon arrival into the fabrication clean room and before spool fabrication begins.
- E. Fabricated spool pieces shall be supported and padded to prevent damage during transport.
- F. All pipe fitting ends of fabricated spool pieces shall be double bagged and sealed. Bags shall be secured with cap or cleanroom tape a minimum 6 inches away from pipe end. Cleanroom tape directly over pipe or fitting end is not acceptable.

SYGEF® HP (High Purity) Pipe, Valves, and Fittings for BCF (Bead and Crevice Free) Fusion Joining

Marking

SYGEF system pipes and fittings are marked as follows:

- +GF+
- Pipe o.d. and nominal bore
- SYGEF®

Dimensions

All pipe sizes are given in mm or equivalent closest inch size. Subject to alteration resulting from modifications in design.

Pressure Rating

George Fischer SYGEF and SYGEF HP is a constant rated system, 232 psi (16 bar) up to 110 mm (4") and either 150 psi (10 bar) or 232 psi (16 bar) for sizes 160 mm (6") and above. The pipe wall is proportioned to pipe O.D. based on the standard dimensional rating (SDR).

List of abbreviations

PVDF	Polyvinylidene Fluoride
®	Registered trademark
d	Pipe o. d.
lbs	Weight in pounds
e	Wall thickness, mm
z	z-dimension, inches
SP	Standard packaging

Orders

Always quote the George Fischer part number when placing orders.

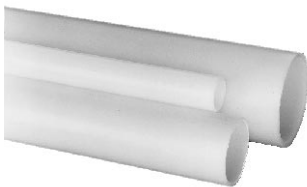
Ordering Example

PVDF HP pipe 175 481 669
45° elbow Standard 735 158 516

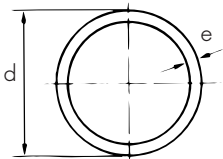
Pipe

PVDF Capped and Bagged

Supplied in 5 meter (16.4 ft.) lengths, clean, capped and bagged.



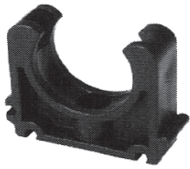
d m m	psi	Part Number			lbs./ meter	e m m			ss tube size	Closest IPS size
20	232	175 480 203			.45	1.9			3/4	1/2
25	232	175 480 204			.60	1.9			1	3/4
32	232	175 480 205			.95	2.4			1 1/2	1
40	232	175 480 206			1.20	2.4			1 1/2	1 1/4
50	232	175 480 207			1.85	3.0			2	1 1/2
63	232	175 480 208			2.40	3.0			2 1/2	2



PVDF HP

Supplied in 5 meter (16.4 ft.) lengths, clean, capped and double bagged.

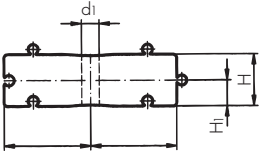
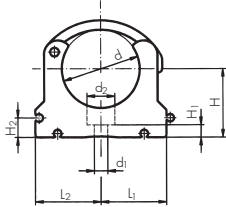
d m m	psi	Part Number			lbs./ meter	e m m			ss tube size	Closest IPS size
20	232	175 481 203			.45	1.9			3/4	1/2
25	232	175 481 204			.60	1.9			1	3/4
32	232	175 481 205			.95	2.4			1 1/2	1
40	232	175 481 206			1.20	2.4			1 1/2	1 1/4
50	232	175 481 207			1.85	3.0			2	1 1/2
63	232	175 481 208			2.40	3.0			2 1/2	2



d 20 mm - 32 mm*



d 40 mm - 63 mm



Pipe Bracket, Type 061 for mm pipes

Material: Bracket: PP Safety clip: PP

Not recommended for applications where pipe surface temperatures exceed 60°C.

d mm	Part Number	SP	d ₁ inch	d ₂ inch	L ₁ inch	L ₂ inch	h inch	h ₁ inch	h ₂ inch	b inch	screw/bolt size
20*	167 061 006	10	.22	.41	0.65	0.75	0.98	0.24	0.39	0.63	³ / ₁₆
25*	167 061 007	10	.22	.41	0.75	0.85	1.08	0.24	0.39	0.63	³ / ₁₆
32*	167 061 008	10	.22	.41	0.94	1.04	1.22	0.24	0.39	0.63	³ / ₁₆
40	167 061 009	10	.26	.55	1.32	1.31	1.38	0.26	0.39	0.87	¹ / ₄
50	167 061 010	10	.26	.55	1.46	1.46	1.57	0.26	0.39	0.87	¹ / ₄
63	167 061 011	10	.33	.67	1.75	1.75	2.03	0.39	0.39	0.98	⁵ / ₁₆

*Without safety clip

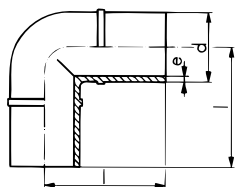
4

Spacer, Type 061

to PP pipe Bracket, Type 061

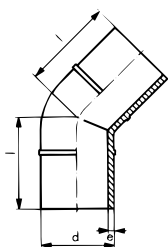
d mm	Part Number	SP	lbs./ each	d ₁ inch	L ₁ inch	L ₂ inch	H inch	H ₁ inch	b inch
20	167 061 156	10	.01	0.22	0.65	0.75	.79	.39	.63
25	167 061 157	10	.02	0.22	0.75	0.85	.79	.39	.63
32	167 061 158	10	.02	0.22	0.94	1.04	.79	.39	.63
40	167 061 159	10	–	0.26	1.32	1.32	.79	.39	.87
50	167 061 160	10	–	0.26	1.46	1.46	.79	.39	.87
63	167 061 161	10	.06	0.33	1.75	1.75	.79	.39	.93

SYGEF® HP BCF Fittings for BCF Fusion Joining



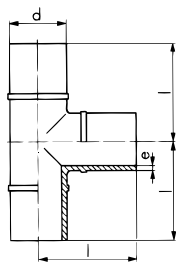
BCF 90° Elbow

d mm	psi	Part Number		SP	lbs./ each	l inch	e mm						Closest inch size
20	232	735 108 706		1	.05	2.17	1.9						1/2
25	232	735 108 707		1	.09	2.17	1.9						3/4
32	232	735 108 708		1	.10	2.17	2.4						1
40	232	735 108 709		1	.22	3.15	2.4						1 1/4
50	232	735 108 710		1	.33	3.15	3.0						1 1/2
63	232	735 108 711		1	.43	3.15	3.0						2



BCF 45° Elbow

d mm	psi	Part Number		SP	lbs./ each	l inch	e mm						Closest inch size
20	232	735 158 706		1	.05	1.87	1.9						1/2
25	232	735 158 707		1	.06	1.78	1.9						3/4
32	232	735 158 708		1	.08	1.71	2.4						1
40	232	735 158 709		1	.15	2.58	2.4						1 1/4
50	232	735 158 710		1	.23	2.46	3.0						1 1/2
63	232	735 158 711		1	.27	2.31	3.0						2

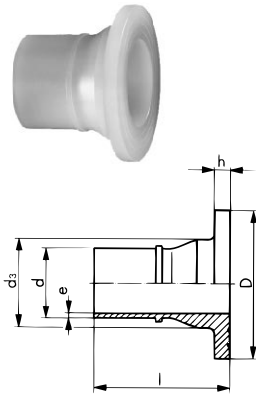


BCF Tee

d mm	psi	Part Number		SP	lbs./ each	l inch	e mm						Closest inch size
20	232	735 208 706		1	.07	2.17	1.9						1/2
25	232	735 208 707		1	.09	2.17	1.9						3/4
32	232	735 208 708		1	.14	2.17	2.4						1
40	232	735 208 709		1	.30	3.15	2.4						1 1/4
50	232	735 208 710		1	.44	3.15	3.0						1 1/2
63	232	735 208 711		1	.58	3.15	3.0						2

BCF Flange Adapter

Note: Flange Rings are found on page 4.47.



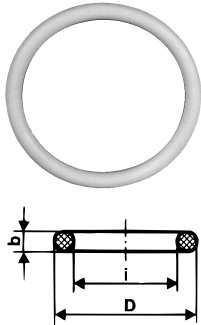
d mm	psi	Part Number	SP	lbs./ each	h inch	d ₁ inch	D inch	l inch	e mm			Closest inch size
20	232	735 798 706	1	.07	.24	1.02	1.73	2.24	1.9			1/2
25	232	735 798 757	1	.11	.28	1.26	2.13	2.39	1.9			3/4
32	232	735 798 758	1	.13	.28	1.58	2.48	2.44	2.4			1
40	232	735 798 759	1	.14	.32	1.93	2.87	2.98	2.4			1 1/4
50	232	735 798 760	1	.29	.32	2.36	3.23	2.98	3.0			1 1/2
63	232	735 798 711	1	.38	.35	2.95	4.02	3.01	3.0			2

4



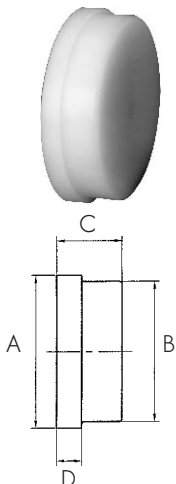
BCF HP Union (with white FPM O-ring)

d mm	psi	Part Number	SP	lbs./ each	D inch	l inch	e mm					Closest inch size
20	232	735 518 706	1	.14	1.78	5.37	1.9					1/2
25	232	735 518 707	1	.27	2.17	5.35	1.9					3/4
32	232	735 518 708	1	.40	2.44	5.43	2.4					1
40	232	735 518 709	1	.64	2.95	6.93	2.4					1 1/4
50	232	735 518 710	1	.81	3.29	7.01	3.0					1 1/2
63	232	735 518 711	1	1.41	3.98	7.37	3.0					2



Union O-Ring, white FPM

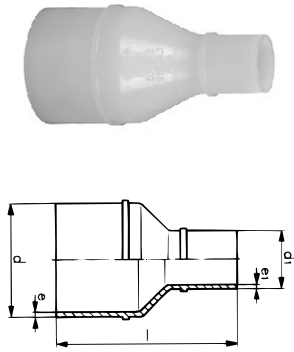
d mm	psi	Part Number	SP	i inch	D inch	b inch					Closest inch size
20	232	749 411 005	1	.61	.82	.10					1/2
25	232	749 411 006	1	.80	1.07	.14					3/4
32	232	749 411 120	1	1.05	1.32	.14					1
40	232	749 411 062	1	1.36	1.64	.14					1 1/4
50	232	749 411 172	1	1.73	2.01	.14					1 1/2
63	232	749 411 054	1	2.17	2.48	.16					2



Union Blank

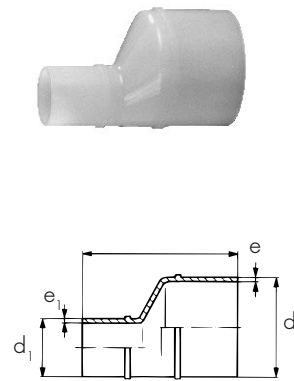
d mm	psi	Part Number	SP	lbs./ each	A inch	B inch	C inch	D inch				Closest inch size
20	232	175 482 101	1		1.18	1.08	0.51	0.20				1/2
25	232	175 482 102	1		1.53	1.42	0.59	0.20				3/4
32	232	175 482 103	1		1.76	1.63	0.67	0.22				1
40	232	175 482 104	1		2.22	2.08	0.71	0.24				1 1/4
50	232	175 482 105	1		2.46	2.31	0.79	0.28				1 1/2
63	232	175 482 106	1		3.43	2.90	0.87	0.30				2

BCF Concentric Reducer



d - d ₁ mm	psi	Part Number	SP	lbs./ each	l inch	e mm	e ₁ mm					Closest inch size
25 - 20	232	735 908 737	1	.04	3.15	1.9	1.9					³ / ₄ - ¹ / ₂
32 - 20	232	735 908 742	1	.06	3.15	2.4	1.9					1- ¹ / ₂
32 - 25	232	735 908 741	1	.06	3.15	2.4	1.9					1- ³ / ₄
40 - 20	232	735 908 748	1	.09	3.94	2.4	1.9					1 ¹ / ₄ - ¹ / ₂
40 - 25	232	735 908 747	1	.09	3.94	2.4	1.9					1 ¹ / ₄ - ³ / ₄
40 - 32	232	735 908 746	1	.11	3.94	2.4	2.4					1 ¹ / ₄ -1
50 - 32	232	735 908 753	1	.14	3.94	3.0	2.4					1 ¹ / ₂ -1
50 - 40	232	735 908 752	1	.15	3.94	3.0	2.4					1 ¹ / ₂ -1 ¹ / ₄
63 - 32	232	735 908 760	1	.18	3.94	3.0	2.4					2-1
63 - 40	232	735 908 759	1	.19	3.94	3.0	2.4					2-1 ¹ / ₄
63 - 50	232	735 908 758	1	.21	3.94	3.0	3.0					2-1 ¹ / ₂

BCF Eccentric Reducer

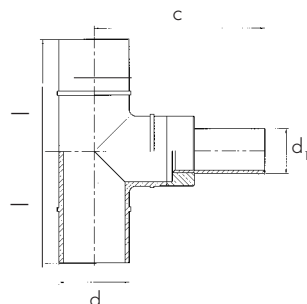


d - d ₁ mm	psi	Part Number	SP	lbs./ each	l inch	e mm	e ₁ mm					Closest inch size
25 - 20	232	735 938 737	1	.04	3.15	1.9	1.9					¹ / ₄ - ¹ / ₂
32 - 20	232	735 938 742	1	.06	3.15	2.4	1.9					1- ¹ / ₂
32 - 25	232	735 938 741	1	.06	3.15	2.4	1.9					1- ³ / ₄
40 - 20	232	735 938 748	1	.09	3.94	2.4	1.9					1 ¹ / ₄ - ¹ / ₂
40 - 25	232	735 938 747	1	.09	3.94	2.4	1.9					1 ¹ / ₄ - ³ / ₄
40 - 32	232	735 938 746	1	.11	3.94	2.4	2.4					1 ¹ / ₄ -1
50 - 32	232	735 938 753	1	.14	3.94	3.0	2.4					1 ¹ / ₂ -1
50 - 40	232	735 938 752	1	.15	3.94	3.0	2.4					1 ¹ / ₂ -1 ¹ / ₄
63 - 32	232	735 938 760	1	.18	3.94	3.0	2.4					2-1
63 - 40	232	735 938 759	1	.19	3.94	3.0	2.4					2-1 ¹ / ₄
63 - 50	232	735 938 758	1	.21	3.94	3.0	3.0					2-1 ¹ / ₂



BCF Reducing Tee

BCF x BCF/IR



BCF x BCF/IR

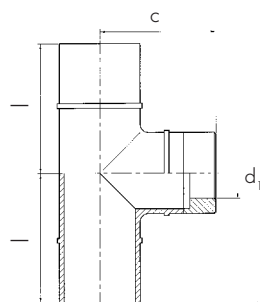
d- d ₁ mm	psi	Part Number BCF x BCF/IR	SP	lbs./ each	l inch	c inch	LT	Run closest inch size	Branch closest inch size
25 - 20	232	735 208 776X	1		2.17	4.53	10	³ / ₄	¹ / ₂
32 - 25	232	735 208 777X	1		2.17	4.69	10	1	³ / ₄
32 - 20	232	735 208 778X	1		2.17	4.69	10	1	¹ / ₂
40 - 32	232	735 208 779X	1		3.15	4.80	10	¹ / ₄	1
40 - 25	232	735 208 780X	1		3.15	4.80	10	¹ / ₄	³ / ₄
40 - 20	232	735 208 781X	1		3.15	4.80	10	¹ / ₄	¹ / ₂
50 - 40	232	735 208 782X	1		3.15	5.20	10	¹ / ₂	¹ / ₄
50 - 32	232	735 208 783X	1		3.15	5.04	10	¹ / ₂	1
50 - 25	232	735 208 784X	1		3.15	5.04	10	¹ / ₂	³ / ₄
50 - 20	232	735 208 785X	1		3.15	5.04	10	¹ / ₂	¹ / ₂
63 - 50	232	735 208 786X	1		3.15	5.71	10	2	¹ / ₂
63 - 40	232	735 208 787X	1		3.15	5.59	10	2	³ / ₄
63 - 32	232	735 208 788X	1		3.15	5.43	10	2	1
63 - 25	232	735 208 789X	1		3.15	5.43	10	2	³ / ₄
63 - 20	232	735 208 790X	1		3.15	5.43	10	2	¹ / ₂

4



BCF x Socket

factory weld, flush style

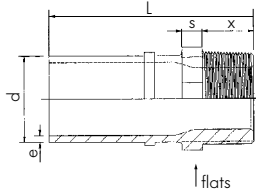


BCF x Socket

d- d ₁ mm	psi	Part Number BCF x Socket	SP	lbs./ each	l inch	c inch	LT	Run closest inch size	Branch closest inch size
25 - 20	232	735 208 776	1		2.17	2.16	10	³ / ₄	¹ / ₂
32 - 25	232	735 208 777	1		2.17	2.32	10	1	³ / ₄
32 - 20	232	735 208 778	1		2.17	2.32	10	1	¹ / ₂
40 - 32	232	735 208 779	1		3.15	2.44	10	¹ / ₄	1
40 - 25	232	735 208 780	1		3.15	2.44	10	¹ / ₄	³ / ₄
40 - 20	232	735 208 781	1		3.15	2.44	10	¹ / ₄	¹ / ₂
50 - 40	232	735 208 782	1		3.15	2.83	10	¹ / ₂	¹ / ₄
50 - 32	232	735 208 783	1		3.15	2.67	10	¹ / ₂	1
50 - 25	232	735 208 784	1		3.15	2.67	10	¹ / ₂	³ / ₄
50 - 20	232	735 208 785	1		3.15	2.67	10	¹ / ₂	¹ / ₂
63 - 50	232	735 208 786	1		3.15	3.35	10	2	¹ / ₂
63 - 40	232	735 208 787	1		3.15	3.22	10	2	³ / ₄
63 - 32	232	735 208 788	1		3.15	3.07	10	2	1
63 - 25	232	735 208 789	1		3.15	3.07	10	2	³ / ₄
63 - 20	232	735 208 790	1		3.15	3.07	10	2	¹ / ₂

BCF Threaded Male Adapter

BCF metric spigot x male pipe thread

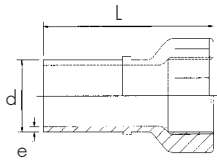


Distance across flats
(decagon)

Size mm x inch	psi	Part Number	SP	lbs./ each	d mm	e mm	L inch	Flats inch	s inch	x inch	
20 x 1/2	150	735 914 306H	1		20	1.9	2.36	0.945	0.24	0.60	
25 x 3/4	150	735 914 307H	1		25	1.9	2.36	1.13	0.24	0.60	
32 x 1	150	735 914 308H	1		32	2.4	2.52	1.38	0.24	0.76	
40 x 1 1/4	150	735 914 309H	1		40	2.4	3.38	1.64	0.35	1.02	
50 x 1 1/2	150	735 914 310H	1		50	3.0	3.53	2.01	0.35	1.17	
63 x 2	150	735 914 311H	1		63	3.0	3.60	2.53	0.35	1.23	

BCF Threaded Female Adapter

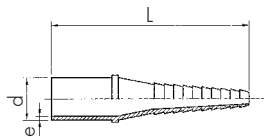
BCF metric spigot x female pipe thread



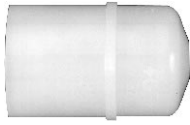
Size mm x inch	psi	Part Number	SP	lbs./ each	d mm	e mm	L inch					
20 x 1/2	150	735 914 406H	1		20	1.9	2.28					
25 x 3/4	150	735 914 407H	1		25	1.9	2.36					
32 x 1	150	735 914 408H	1		32	2.4	2.52					
40 x 1 1/4	150	735 914 409H	1		40	2.4	2.99					
50 x 1 1/2	150	735 914 410H	1		50	3.0	3.07					
63 x 2	150	735 914 411H	1		63	3.0	3.23					

BCF Hose Barb

BCF metric spigot x hose barb

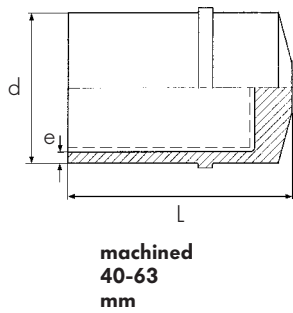
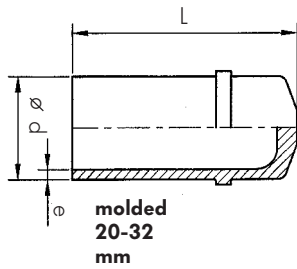


Size mm x inch	psi	Part Number	SP	lbs./ each	d mm	e mm	L inch					
20 x 1/4	150	735 992 190	1		20	1.9	3.68					



BCF Cap

(BCF or IR welded)

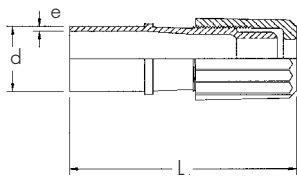


d mm size	psi	Part Number	SP	lbs./ each	e mm	L inch							Closest inch
20	150	735 991 300	1		1.9	1.85							1/2
25	150	735 991 301	1		1.9	1.87							3/4
32	150	735 991 302	1		2.4	2.05							1 1/4
40	150	735 991 654	1		2.4	2.32							1 1/2
50	150	735 991 655	1		3.0	2.52							1
63	150	735 991 656	1		3.0	2.72							2

4

BCF Flare Transition

Note: Connects to PFA tubing



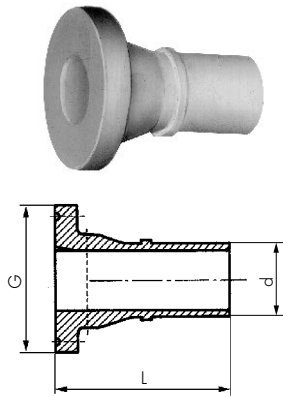
Size mm x inch	psi*	Part Number	SP	lbs./ each	d mm	e mm	L inch						
20 x 1/4		735 991 430	1	.04	20	1.9	2.92						
20 x 3/8		735 991 431	1	.04	20	1.9	3.02						
20 x 1/2		735 991 432	1	.05	20	1.9	3.10						
20 x 3/4		735 991 433	1	.09	20	1.9	3.28						
25 x 1/4		735 991 435	1	.04	25	1.9	2.92						
25 x 3/8		735 991 436	1	.05	25	1.9	3.02						
25 x 1/2		735 991 437	1	.06	25	1.9	3.10						
25 x 3/4		735 991 438	1	.10	25	1.9	3.28						
25 x 1		735 991 439	1	.10	25	1.9	3.31						
32 x 1/2		735 991 442	1	.07	32	2.4	3.45						
32 x 3/4		735 991 443	1	.11	32	2.4	3.28						
32 x 1		735 991 444	1	.18	32	2.4	3.50						

*Depending on the pressure rating of the tube size, maximum available pressure rating is 232 psi.



Flaring Tool

Size inch	Part Number	SP											
1/4	700 223 942	1											
3/8	700 223 943	1											
1/2	700 223 944	1											
3/4	700 223 945	1											
1	700 223 946	1											



BCF Sanitary Adapter Fitting*

Eccentric connection provides self-draining (connects 3A SS to PVDF)

d mm	psi	Part Number		SP	lbs./ each	G inch	L inch						SS tube size (inch)
20	232	735 598 706		1		.98	1.91						3/4
25	232	735 598 707		1		1.99	2.43						1
32	232	735 598 708		1		1.99	2.44						1 1/2
40	232	735 598 709		1		1.99	2.44						1 1/2
50	232	735 598 710		1		2.52	2.44						2
63	232	735 598 711		1		3.05	2.44						2 1/2

*Must mate with SS adapter and use special clamp, below.

Sanitary Clamp for BCF Sanitary Adapter

connects SS to PVDF Adapter



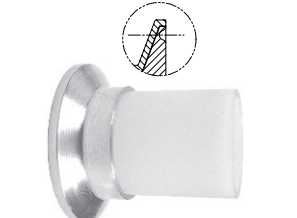
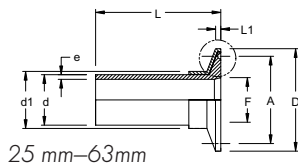
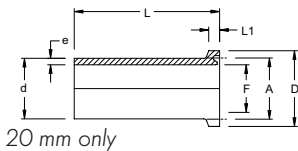
d mm		Part Number		SP									SS tube size (inch)
20		720 668 706		1									3/4
25		720 668 707		1									1
32		720 668 707		1									1 1/2
40		720 668 707		1									1 1/2
50		720 668 710		1									2
63		720 668 711		1									2 1/2

Sanitary Gasket, natural silicone

for SS to PVDF Adapter



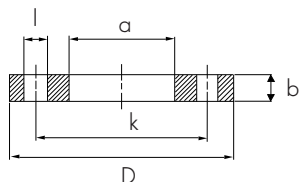
d mm		Part Number		SP									SS tube size (inch)
20		747 460 005		1									3/4
25		700 223 768		1									1
32		747 460 008		1									1 1/2
40		747 460 008		1									1 1/2
50		700 223 771		1									2
63		700 223 772		1									2 1/2



Sanitary Adapter Fittings w/ Aluminum Backing Rings For 3A Tri-Clamp Connections

d mm	psi	Part Number	D mm	d1 mm	e mm	A mm	F mm	L mm	L1 mm		SS Tube size (inch)
20*	232	735 598 706	24.9		1.9		15.7	48.5	3.6		3/4"
25	232	155 599 707	50.4	28.3	1.9	43.5	22.1	49.0	2.6		1"
32	232	155 599 708	50.4	35.3	2.4	43.5	34.8	49.0	2.6		1 1/2"
40	232	155 599 709	50.4	43.3	2.4	43.5	34.8	49.0	2.6		1 1/2"
50	232	155 599 710	63.9	53.3	3.0	56.5	47.5	49.0	2.6		2"
63	232	155 599 711	77.4	66.3	3.0	70.5	60.2	49.0	2.6		2 1/2"

* This part does not require an aluminum backing ring



Flange Ring

Material: PVDF blue coated steel. For use with all type flange adaptors.
Bolt holes drilled in accordance with ANSI B16.5, Class 150 pattern.

d mm	ANSI bolt pattern	Part Number	SP	lbs./ each	D inch	a inch	k inch	b inch	l inch	Bolt holes
20	1/2	155 701 806	1	.50	3.50	1.10	2.36	.28	.63	4
25	3/4	155 701 807	1	.75	3.86	1.34	2.76	.28	.63	4
32	1	155 701 808	1	.75	4.25	1.65	3.11	.28	.63	4
40	1 1/4	155 701 809	1	1.13	4.61	2.01	3.50	.32	.63	4
50	1 1/2	155 701 810	1	1.31	5.00	2.44	3.86	.32	.63	4
63	2	155 701 811	1	2.13	5.98	3.07	4.76	.39	.75	4

4

BCF® Fusion Joining Machine

For detailed technical information see the Section on Equipment for Fusion Joining



For a complete guide to proper installation techniques, the George Fischer factory sponsored installer certification program is recommended. It teaches a basic understanding of plastics and fusion technology. For more information, contact your George Fischer representative.

For complete technical information see the Valves Section.

SYGEF® HP BCF Valves

Diaphragm Valve Type 314, true union design, BCF, IR or spigot fusion ends



Diaphragm Valve Type 315, BCF, IR or spigot fusion ends



Zero Static Diaphragm Valve Type 319, BCF fusion ends



Pneumatically Actuated Diaphragm Valve DIASTAR



Pneumatically Actuated Diaphragm Valve DIASTAR

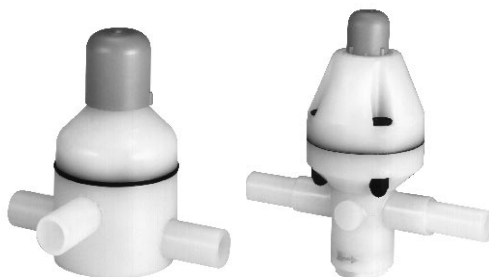


Pneumatically Actuated Zero Static Diaphragm Valve DIASTAR



For detailed technical information see the respective sections

Pressure Regulating Valves



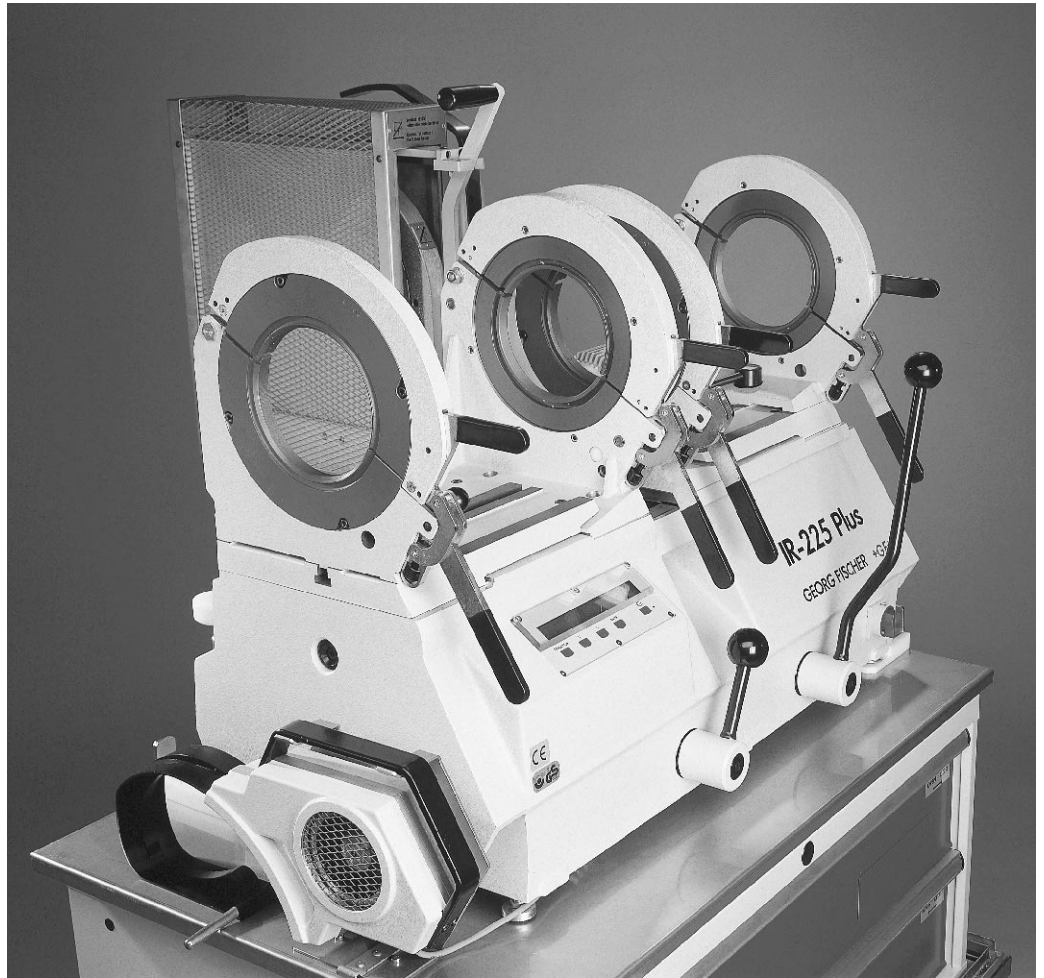
Rotameters for Ambient UPW



IR Plus™ (Infrared) Joining Technology

4

For a complete guide to proper installation techniques, the George Fischer factory sponsored installer certification program is recommended. It teaches a basic understanding of plastics and fusion technology. For more information, contact your George Fischer representative.



George Fischer's newest product line is the IR Plus™ (Infrared) joining system. The system uses IR radiant heat to fuse the components together and is used with newly designed SYGEF-PVDF (polyvinylidene fluoride) or polypropylene butt fusion fittings in 20–225 mm diameter. By using radiant heat, the pipe never touches the heating surface, thus offering the user a purer, non-contaminated end-product and also a stronger weld with a much smaller and uniform weld bead. The Infrared system virtually eliminates

the chance of error through a completely computerized program which directs the operator at each step of the joining process, including facing time, temperature, cleaning, and joining distance. The operator has only to position the pipe and fitting and follow the computer directions. Computerized temperature monitoring and heat sensing automatically produces the proper weld for each material and particular pipe size. The system can also provide a complete written document of all welding parameters for future reference.

The IR Plus™ System is the latest example of George Fischer's innovative engineering approach to solving today's tough plastic piping problems.

Specification Guide for High Purity SYGEF® HP PVDF Piping System for UPW Distribution

Part 1 General

1.1 Work Included

- A. This section provides the requirements for materials, cleaning, fabrication, and installation of high purity polyvinylidene fluoride (PVDF) piping systems that are to be used for Ultrapure Water (UPW) service.
- B. This section establishes requirements for work to be performed by the contractor in a pre-fab cleanroom whether on-site or at Contractor's site, as well as the work to be performed in the permanent facility. Work shall be performed in a dedicated area for PVDF assembly within the cleanroom isolated from UHP stainless steel fabrication work.
- C. In the event of conflict regarding requirements for PVDF piping systems between this Section and any other section, the provisions of this Section shall govern.

1.2 Quality Assurance of Materials

- A. Any deviation from the materials, packaging and inspection requirements of this section must be approved in writing by QAR (Quality Assurance Representative) or the owner.
- B. Manufacturer shall 100% visually inspect all piping components prior to packaging for cleanliness and imperfections. If any defect or contamination is discovered, the material shall be rejected.
- C. Manufacturer shall select at random a minimum of one pipe and one fitting per lot (or 10% whichever is greater) and test for interior/surface finish, dimensional tolerances, and inclusions.

- D. QAR acceptance of material shall be contingent on submitted SEM analysis confirming absence of porosity, defects, inclusions, or surface contamination and satisfactory tests as outlined above.
- E. Random samples from each lot may be selected by QAR or the owner for testing. Failure of test or inspection shall be grounds for rejection of entire lot.
- F. Results of quality assurance tests shall be stored by the supplier for a period of one year and made available to QAR or owner upon request.

1.3 Installation Training

- A. The Contractor and his field personnel shall be certified by the manufacturer for the installation of the PVDF system for Ultra Pure Water. The certification shall be current (within one year of date of issue) and each welder shall display a laminated badge identifying the individual by name, date of certification and type of fusion machine for which certification is granted.

(Specification Guide for High Purity SYGEF® HP PVDF Piping System for UPW Distribution continued)

1.4 Submittals

- A. The Ultra Pure Water Contractor shall submit the following:
 - 1. A detailed description of the Contractor pre-fabrication cleanroom whether on-site, at the Contractor's site, or both, and conformance with current Federal Specifications.
 - 2. Contractor's proposed protocol for all work to be performed by Contractor's personnel in the pre-fabrication cleanroom(s).
 - 3. Installation Quality Control and Field Quality Assurance procedures for review and approval by Facilities Engineering or QAR representative.
 - 4. Provide catalog and operating information for all equipment submitted.
 - 5. Documentation shall be submitted for the materials supplied to show their compliance with the attached Piping Specification Sheet. This shall include manufacturer's surface testing results as required in this specification.
 - 6. Contractor training plan for UPW material handling protocol for all contractor personnel involved in the installation of the UPW piping system.

Part 2 Products

2.1 General

- A. This specification is for the installation of pipe, fittings and valves required throughout the UPW system equipment and distribution system.
- B. Acceptable manufacturer of high purity pipe, valves and fittings is:
 - a) George Fischer's SYGEF HP PVDF products or other products of equal quality manufactured under similar clean room processes.

2.2 Piping, Fitting and Valves - Raw Material

- A. In general, all piping, fittings and valves shall be in accordance with these specifications and approved submittals. All materials shall be designed, fabricated and prepared for semiconductor microelectronics application.
- B. SYGEF® HP (PVDF) pipe shall be manufactured from "Kynar 740 SYGEF® natural, unpigmented, virgin polyvinylidene fluoride (PVDF) homopolymer conforming to the standards of ASTM D-3222. SYGEF® High Purity (HP) PVDF valves and SYGEF® HP PVDF fittings shall be manufactured from Solef 1008 natural, unpigmented, virgin polyvinylidene fluoride (PVDF) homopolymer conforming to the standards of ASTM D-3222. This high purity PVDF material shall have a tensile strength of 6815 psi/470 bar and a flexural strength of 11165 psi/770 bar when tested at 73°F/23°C according to ASTM D-638 and ASTM D-790. Each lot of resin shall be inspected for proper melt flow index, color, and density: melting point per ASTM D3222; vicat softening per ASTM D1525. All raw material utilized for SYGEF® HP (PVDF) production shall be specially controlled regarding procurement, shipment, handling and storage prior to production to minimize contact with extraneous contamination.
- C. PVDF resins shall be handled in a clean room environment to prevent contamination from entering resin. Resin shall be gravity fed to processing equipment. Pneumatic conveyance of resin shall be prohibited.
- D. PVDF resin shall meet the testing requirements for impurities per Sematech 92010936B.

**(Specification Guide for High Purity SYGEF® HP
PVDF Piping System for UPW Distribution continued)**

**2.3 Piping, Valves and Fittings -
Dimension and Pressure Rating**

- A. Pipe and Fitting shall be extruded or molded in a class 10,000 clean room or better as defined by the current Federal Standard. SYGEF HP (PVDF) pipe shall be a Standard Dimensions Ratio (SDR) series which defines the outer pipe diameter, wall thickness and tolerances. The pressure rating for all pipe sizes through 4" (110mm) diameter shall be 232 psi (16 bar) when measured at 68°F. The pressure rating for all pipe sizes greater than 4" (110mm) diameter shall be 150 psi at 68°F. For elevated temperature applications (65°C to 80°C) 16 bar pipe shall be used for pipe sizes greater than 4" (110mm).
- B. All PVDF diaphragm and butterfly valves shall have a minimum pressure rating of 150 psi at 68°F (10 bar at 23°C). Flanged valves shall have ANSI bolt pattern for Class 150 rating. All threaded valves connection for sample ports, instrumentation or venting shall have NPT outlets.
- C. All high purity PVDF valves in sizes through 2" (63mm) shall be Type 314/315/319 Diaphragm Valves as manufactured by George Fischer. All high purity PVDF valves in sizes 2-1/2" (75mm) through 4" (110mm) shall be George Fischer Type 317 Diaphragm Valves with flanged connections. All diaphragm valves shall be weir style with PTFE Teflon® diaphragm seals backed with EPDM or FPM.

2.4 PVDF Pipe - Manufacturing

- A. Environment:
SYGEF® HP (PVDF) pipe shall be extruded in a dedicated high purity PVDF production line which is located in a Class 10,000 Clean Room or better, as defined by the current Federal Standard, environment. All pipes shall be extruded on dedicated production equipment used exclusively for the production of high purity PVDF. Pipe dimensions and tolerances shall be continually monitored by use of ultra-sonic equipment.
- B. Stress Relieving:
Extrusion stresses shall be relieved by use of a continuous in-line annealing oven. Stress relief shall be measured and relate to a maximum 0.4% dimensional change when tested according to ISO Draft #10931-2.
- C. Pipe Identification:
SYGEF® HP (PVDF) pipe shall be identified on the pipe outer surface with the production lot, pipe diameter and wall thickness. Pipe identification shall be accomplished by use of heat embossed lettering and without the use of any ink on the pipe surface. After packaging, each pipe length shall have a label adhered to the outside of the outer polyethylene bag. The label shall denote production lot, pipe diameter, wall thickness and surface quality.

**(Specification Guide for High Purity SYGEF® HP
PVDF Piping System for UPW Distribution continued)**

- D. Surface Finish:
SYGEF HP (PVDF) pipe shall have samples taken which are measured for micropore size and mean roughness of the interior pipe surface. Samples are examined by use of scanning electron microphotography (at 3500 magnification) for detection of micropores larger than 1 micron. Any pore shall be non-fragmented at the edge and smooth shouldered. Using SEMASPEC 92010955B, SYGEF® HP (PVDF) pipe surface defects shall be: < 40 total. Using SEMASPEC 92010950B, SYGEF® HP (PVDF) pipe shall have profilometer mean roughness values, Ra, as follows:
Ra longitudinal: 0.15 micron or less
Ra diagonal: 0.20 micron or less

- E. SYGEF® HP (PVDF) pipe interior shall also be visually inspected for defects on a lighted table prior to fitting with protective polyethylene end caps and double bagged in heat sealed polyethylene liners immediately after production within the cleanroom.

- F. Pipe dimensional tolerance (mm) shall be according to the following:

Size	Tolerance	Ovality	Wall	Tolerance
20	+0.3, -0.0	0.3	1.9	+0.4, -0.0
25	+0.3, -0.0	0.4	1.9	+0.4, -0.0
32	+0.3, -0.0	0.5	2.4	+0.5, -0.0
40	+0.3, -0.0	0.5	2.4	+0.5, -0.0
50	+0.3, -0.0	0.6	3.0	+0.6, -0.0
63	+0.4, -0.0	0.8	3.0	+0.6, -0.0
75	+0.4, -0.0	0.9	3.6	+0.6, -0.0
90	+0.4, -0.0	1.1	4.3	+0.7, -0.0
110	+0.5, -0.0	1.3	5.3	+0.8, -0.0
160	+1.0, -0.0	2.0	4.9	+0.8, -0.0
200	+1.2, -0.0	2.5	6.2	+0.9, -0.0
225	+1.4, -0.0	2.7	7.0	+0.9, -0.0

} 10 bar

**2.5 PVDF Fittings and Valves -
Manufacturing**

- A. Environment:
All high purity PVDF fittings and valves shall be manufactured on dedicated equipment in Class 10,000 cleanroom environment as defined in the current Federal Standard. Any machined valve components shall be done in a Clean Room Class 10,000 environment with no coolant other than filtered air.
- B. Cleaning:
Fittings and valves (diaphragm and butterfly) shall be machined washed in a Class 100 Clean Room, as defined in the current Federal Standard, using DI water with nonionic, phosphate free surfactant solution. After cleaning, the components shall be rinsed with hot (80°C) DI water, flushed with ambient DI water 15 meg-ohm (min.) resistivity and then heat dried with HEPA filtered air or filtered nitrogen.

**(Specification Guide for High Purity SYGEF® HP
PVDF Piping System for UPW Distribution continued)**

- C. DI Water Specification for Cleaning:
DI water for cleaning shall meet or exceed the quality water listed in the following table.

Resistivity (min.)	15.0 meg-ohm/ cm @25°C
TOC	10 ppb
Particles	0.1/ml @ 0.1 micron
Bacteria	<2 cfu/1 00ml
Copper	0.1 ppb
Zinc	0.5 ppb
Nickel	0.1 ppb
Sodium	0.5 ppb
Potassium	2 ppb
Chloride	1 ppb
Nitrate	1 ppb
Phosphate	1 ppb
Sulfate	1 ppb

- D. Nitrogen Specification for Drying Components:
Nitrogen used for drying shall be clean-, dry, high purity nitrogen meeting the following requirements:

Oxygen content	< 3 ppm
Hydrogen content	< 2 ppm
CO Content	< 5 ppm
CO ₂ Content	< 1 ppm
Moisture Content	< 1 ppm
Total Hydrocarbon	< 1 ppm
Content Particles	Filtered to 0.1 micron absolute

Nonionic surfactant shall be Triton X-100 or submitted and approved equal.

- E. Fitting/Valves Packaging:
After cleaning fittings and valves shall be immediately and individually heat sealed in PA6/PE double bags while in the cleanroom. Valves shall be assembled in a Class 100 environment without the use of lubricants on any wetted surface. No external markings or labeling shall be permitted except on the outer bag. The production label shall denote production lot, dimension and logistical information.

- F. Fitting/Valves Identification:
All high purity PVDF fittings and valves shall be molded with permanent identification to allow tractability to production lot and resin batch. In addition, all high purity PVDF fitting and valves labels shall have an identification code or numbering scheme on packaging that permits traceability back to the lot and batch cleaning of fittings or valves.

- G. Fabricated Components:
Production of PVDF fabricated items are to be done under a minimum Class 10,000 Clean Room environment as defined in the current Federal Standard. Machine components made from semi-finished PVDF block and rod used in this fabrication of parts or sub-assemblies shall be inspected, cleaned and packaged similar to fittings and valves. Final inspection is made prior to packaging by 100% visual inspection of every weld. Pressure test for welded assemblies as required. Surface finish for any machined component shall be: Ra = 0.62μ or better.

**(Specification Guide for High Purity SYGEF® HP
PVDF Piping System for UPW Distribution continued)**

- H. Traceability of Machined Components:
Welding of sub-components shall only be done by manufacturers certified technicians. All factory welds shall be labeled using the manufacturers fusion machine printouts from actual welds. All finished parts and assemblies shall be heat embossed with a serial number for traceability which links incoming material, production dates, machines used and welding personnel.
- B. For ease of installation, all fusion equipment shall permit the use of remote or in-place fusion welding of all components up to 63 mm (2") diameter.
- C. Printouts or electronic storage using a PCMCIA card for weld history and fusion parameters shall be made (and retained) for every weld. Printouts are accessible through a standard parallel port interface or PCMCIA card on the IR Plus Fusion machine.

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2.6 Fusion Equipment

- A. IR Plus Fusion Equipment:
All SYGEF® HP (PVDF) Infrared Fusion Components shall be joined using the IR-63 Plus or the IR-225 Plus Infrared Fusion Machine. The infrared fusion machines shall utilize overlap distance measurement as a precise means of developing joining pressure. The joining equipment shall control the fusion process through an integrated software program which automatically compensates for ambient temperature variations and limits operator dependency. The fusion process shall produce repeatable weld profiles that can be visually inspected according to a specified Weld Inspection Program (see 2.8 Weld Inspection part A).
- D. Joining Times Using the IR Plus Fusion Equipment:
The fusion times to complete an IR Plus weld shall be based on ambient temperature conditions which reduces the overall welding process by up to 50% compared to standard IR butt fusion. Typical fusion times shall be as follows:

Size (mm)	Inch	Typical fusion time (sec.)
20	1/2	108
25	3/4	108
32	1	152
40	1 1/4	152
50	1 1/2	203
63	2	149
75	2 1/2	187
90	3	214
110	4	254
160	6	263
200	8	294
225	9	330

**(Specification Guide for High Purity SYGEF® HP
PVDF Piping System for UPW Distribution continued)**

2.7 Fusion Training and Certification

- A. SYGEF HP (PVDF) piping installation shall only be performed by factory trained and certified installers in accordance with the manufacturer's written procedures. Each installer shall complete the manufacturers Certification Course including written test examinations and submittal of fusion test welds to the manufacturer for weld evaluation. All PVDF pipe, valves and fittings shall be properly prepared in accordance with high purity standards and the manufacturer's written instructions. Each certified welder shall display at all times a permanent certification card showing name, type of fusion machine, certification number and date of certification. Installation practices, including support spacing and expansion considerations, shall be in compliance with the manufacturer's certification course and written recommendations.

2.8 Weld Inspection

- A. The manufacturers shall provide a written Weld Inspection Program to the QAR or owner that specifies minimum guidelines for IR weld acceptance. Inspection of infrared butt fusion welds shall reveal uniform double fusion beads of minimal size and proper alignment of component parts having a maximum displacement relating to 10% of the pipe wall thickness. All properly made IR fusion welds should be uniform in color with a smooth and consistent appearance indicating proper fusion temperature, heating time and joining pressure. At a minimum the following requirements shall be met:
1. Two complete weld beads for the full 360° circumference
 2. No contamination within the fusion zone
 3. A maximum of 10% component misalignment
 4. The "k" value ("k" defined as the height as measured at the center of weld bead compared to pipe wall) shall be ≥ 0 . For further criteria refer to manufacturer's Weld Inspection Program (WIP).

(Specification Guide for High Purity SYGEF® HP P
VDF Piping System for UPW Distribution continued)

Part 3 Execution

3.1 Delivery, Storage and Handling

- A. Any Material that becomes damaged and/or contaminated in transit handling or storage shall not be used. It will be rejected by the QAR representative and returned to the manufacturer/distributor.
- B. All material and equipment shall be handled and stored in an indoor location throughout the progress of the job in such a manner as to prevent damage and/or contamination. Room shall be maintained dry and dust free. Room shall be kept at a temperature between 60 and 85 degrees F.
- C. Piping, fittings, and valves shall be stored in their original factory sealed poly bags. Use nylon or polypropylene rope or soft strand for slings and tie-downs used to let, load, or transport pipe bundles. Do not stack pipe higher than 2 feet.
- D. All fabricated material shall be used within 48 hours of being removed from the storage site. All high-purity PVDF piping system components shall be inspected and approved by fabricator and installer upon arrival into the fabrication clean room and before spool fabrication begins.
- E. Fabricated spool pieces shall be supported and padded to prevent damage during transport.
- F. All pipe fitting ends of fabricated spool pieces shall be double bagged and sealed. Bags shall be secured with cap or cleanroom tape a minimum 6 inches away from pipe end. Cleanroom tape directly over pipe or fitting end is not acceptable.

SYGEF® HP (High Purity) Pipe, Valves, and Fittings for IR™ (Infrared)/Butt Fusion Joining

Marking

SYGEF system pipes and fittings are marked as follows:

- +GF+
- Pipe O.D. and nominal bore
- SYGEF®

Dimensions

All pipe sizes are given in mm or equivalent closest inch size. Subject to alteration resulting from modifications in design.

Pressure Rating

George Fischer SYGEF and SYGEF HP is a constant rated system, 232 psi (16 bar) up to 110 mm (4") and either 150 psi (10 bar) or 232 psi (16 bar) for sizes 160 mm (6") and above. The pipe wall is proportioned to pipe O.D. based on the standard dimensional rating (SDR).

List of abbreviations

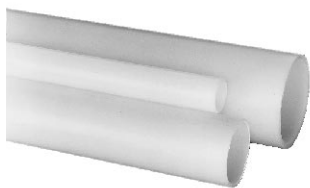
PVDF	Polyvinylidene Fluoride
®	Registered trademark
d	Pipe o. d.
lbs	Weight in pounds
e	Wall thickness, mm
z	z-dimension, inches
SP	Standard packaging

Orders

Always quote the George Fischer part number when placing orders.

Ordering Example

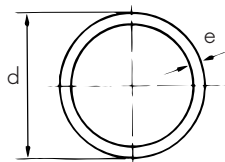
PVDF HP pipe 175 481 669
45° elbow Standard 735 158 516



SYGEF® Pipe for IR™/Butt Fusion Joining

PVDF Capped and Bagged

Supplied in 5 meter (16.4 ft.) lengths, clean, capped and bagged.



d m m	psi	Part Number			lbs./ meter	e m m					Closest inch size
20	232	175 480 203			.45	1.9					1/2
25	232	175 480 204			.60	1.9					3/4
32	232	175 480 205			.95	2.4					1
40	232	175 480 206			1.20	2.4					1 1/4
50	232	175 480 207			1.85	3.0					1 1/2
63	232	175 480 208			2.40	3.0					2
75	232	175 480 209			3.40	3.6					2 1/2
90	232	175 480 210			4.90	4.3					3
110	232	175 480 211			7.30	5.3					4

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PVDF Capped and Bagged

Supplied in 6 meter (19.7 ft.) lengths, clean, capped and bagged.

125	150	175 480 667			6.13	3.9					5
140	150	175 480 673			8.12	4.4					5 1/2
160	150	175 480 668			10.00	4.9					6
200	150	175 480 669			15.70	6.2					8
225	150	175 480 670			19.95	7.0					9
160	232	175 480 214			14.75	7.7					6
200	232	175 480 216			23.86	9.6					8
225	232	175 480 217			30.14	10.8					9

PVDF HP

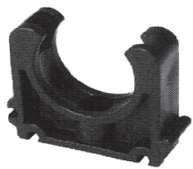
Supplied in 5 meter (16.4 ft.) lengths, clean, capped and double bagged.

d m m	psi	Part Number			lbs./ meter	e m m					Closest inch size
16	232	175 481 202			.30	1.5					3/8
20	232	175 481 203			.45	1.9					1/2
25	232	175 481 204			.60	1.9					3/4
32	232	175 481 205			.95	2.4					1
40	232	175 481 206			1.20	2.4					1 1/4
50	232	175 481 207			1.85	3.0					1 1/2
63	232	175 481 208			2.40	3.0					2
75	232	175 481 209			3.40	3.6					2 1/2
90	232	175 481 210			4.90	4.3					3
110	232	175 481 211			7.30	5.3					4

PVDF HP

Supplied in 6 meter (19.7 ft.) lengths, clean, capped and double bagged.

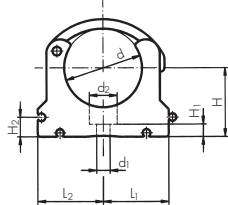
125	150	175 481 667			6.13	3.9					5
140	150	175 481 673			8.12	4.4					5 1/2
160	150	175 481 668			10.00	4.9					6
200	150	175 481 669			15.70	6.2					8
225	150	175 481 670			19.95	7.0					9
160	232	175 481 214			14.75	7.7					6
200	232	175 481 216			23.86	9.6					8
225	232	175 481 217			30.14	10.8					9



d 20 - 32 *



d 40 - 63



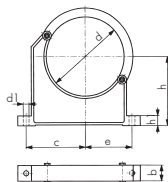
Pipe Bracket, Type 061 for mm pipes

Material: Bracket: PP Safety clip: PP

Not recommended for applications where pipe surface temperatures exceed 60°C.

d mm	Part Number	SP	d ₁ inch	d ₂ inch	L ₁ inch	L ₂ inch	h inch	h ₁ inch	h ₂ inch	b inch	screw/bolt size
16*	167 061 005	10	.22	.41	0.55	0.65	0.91	0.24	0.39	0.63	³ / ₁₆
20*	167 061 006	10	.22	.41	0.65	0.75	0.98	0.24	0.39	0.63	³ / ₁₆
25*	167 061 007	10	.22	.41	0.75	0.85	1.08	0.24	0.39	0.63	³ / ₁₆
32*	167 061 008	10	.22	.41	0.94	1.04	1.22	0.24	0.39	0.63	³ / ₁₆
40	167 061 009	10	.26	.55	1.32	1.31	1.38	0.26	0.39	0.87	¹ / ₄
50	167 061 010	10	.26	.55	1.46	1.46	1.57	0.26	0.39	0.87	¹ / ₄
63	167 061 011	10	.33	.67	1.75	1.75	2.03	0.39	0.39	0.98	⁵ / ₁₆
75	167 061 012	10	.33	.67	2.05	2.05	2.26	0.39	0.39	0.98	⁵ / ₁₆

*Without safety clip



Pipe Bracket, Type 060 for mm pipes

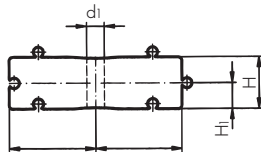
Material: Clip and safety clip PP

Minimum order quantity: Only standard packings (SP) are delivered.

Clip and safety clip are not assembled in packaging.

Technical features: Accidental opening of the safety clip is not possible.

d mm	Part Number	SP	lbs./ each	h inch	h ₁ inch	d ₁ inch	b inch	c inch	e inch	Closest inch size
90	167 060 038	10	.36	4.13	.59	.35	1.28	3.50	2.80	3
110	167 060 039	10	.39	4.53	.59	.35	1.28	3.70	3.13	4
125	167 060 040	10	.66	5.12	.79	.43	1.38	4.54	3.58	5
140	167 060 041	10	.68	5.12	.79	.43	1.38	4.74	3.84	5 1/2
160	167 060 042	10	.77	5.81	.98	.43	1.38	5.14	4.19	6
200	167 060 019	5	1.28	6.89	.98	.51	1.54	5.97	4.70	8
225	167 060 020	5	1.28	6.89	.98	.51	1.54	6.48	5.18	9



Spacer, Type 061

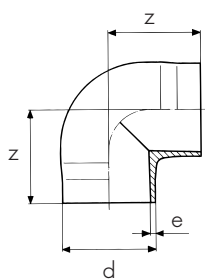
to PP pipe Bracket, Type 061

d mm	Part Number	SP	lbs./ each	d ₁ inch	L ₁ inch	L ₂ inch	H inch	H ₁ inch	b inch
16	167 061 155	10	.01	0.22	0.55	0.65	.79	.39	.63
20	167 061 156	10	.01	0.22	0.65	0.75	.79	.39	.63
25	167 061 157	10	.02	0.22	0.75	0.85	.79	.39	.63
32	167 061 158	10	.02	0.22	0.94	1.04	.79	.39	.63
40	167 061 159	10	—	0.26	1.32	1.32	.79	.39	.87
50	167 061 160	10	—	0.26	1.46	1.46	.79	.39	.87
63	167 061 161	10	.06	0.33	1.75	1.75	.79	.39	.93
75	167 061 162	10	—	0.33	2.05	2.05	.79	.39	.98

SYGEF® Fittings for IR/Butt Fusion Joining

90° Elbow

PVDF Standard



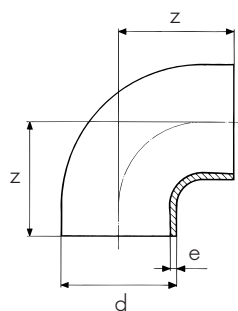
d 20 – 63 mm

d mm	psi	Part Number	SP	lbs./ each	z inch	e mm							Closest inch size
20	232	735 108 606	5	.03	1.49	1.9							1/2
25	232	735 108 607	5	.05	1.65	1.9							3/4
32	232	735 108 608	5	.09	1.81	2.4							1
40	232	735 108 609	5	.15	2.00	2.4							1 1/4
50	232	735 108 610	5	.26	2.28	3.0							1 1/2
63	232	735 108 611	5	.40	2.59	3.0							2
75	232	735 018 612	1	.50	2.95	3.6							2 1/2
90	232	735 018 613	1	.84	3.54	4.3							3
110	232	735 018 614	1	1.54	4.33	5.3							4

PVDF Standard

125	150	735 018 515	1	1.48	4.92	3.9							5
140	150	735 018 516	1	2.14	5.51	4.4							5 1/2
160	150	735 018 517	1	3.16	6.29	4.9							6
200	150	735 018 519	1	6.02	7.87	6.2							8
225	150	735 018 520	1	8.58	8.66	7.0							9
160	232	735 018 617	1	3.99	6.29	7.7							6
200	232	735 018 619	1		7.87	9.6							8
225	232	735 018 620	1		8.66	10.8							9

PVDF HP



d 75 – 225 mm

d mm	psi	Part Number	SP	lbs./ each	z inch	e mm							Closest inch size
20	232	735 108 631	1	.03	1.49	1.9							1/2
25	232	735 108 632	1	.05	1.65	1.9							3/4
32	232	735 108 633	1	.09	1.81	2.4							1
40	232	735 108 634	1	.15	2.00	2.4							1 1/4
50	232	735 108 635	1	.26	2.28	3.0							1 1/2
63	232	735 108 636	1	.40	2.59	3.0							2
75	232	735 018 637	1	.50	2.95	3.6							2 1/2
90	232	735 018 638	1	.84	3.54	4.3							3
110	232	735 018 639	1	1.54	4.33	5.3							4

PVDF HP

125	150	735 018 540	1	1.48	4.92	3.9							5
140	150	735 018 541	1	2.14	5.51	4.4							5 1/2
160	150	735 018 542	1	3.16	6.29	4.9							6
200	150	735 018 544	1	6.02	7.87	6.2							8
225	150	735 018 545	1	8.58	8.66	7.0							9
160	232	735 018 642	1	3.99	6.29	7.7							6
200	232	735 018 644	1		7.87	9.6							8
225	232	735 018 645	1		8.66	10.8							9

45° Elbow

PVDF Standard

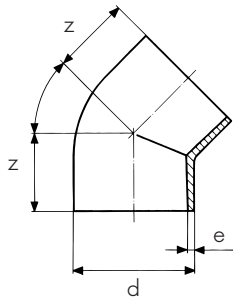
d mm	psi	Part Number		SP	lbs./ each	z inch	e mm						Closest inch size
20	232	735 158 606		5	.03	1.25	1.9						1/2
25	232	735 158 607		5	.04	1.33	1.9						3/4
32	232	735 158 608		5	.06	1.41	2.4						1
40	232	735 158 609		5	.11	1.53	2.4						1 1/4
50	232	735 158 610		5	.17	1.65	3.0						1 1/2
63	232	735 158 611		5	.25	1.85	3.0						2
75	232	735 158 612		1	.35	1.92	3.6						2 1/2
90	232	735 158 613		1	.57	2.24	4.3						3
110	232	735 158 614		1	1.05	2.75	5.3						4



PVDF Standard

125	150	735 158 515		1	1.08	3.11	3.9						5
140	150	735 158 516		1	1.50	3.46	4.4						5 1/2
160	150	735 158 517		1	2.17	3.93	4.9						6
200	150	735 158 519		1	4.26	4.88	6.2						8
225	150	735 158 520		1	6.11	5.51	7.0						9
160	232	735 158 617		1	3.24	3.93	7.7						6
200	232	735 158 619		1	6.17	4.88	9.6						8
225	232	735 158 620		1	8.82	5.51	10.8						9

PVDF HP



d mm	psi	Part Number		SP	lbs./ each	z inch	e mm						Closest inch size
20	232	735 158 631		1	.03	1.25	1.9						1/2
25	232	735 158 632		1	.04	1.33	1.9						3/4
32	232	735 158 633		1	.06	1.41	2.4						1
40	232	735 158 634		1	.11	1.53	2.4						1 1/4
50	232	735 158 635		1	.17	1.65	3.0						1 1/2
63	232	735 158 636		1	.26	1.85	3.0						2
75	232	735 158 637		1	.35	1.92	3.6						2 1/2
90	232	735 158 638		1	.57	2.24	4.3						3
110	232	735 158 639		1	1.05	2.75	5.3						4

PVDF HP

125	150	735 158 540		1	1.08	3.11	3.9						5
140	150	735 158 541		1	1.50	3.46	4.4						5 1/2
160	150	735 158 542		1	2.17	3.93	4.9						6
200	150	735 158 544		1	4.26	4.88	6.2						8
225	150	735 158 545		1	6.11	5.51	7.0						9
160	232	735 158 642		1	3.24	3.93	7.7						6
200	232	735 158 644		1	6.17	4.88	9.6						8
225	232	735 158 645		1	8.82	5.51	10.8						9

Tee

PVDF Standard

d mm	psi	Part Number	SP	lbs./ ea.	z inch	e mm							Closest inch size
20	232	735 208 606	5	.05	1.49	1.9							1/2
25	232	735 208 607	5	.06	1.65	1.9							3/4
32	232	735 208 608	5	.11	1.81	2.4							1
40	232	735 208 609	5	.19	2.00	2.4							1 1/4
50	232	735 208 610	5	.34	2.28	3.0							1 1/2
63	232	735 208 611	5	.51	2.59	3.0							2
75	232	735 208 612	1	.81	2.95	3.6							2 1/2
90	232	735 208 613	1	1.45	3.54	4.3							3
110	232	735 208 614	1	2.66	4.33	5.3							4

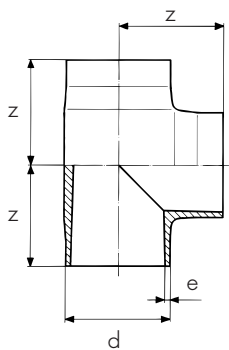
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PVDF Standard

125	150	735 208 515	1	2.82	4.92	3.9							5
140	150	735 208 516	1	3.92	5.51	4.4							5 1/2
160	150	735 208 517	1	5.65	6.29	4.9							6
200	150	735 208 519	1	11.29	7.87	6.2							8
225	150	735 208 520	1	15.95	8.66	7.0							9
160	232	735 208 617	1	7.72	6.29	7.7							6
200	232	735 208 619	1	16.54	7.87	9.6							8
225	232	735 208 620	1	23.37	8.66	10.8							9

PVDF HP



d mm	psi	Part Number	SP	lbs./ ea.	z inch	e mm							Closest inch size
20	232	735 208 631	1	.05	1.49	1.9							1/2
25	232	735 208 632	1	.06	1.65	1.9							3/4
32	232	735 208 633	1	.11	1.81	2.4							1
40	232	735 208 634	1	.19	2.00	2.4							1 1/4
50	232	735 208 635	1	.34	2.28	3.0							1 1/2
63	232	735 208 636	1	.51	2.59	3.0							2
75	232	735 208 637	1	.81	2.95	3.6							2 1/2
90	232	735 208 638	1	1.45	3.54	4.3							3
110	232	735 208 639	1	2.66	4.33	5.3							4

PVDF HP

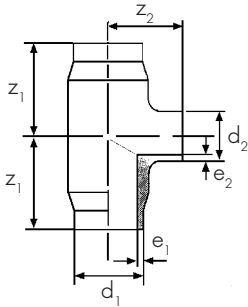
125	150	735 208 540	1	2.82	4.92	3.9							5
140	150	735 208 541	1	3.92	5.51	4.4							5 1/2
160	150	735 208 542	1	5.65	6.29	4.9							6
200	150	735 208 544	1	11.29	7.87	6.2							8
225	150	735 208 545	1	15.95	8.66	7.0							9
160	232	735 208 642	1	7.72	6.29	7.7							6
200	232	735 208 644	1	16.54	7.87	9.6							8
225	232	735 208 645	1	23.37	8.66	10.8							9

Please refer to the SYGEF HP BCF® section for

- Union Blanks
- Flare Fittings
- Caps
- Sanitary Adapters
- Male Adapters
- Female Adapters

Reducer Tee (molded)

PVDF Standard



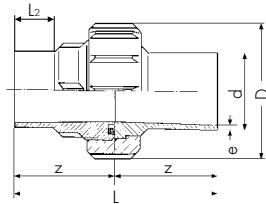
d ₁ - d ₂ mm	psi	Part Number		SP	lbs./ ea.	z ₁ inch	z ₂ inch	e ₁ mm	e ₂ mm				Closest inch size
160-110	150	735 208 561		1	4.98	6.10	5.12	4.9	5.3				6 x 4
160-90	150	735 208 562		1	4.85	6.10	5.12	4.9	4.3				6 x 3
225-110	150	735 208 569		1	9.26	6.10	6.30	7.0	5.3				9 x 4
225-90	150	735 208 570		1	9.04	6.10	6.30	7.0	4.3				9 x 3
160-110	232	735 208 661		1	7.28	6.10	5.12	7.7	5.3				6 x 4
160-90	232	735 208 662		1	7.06	6.10	5.12	7.7	4.3				6 x 3
225-110	232	735 208 669		1	13.45	6.10	6.30	10.8	5.3				9 x 4
225-90	232	735 208 670		1	13.23	6.10	6.30	10.8	4.3				9 x 3

PVDF HP

d ₁ - d ₂ mm	psi	Part Number		SP	lbs./ ea.	z ₁ inch	z ₂ inch	e ₁ mm	e ₂ mm				Closest inch size
160-110	150	735 208 586		1	4.98	6.10	5.12	4.9	5.3				6 x 4
160-90	150	735 208 587		1	4.85	6.10	5.12	4.9	4.3				6 x 3
225-110	150	735 208 594		1	9.26	6.10	6.30	7.0	5.3				9 x 4
225-90	150	735 208 595		1	9.04	6.10	6.30	7.0	4.3				9 x 3
160-110	232	735 208 686		1	7.28	6.10	5.12	7.7	5.3				6 x 4
160-90	232	735 208 687		1	7.06	6.10	5.12	7.7	4.3				6 x 3
225-110	232	735 208 694		1	13.45	6.10	6.30	10.8	5.3				9 x 4
225-90	232	735 208 695		1	13.23	6.10	6.30	10.8	4.3				9 x 3

Union

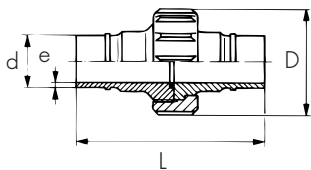
PVDF Standard



d mm	psi	Part Number FPM O-ring		SP	lbs./ each	D inch	L inch	z inch	e mm	L ₂ inch			Closest inch size
20	232	735 528 606		1	.18	1.78	4.21	2.11	1.9	.98			1/2
25	232	735 528 607		1	.58	2.17	4.45	2.22	1.9	.98			3/4
32	232	735 528 608		1	.81	2.44	4.69	2.34	2.4	.98			1
40	232	735 528 609		1	1.30	2.95	4.96	2.48	2.4	.98			1 1/4
50	232	735 528 610		1	1.79	3.29	5.16	2.58	3.0	.98			1 1/2
63	232	735 528 611		1	2.87	3.98	5.39	2.70	3.0	.98			2

PVDF BCF HP (with white FPM O-ring) (different sizes than Standard Union)

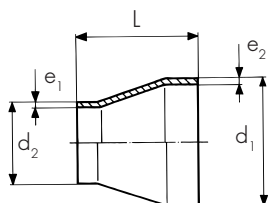
Note: May be IR welded.



d mm	psi	Part Number FPM O-ring		SP	lbs./ each	D inch	L inch	e mm					Closest inch size
20	232	735 518 706		1	.14	1.78	5.37	1.9					1/2
25	232	735 518 707		1	.28	2.17	5.35	1.9					3/4
32	232	735 518 708		1	.40	2.44	5.43	2.4					1
40	232	735 518 709		1	.64	2.95	6.93	2.4					1 1/4
50	232	735 518 710		1	.81	3.29	7.01	3.0					1 1/2
63	232	735 518 711		1	1.41	3.98	7.37	3.0					2

Reducer

PVDF Standard



d ₁ -d ₂ mm	psi	Part Number	SP	lbs./ each	L inch	e ₁ mm	e ₂ mm						Closest inch size
25-20	232	735 908 637	1	.02	1.96	1.9	1.9						³ / ₄ x ¹ / ₂
32-25	232	735 908 641	1	.04	1.96	2.4	1.9						1 x ³ / ₄
32-20	232	735 908 642	1	.03	1.96	2.4	1.9						1 x ¹ / ₂
40-32	232	735 908 646	1	.06	2.16	2.4	2.4						¹ / ₄ x 1
40-25	232	735 908 647	1	.05	2.16	2.4	1.9						¹ / ₄ x ³ / ₄
40-20	232	735 908 648	1	.04	2.16	2.4	1.9						¹ / ₄ x ¹ / ₂
50-40	232	735 908 652	1	.08	2.36	3.0	2.4						¹ / ₂ x ¹ / ₄
50-32	232	735 908 653	1	.08	2.36	3.0	2.4						¹ / ₂ x 1
50-25	232	735 908 654	1	.07	2.36	3.0	1.9						¹ / ₂ x ³ / ₄
63-50	232	735 908 658	1	.13	2.55	3.0	3.0						2 x ¹ / ₂
63-40	232	735 908 659	1	.11	2.55	3.0	2.4						2 x ¹ / ₄
63-32	232	735 908 660	1	.11	2.55	3.0	2.4						2 x 1
75-63	232	735 908 664	1	.18	2.55	3.6	3.0						² / ₂ x 2
75-50	232	735 908 665	1	.17	2.55	3.6	3.0						² / ₂ x ¹ / ₂
75-40	232	735 908 666	1	.15	2.68	3.6	2.4						² / ₂ x ¹ / ₄
90-75	232	735 908 670	1	.27	2.95	4.3	3.6						3 x ² / ₂
90-63	232	735 908 671	1	.26	2.95	4.3	3.0						3 x 2
110-90	232	735 908 676	1	.51	3.54	5.3	4.3						4 x 3
110-75	232	735 908 677	1	.47	3.54	5.3	3.6						4 x ² / ₂

4

PVDF Standard

125-110	150	735 908 580	1	0.51	3.94	3.9	5.3						5 x 4
140-125	150	735 908 584	1	0.70	4.33	4.4	3.9						⁵ / ₂ x 5
140-110	150	735 908 585	1	0.68	4.33	4.4	5.3						⁵ / ₂ x 4
160-140	150	735 908 588	1	0.99	4.72	4.9	4.4						6 x ⁵ / ₂
160-110	150	735 908 590	1	0.88	4.72	4.9	5.3						6 x 4
200-160	150	735 908 592	1	1.82	5.70	6.2	4.9						8 x 6
225-110	150	735 908 595	1	2.06	6.29	7.0	5.3						9 x 4
225-160	150	735 908 596	1	2.50	6.29	7.0	4.9						9 x 6
225-200	150	735 908 597	1	2.64	6.29	7.0	6.2						9 x 8
160-110	232	735 908 690	1	1.43	4.72	7.7	5.3						6 x 4
200-160	232	735 908 692	1	2.95	5.70	9.6	7.7						8 x 6
225-160	232	735 908 696	1	3.81	6.29	10.8	7.7						9 x 6
225-200	232	735 908 697	1	4.37	6.29	10.8	9.6						9 x 8

Union Components – PVDF (BCF ends not available as components)

IR/Butt Fusion End Connectors

d mm	psi	Part Number
20		735 608 606
25		735 608 607
32		735 608 608
40		735 608 609
50		735 608 610
63		735 608 611

O-Rings FPM for standard unions

d mm	Part Number	Dash #
20	749 410 006	-211
25	749 410 007	-216
32	749 410 008	-219
40	749 410 009	-326
50	749 410 010	-328
63	749 410 011	-332

Union Nuts

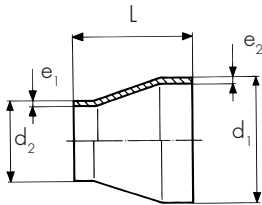
d mm	psi	Part Number
20		735 690 406
25		735 690 407
32		735 690 408
40		735 690 409
50		735 690 410
63		735 690 411

O-Rings FPM for BCF unions (white)

d mm	Part Number	Dash #
20	749 411 005	-114
25	749 411 006	-211
32	749 411 120	-215
40	749 411 062	-220
50	749 411 172	-224
63	749 411 054	(4 x 55 mm)

Reducer

PVDF HP



d ₁ -d ₂ mm	psi	Part Number	SP	lbs./ each	L inch	e ₁ mm	e ₂ mm					Closest inch size
25-20	232	735 908 600	1	.02	1.96	1.9	1.9					³ / ₄ x ¹ / ₂
32-25	232	735 908 601	1	.04	1.96	2.4	1.9					1 x ³ / ₄
32-20	232	735 908 602	1	.03	1.96	2.4	1.9					1 x ¹ / ₂
40-32	232	735 908 603	1	.06	2.16	2.4	2.4					1 ¹ / ₄ x 1
40-25	232	735 908 604	1	.05	2.16	2.4	1.9					1 ¹ / ₄ x ³ / ₄
40-20	232	735 908 605	1	.04	2.16	2.4	1.9					1 ¹ / ₄ x ¹ / ₂
50-40	232	735 908 606	1	.08	2.36	3.0	2.4					1 ¹ / ₂ x 1 ¹ / ₄
50-32	232	735 908 607	1	.08	2.36	3.0	2.4					1 ¹ / ₂ x 1
50-25	232	735 908 608	1	.07	2.36	3.0	1.9					1 ¹ / ₂ x ³ / ₄
63-50	232	735 908 609	1	.13	2.55	3.0	3.0					2 x 1 ¹ / ₂
63-40	232	735 908 610	1	.11	2.55	3.0	2.4					2 x 1 ¹ / ₄
63-32	232	735 908 611	1	.11	2.55	3.0	2.4					2 x 1
75-63	232	735 908 612	1	.18	2.55	3.6	3.0					2 ¹ / ₂ x 2
75-50	232	735 908 613	1	.17	2.55	3.6	3.0					2 ¹ / ₂ x 1 ¹ / ₂
75-40	232	735 908 614	1	.15	2.68	3.6	2.4					2 ¹ / ₂ x 1 ¹ / ₄
90-75	232	735 908 615	1	.29	2.95	4.3	3.6					3 x 2 ¹ / ₂
90-63	232	735 908 616	1	.26	2.95	4.3	3.0					3 x 2
110-90	232	735 908 617	1	.51	3.54	5.3	4.3					4 x 3
110-75	232	735 908 618	1	.47	3.54	5.3	3.6					4 x 2 ¹ / ₂

PVDF HP

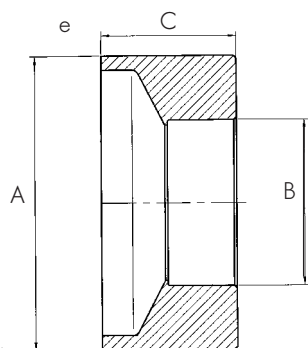
125-110	150	735 908 500	1	0.51	3.94	3.9	5.3					5 x 4
140-125	150	735 908 501	1	0.70	4.33	4.4	3.9					5 ¹ / ₂ x 5
140-110	150	735 908 502	1	0.68	4.33	4.4	5.3					5 ¹ / ₂ x 4
160-140	150	735 908 503	1	0.99	4.72	4.9	4.4					6 x 5 ¹ / ₂
160-110	150	735 908 504	1	0.88	4.72	4.9	5.3					6 x 4
200-160	150	735 908 505	1	1.82	5.70	6.2	4.9					8 x 6
225-110	150	735 908 506	1	2.06	6.29	7.0	4.3					9 x 4
225-160	150	735 908 507	1	2.50	6.29	7.0	4.9					9 x 6
225-200	150	735 908 508	1	2.64	6.29	7.0	6.2					9 x 8
160-110	232	735 908 623	1	1.43	4.72	7.7	5.3					6 x 4
200-160	232	735 908 624	1	2.95	5.70	9.6	7.7					8 x 6
225-160	232	735 908 626	1	3.81	6.29	10.8	7.7					9 x 6
225-200	232	735 908 627	1	4.37	6.29	10.8	9.6					9 x 8

Flush Style Reducer

PVDF HP

Butt Fusion x Socket Fusion*

*also available with threaded outlet for instrumentation (see page 4.69)

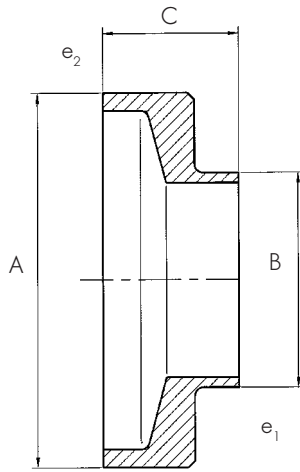


d mm	psi	Part Number	SP	A mm	B mm	C inch	e mm	LT	Closest inch size
75-20	232	735 991 510	1	75	20	1.54	3.6	20	2 1/2-1/2
75-25	232	735 991 511	1	75	25	1.54	3.6	20	2 1/2-3/4
75-32	232	735 991 512	1	75	32	1.54	3.6	20	2 1/2-1
75-40	232	735 991 513	1	75	40	1.54	3.6	20	2 1/2-1 1/4
75-50	232	735 991 514	1	75	50	1.54	3.6	20	2 1/2-1 1/2
75-63	232	735 991 515	1	75	63	1.61	3.6	20	2 1/2-2
90-20	232	735 991 124	1	90	20	1.54	4.3	20	3-1/2
90-25	232	735 991 125	1	90	25	1.54	4.3	20	3-3/4
90-32	232	735 991 126	1	90	32	1.61	4.3	10	3-1
90-40	232	735 991 127	1	90	40	1.61	4.3	10	3-1 1/4
90-50	232	735 991 128	1	90	50	1.97	4.3	10	3-1 1/2
90-63	232	735 991 129	1	90	63	1.97	4.3	10	3-2
90-75	232	735 991 130	1	90	75	1.97	4.3	20	3-2 1/2
110-20	232	735 991 131	1	110	20	1.54	5.3	20	4-1/2
110-25	232	735 991 132	1	110	25	1.54	5.3	20	4-3/4
110-32	232	735 991 133	1	110	32	1.61	5.3	10	4-1
110-40	232	735 991 134	1	110	40	1.61	5.3	10	4-1 1/4
110-50	232	735 991 135	1	110	50	1.97	5.3	10	4-1 1/2
110-63	232	735 991 136	1	110	63	1.97	5.3	10	4-2
110-75	232	735 991 137	1	110	75	1.97	5.3	20	4-2 1/2
110-90	232	735 991 138	1	110	90	1.97	5.3	10	4-3
160-20	150	735 991 520	1	160	20	1.97	4.9	20	6-1/2
160-25	150	735 991 521	1	160	25	1.97	4.9	20	6-3/4
160-32	150	735 991 522	1	160	32	1.97	4.9	10	6-1
160-40	150	735 991 523	1	160	40	1.97	4.9	20	6-1 1/4
160-50	150	735 991 139	1	160	50	1.97	4.9	10	6-1 1/2
160-63	150	735 991 140	1	160	63	1.97	4.9	10	6-2
160-75	150	735 991 141	1	160	75	1.97	4.9	20	6-2 1/2
160-90	150	735 991 142	1	160	90	1.97	4.9	10	6-3
160-110	150	735 991 143	1	160	110	2.36	4.9	20	6-4
200-20	150	735 991 525	1	200	20	1.97	6.2	20	8-1/2
200-25	150	735 991 526	1	200	25	1.97	6.2	20	8-3/4
200-32	150	735 991 527	1	200	32	1.97	6.2	20	8-1
200-40	150	735 991 528	1	200	40	1.97	6.2	20	8-1 1/4
200-50	150	735 991 529	1	200	50	1.97	6.2	20	8-1 1/2
200-63	150	735 991 530	1	200	63	1.97	6.2	20	8-2
200-75	150	735 991 531	1	200	75	1.97	6.2	20	8-2 1/2
200-90	150	735 991 532	1	200	90	1.97	6.2	20	8-3
200-110	150	735 991 533	1	200	110	2.36	6.2	20	8-4
225-20	150	735 991 536	1	225	20	1.97	7.0	20	9-1/2
225-25	150	735 991 537	1	225	25	1.97	7.0	20	9-3/4
225-32	150	735 991 538	1	225	32	1.97	7.0	10	9-1
225-40	150	735 991 539	1	225	40	1.97	7.0	20	9-1 1/4
225-50	150	735 991 144	1	225	50	1.97	7.0	10	9-1 1/2
225-63	150	735 991 145	1	225	63	1.97	7.0	10	9-2
225-75	150	735 991 146	1	225	75	1.97	7.0	20	9-2 1/2
225-90	150	735 991 147	1	225	90	1.97	7.0	10	9-3
225-110	150	735 991 148	1	225	110	2.36	7.0	10	9-4

Flush Style Reducer

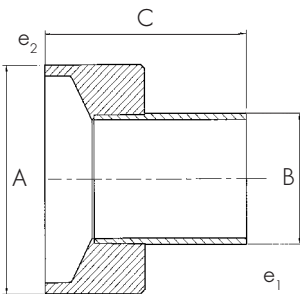
PVDF HP

Butt fusion x butt fusion (shaded) or butt fusion x butt fusion/BCF (not shaded)



butt fusion x butt fusion

Style 1 (shaded)



butt fusion x butt fusion BCF

Style 2 (not shaded)

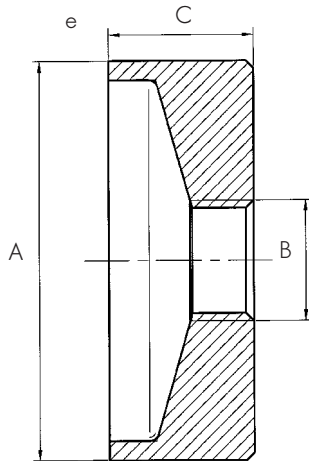
Note: Larger dimension (d160 to d225mm) fitting area are available with PN16 (232 psi) wall thickness.

d mm	psi	Part Number		SP	A mm	B mm	C inch	e ₂ mm	e ₁ mm		LT	Closest inch size
50-20	232	735 991 561		1	50	20	1.42	3	1.9		20	1 1/2-1/2
50-25	232	735 991 562		1	50	25	1.42	3	1.9		20	1 1/2-3/4
50-32	232	735 991 563		1	50	32	1.57	3	2.4		20	1 1/2-1
50-40	232	735 991 564		1	50	40	1.57	3	2.4		20	1 1/2-1 1/4
63-20	232	735 991 556		1	63	20	1.42	3	1.9		20	2-1/2
63-25	232	735 991 557		1	63	25	1.42	3	1.9		20	2-3/4
63-32	232	735 991 558		1	63	32	1.57	3	2.4		20	2-1
63-40	232	735 991 559		1	63	40	1.57	3	2.4		20	2-1 1/4
63-50	232	735 991 764		1	63	50	1.42	3	3.0		20	2-1 1/2
75-20	232	735 991 550		1	75	20	3.90	3.6	1.9		20	2 1/2-1/2
75-25	232	735 991 551		1	75	25	3.90	3.6	1.9		20	2 1/2-3/4
75-32	232	735 991 552		1	75	32	3.90	3.6	2.4		20	2 1/2-1
75-40	232	735 991 553		1	75	40	3.90	3.6	2.4		20	2 1/2-1 1/4
75-50	232	735 991 554		1	75	50	3.90	3.6	3.0		20	2 1/2-1 1/2
75-63	232	735 991 555		1	75	63	3.98	3.6	3.0		20	2 1/2-2
90-20	232	735 991 181		1	90	20	3.90	4.3	1.9		20	3-1/2
90-25	232	735 991 182		1	90	25	3.90	4.3	1.9		20	3-3/4
90-32	232	735 991 152		1	90	32	3.98	4.3	2.4		5	3-1
90-40	232	735 991 153		1	90	40	3.98	4.3	2.4		20	3-1 1/4
90-50	232	735 991 154		1	90	50	4.33	4.3	3.0		5	3-1 1/2
90-63	232	735 991 155		1	90	63	1.57	4.3	3.0		5	3-2
90-75	232	735 991 156		1	90	75	1.57	4.3	3.6		20	3-2 1/2
110-20	232	735 991 184		1	110	20	3.90	5.3	1.9		20	4-1/2
110-25	232	735 991 185		1	110	25	3.90	5.3	1.9		20	4-3/4
110-32	232	735 991 159		1	110	32	3.98	5.3	2.4		5	4-1
110-40	232	735 991 160		1	110	40	3.98	5.3	2.4		20	4-1 1/4
110-50	232	735 991 161		1	110	50	4.33	5.3	3.0		5	4-1 1/2
110-63	232	735 991 162		1	110	63	1.57	5.3	3.0		5	4-2
110-75	232	735 991 163		1	110	75	1.57	5.3	3.6		20	4-2 1/2
110-90	232	735 991 164		1	110	90	1.57	5.3	4.3		5	4-3
160-20	150	735 991 187		1	160	20	4.33	4.9	1.9		20	6-1/2
160-25	150	735 991 188		1	160	25	4.33	4.9	1.9		20	6-3/4
160-32	150	735 991 189		1	160	32	4.33	4.9	2.4		5	6-1
160-40	150	735 991 190		1	160	40	4.33	4.9	2.4		20	6-1 1/4
160-50	150	735 991 191		1	160	50	4.33	4.9	3.0		5	6-1 1/2
160-63	150	735 991 167		1	160	63	1.97	4.9	3.0		5	6-2
160-75	150	735 991 168		1	160	75	1.97	4.9	3.6		20	6-2 1/2
160-90	150	735 991 169		1	160	90	1.97	4.9	4.3		5	6-3
160-110	150	735 991 170		1	160	110	1.97	4.9	5.3		5	6-4
200-20	150	735 991 740		1	200	20	4.33	6.2	1.9		20	8-1/2
200-25	150	735 991 741		1	200	25	4.33	6.2	1.9		20	8-3/4
200-32	150	735 991 742		1	200	32	4.33	6.2	2.4		20	8-1
200-40	150	735 991 743		1	200	40	4.33	6.2	2.4		20	8-1 1/4
200-50	150	735 991 744		1	200	50	4.33	6.2	3.0		10	8-1 1/2
200-63	150	735 991 570		1	200	63	1.97	6.2	3.0		20	8-2
200-75	150	735 991 571		1	200	75	1.97	6.2	3.6		20	8-2 1/2
200-90	150	735 991 572		1	200	90	1.97	6.2	4.3		20	8-3
200-110	150	735 991 573		1	200	110	1.97	6.2	5.3		20	8-4
200-160	150	735 991 574		1	200	160	1.97	6.2	4.9		20	8-6
225-20	150	735 991 193		1	225	20	4.33	7.0	1.9		20	9-1/2
225-25	150	735 991 194		1	225	25	4.33	7.0	1.9		20	9-3/4
225-32	150	735 991 195		1	225	32	4.33	7.0	2.4		20	9-1
225-40	150	735 991 196		1	225	40	4.33	7.0	2.4		20	9-1 1/4
225-50	150	735 991 197		1	225	50	4.33	7.0	3.0		10	9-1 1/2
225-63	150	735 991 198		1	225	63	1.97	7.0	3.0		10	9-2
225-75	150	735 991 199		1	225	75	1.97	7.0	3.6		20	9-2 1/2
225-90	150	735 991 177		1	225	90	1.97	7.0	4.3		5	9-3
225-110	150	735 991 178		1	225	110	1.97	7.0	5.3		5	9-4
225-160	150	735 991 179		1	225	160	1.97	7.0	4.9		5	9-6
225-200	150	735 991 180		1	225	200	1.97	7.0	6.2		10	9-8

Flush Style Reducer

PVDF HP

Butt fusion x thread (NPT)



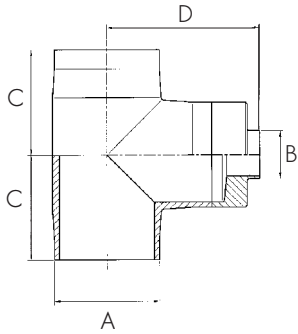
Note: Larger dimension (d160 to d225mm) fitting area are available with PN16 (232 psi) wall thickness.

d mm x inch	psi	Part Number	SP	A mm	B inch NPT	C inch	e mm	LT
20-1/4	150	735 991 450	1	20	1/4	.788	1.9	20
20-3/8	150	735 991 451	1	20	3/8	.788	1.9	20
25-1/4	150	735 991 455	1	25	1/4	.788	1.9	20
25-3/8	150	735 991 456	1	25	3/8	.788	1.9	20
25-1/2	150	735 991 457	1	25	1/2	.788	1.9	20
32-1/4	150	735 991 460	1	32	1/4	.788	2.4	20
32-3/8	150	735 991 461	1	32	3/8	.788	2.4	20
32-1/2	150	735 991 462	1	32	1/2	.788	2.4	20
32-3/4	150	735 991 463	1	32	3/4	.788	2.4	20
40-1/4	150	735 991 465	1	40	1/4	.788	2.4	20
40-3/8	150	735 991 466	1	40	3/8	.788	2.4	20
40-1/2	150	735 991 467	1	40	1/2	.788	2.4	20
40-3/4	150	735 991 468	1	40	3/4	.788	2.4	20
40-1	150	735 991 469	1	40	1	.788	2.4	20
50-1/4	150	735 991 475	1	50	1/4	.788	3.0	20
50-3/8	150	735 991 476	1	50	3/8	.788	3.0	20
50-1/2	150	735 991 477	1	50	1/2	.788	3.0	20
50-3/4	150	735 991 478	1	50	3/4	.788	3.0	20
50-1	150	735 991 479	1	50	1	.788	3.0	20
63-1/4	150	735 991 482	1	63	1/4	.788	3.0	20
63-3/8	150	735 991 483	1	63	3/8	.788	3.0	20
63-1/2	150	735 991 484	1	63	1/2	.788	3.0	20
63-3/4	150	735 991 485	1	63	3/4	.788	3.0	20
63-1	150	735 991 486	1	63	1	.788	3.0	20
75-1/4	150	735 991 490	1	75	1/4	1.57	3.6	20
75-3/8	150	735 991 491	1	75	3/8	1.57	3.6	20
75-1/2	150	735 991 492	1	75	1/2	1.57	3.6	20
75-3/4	150	735 991 493	1	75	3/4	1.57	3.6	20
75-1	150	735 991 494	1	75	1	1.57	3.6	20
90-1/4	150	735 991 103	1	90	1/4	1.57	4.3	20
90-3/8	150	735 991 104	1	90	3/8	1.57	4.3	20
90-1/2	150	735 991 105	1	90	1/2	1.57	4.3	20
90-3/4	150	735 991 106	1	90	3/4	1.57	4.3	20
90-1	150	735 991 107	1	90	1	1.57	4.3	20
110-1/4	150	735 991 108	1	110	1/4	1.57	5.3	20
110-3/8	150	735 991 109	1	110	3/8	1.57	5.3	20
110-1/2	150	735 991 110	1	110	1/2	1.57	5.3	20
110-3/4	150	735 991 111	1	110	3/4	1.57	5.3	20
110-1	150	735 991 112	1	110	1	1.57	5.3	20
160-1/4	150	735 991 113	1	160	1/4	1.57	4.9	20
160-3/8	150	735 991 114	1	160	3/8	1.57	4.9	20
160-1/2	150	735 991 115	1	160	1/2	1.57	4.9	20
160-3/4	150	735 991 116	1	160	3/4	1.57	4.9	20
160-1	150	735 991 117	1	160	1	1.57	4.9	20
200-1/4	150	735 991 501	1	200	1/4	1.57	6.2	20
200-3/8	150	735 991 502	1	200	3/8	1.57	6.2	20
200-1/2	150	735 991 503	1	200	1/2	1.57	6.2	20
200-3/4	150	735 991 504	1	200	3/4	1.57	6.2	20
200-1	150	735 991 505	1	200	1	1.57	6.2	20
225-1/4	150	735 991 118	1	225	1/4	1.57	7.0	20
225-3/8	150	735 991 119	1	225	3/8	1.57	7.0	20
225-1/2	150	735 991 120	1	225	1/2	1.57	7.0	20
225-3/4	150	735 991 121	1	225	3/4	1.57	7.0	20
225-1	150	735 991 122	1	225	1	1.57	7.0	20

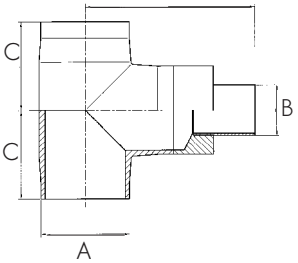
Reducing Tee

PVDF HP

Butt fusion x butt fusion (shaded); Butt fusion x butt fusion/BCF (not shaded)



Style 1 (shaded)



Style 2 (not shaded)

Note: Larger dimension (d160 to d225mm) fitting area are available with PN16 (232 psi) wall thickness.

d mm	psi	Part Number		SP	A mm	B mm	C inch	D inch		LT	Closest inch size
50-20	232	735 991 591		1	50	20	2.28	3.50		20	1 ¹ / ₂ -1 ¹ / ₂
50-25	232	735 991 592		1	50	25	2.28	3.50		10	1 ¹ / ₂ -3 ³ / ₄
50-32	232	735 991 593		1	50	32	2.28	3.66		10	1 ¹ / ₂ -1
50-40	232	735 991 594		1	50	40	2.28	3.66		20	1 ¹ / ₂ -1 ¹ / ₄
63-20	232	735 991 597		1	63	20	2.60	3.82		10	2-1 ¹ / ₂
63-25	232	735 991 598		1	63	25	2.60	3.82		10	2-3 ³ / ₄
63-32	232	735 991 599		1	63	32	2.60	3.98		10	2-1
63-40	232	735 991 600		1	63	40	2.60	3.98		20	2-1 ¹ / ₄
63-50	232	735 991 601		1	63	50	2.60	3.98		10	2-1 ¹ / ₂
75-20	232	735 991 603		1	75	20	2.95	6.65		20	2 ¹ / ₂ -1 ¹ / ₂
75-25	232	735 991 604		1	75	25	2.95	6.65		20	2 ¹ / ₂ -3 ³ / ₄
75-32	232	735 991 605		1	75	32	2.95	6.65		20	2 ¹ / ₂ -1
75-40	232	735 991 606		1	75	40	2.95	6.65		20	2 ¹ / ₂ -1 ¹ / ₄
75-50	232	735 991 607		1	75	50	2.95	6.73		10	2 ¹ / ₂ -1 ¹ / ₂
75-63	232	735 991 608		1	75	63	2.95	4.33		10	2 ¹ / ₂ -2
90-20	232	735 991 008		1	90	20	3.54	7.24		20	3-1 ¹ / ₂
90-25	232	735 991 009		1	90	25	3.54	7.24		20	3-3 ³ / ₄
90-32	232	735 991 010		1	90	32	3.54	7.32		10	3-1
90-40	232	735 991 011		1	90	40	3.54	7.32		20	3-1 ¹ / ₄
90-50	232	735 991 012		1	90	50	3.54	7.68		10	3-1 ¹ / ₂
90-63	232	735 991 013		1	90	63	3.54	4.92		10	3-2
90-75	232	735 991 014		1	90	75	3.54	4.92		20	3-2 ¹ / ₂
110-20	232	735 991 015		1	110	20	4.33	8.03		20	4-1 ¹ / ₂
110-25	232	735 991 016		1	110	25	4.33	8.03		20	4-3 ³ / ₄
110-32	232	735 991 017		1	110	32	4.33	8.11		10	4-1
110-40	232	735 991 018		1	110	40	4.33	8.11		20	4-1 ¹ / ₄
110-50	232	735 991 019		1	110	50	4.33	8.46		10	4-1 ¹ / ₂
110-63	232	735 991 020		1	110	63	4.33	5.71		10	4-2
110-75	232	735 991 021		1	110	75	4.33	5.71		20	4-2 ¹ / ₂
110-90	232	735 991 022		1	110	90	4.33	5.71		10	4-3
160-20	150	735 991 024		1	160	20	6.30	10.43		20	6-1 ¹ / ₂
160-25	150	735 991 025		1	160	25	6.30	10.43		20	6-3 ³ / ₄
160-32	150	735 991 026		1	160	32	6.30	10.43		10	6-1
160-40	150	735 991 027		1	160	40	6.30	10.43		20	6-1 ¹ / ₄
160-50	150	735 991 028		1	160	50	6.30	10.43		10	6-1 ¹ / ₂
160-63	150	735 991 029		1	160	63	6.30	8.07		10	6-2
160-75	150	735 991 030		1	160	75	6.30	8.07		20	6-2 ¹ / ₂
200-20	150	735 991 610		1	200	20	7.87	12.01		20	8-1 ¹ / ₂
200-25	150	735 991 611		1	200	25	7.87	12.01		20	8-3 ³ / ₄
200-32	150	735 991 612		1	200	32	7.87	12.01		20	8-1
200-40	150	735 991 613		1	200	40	7.87	12.01		20	8-1 ¹ / ₄
200-50	150	735 991 614		1	200	50	7.87	12.01		10	8-1 ¹ / ₂
200-63	150	735 991 615		1	200	63	7.87	9.65		10	8-2
200-75	150	735 991 616		1	200	75	7.87	9.65		20	8-2 ¹ / ₂
200-90	150	735 991 617		1	200	90	7.87	9.65		10	8-3
200-110	150	735 991 618		1	200	110	7.87	9.65		10	8-4
200-160	150	735 991 620		1	200	160	7.87	9.65		10	8-6
225-20	150	735 991 044		1	225	20	8.66	12.80		20	9-1 ¹ / ₂
225-25	150	735 991 043		1	225	25	8.66	12.80		20	9-3 ³ / ₄
225-32	150	735 991 033		1	225	32	8.66	12.80		20	9-1
225-40	150	735 991 034		1	225	40	8.66	12.80		20	9-1 ¹ / ₄
225-50	150	735 991 035		1	225	50	8.66	12.80		10	9-1 ¹ / ₂
225-63	150	735 991 036		1	225	63	8.66	10.43		10	9-2
225-75	150	735 991 037		1	225	75	8.66	10.43		20	9-2 ¹ / ₂
225-160	150	735 991 040		1	225	160	8.66	10.43		10	9-6
225-200	150	735 991 042		1	225	200	8.66	10.43		20	9-8

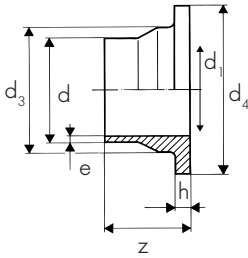
Flange Adaptor** with serrated joining face

Note: Flange Rings are found on page 4.73

PVDF Standard

d mm	psi	Part Number		SP	lbs./each	z inch	e mm	d ₃ inch	d ₄ inch	h inch	d ₁ inch		Closest inch size
20	232	735 798 606		1	.06	1.97	1.9	1.02	1.75	.24	.67		1/2
25	232	735 798 657		1	.10	1.97	1.9	1.26	2.13	.28	.87		3/4
32	232	735 798 658		1	.14	2.13	2.4	1.57	2.48	.28	1.10		1
40	232	735 798 659		1	.21	2.17	2.4	1.93	2.87	.31	1.42		1 1/4
50	232	735 798 660		1	.28	2.44	3.0	2.36	3.23	.31	1.77		1 1/2
63	232	735 798 611		1	.38	2.48	3.0	2.95	4.02	.35	2.28		2
75	232	735 798 802		1	.57	3.15	3.6	3.50	4.78	.39	2.56		2 1/2
90	232	735 798 653		1	1.04	3.15	4.3	4.13	5.24	.43	3.07		3
110	232	735 798 604		1	1.38	3.15	5.3	4.92	6.22	.47	3.78		4

4



PVDF Standard

125	150	735 798 565		1	1.15	3.23	3.9	5.20	6.22	.55	4.49		5
140	150	735 798 566		1	1.74	3.50	4.4	6.10	7.40	.59	5.00		5 1/2
160	150	735 798 567		1	2.15	3.62	4.9	6.89	8.35	.63	5.75		6
200	150	735 798 569		1	4.92	3.94	6.2	9.13	10.55	.71	7.20		8
225	150	735 798 570		1	4.07	3.94	7.0	9.25	10.55	.79	8.15		9
160	232	735 798 617		1	2.43	3.62	7.7	6.89	8.35	.63	5.51		6
200	232	735 798 619		1	4.08	3.94	9.6	9.13	10.55	.71	6.97		8
225	232	735 798 620		1	4.51	3.94	10.8	9.25	10.55	.79	7.83		9

PVDF HP

d mm	psi	Part Number		SP	lbs./each	z inch	e mm	d ₃ inch	d ₄ inch	h inch	d ₁ inch		Closest inch size
20	232	735 798 631		1	.06	1.97	1.9	1.02	1.75	.24	.67		1/2
25	232	735 798 682		1	.10	1.97	1.9	1.26	2.13	.28	.87		3/4
32	232	735 798 683		1	.14	2.13	2.4	1.57	2.48	.28	1.10		1
40	232	735 798 684		1	.21	2.17	2.4	1.93	2.87	.31	1.42		1 1/4
50	232	735 798 685		1	.28	2.44	3.0	2.36	3.23	.31	1.77		1 1/2
63	232	735 798 636		1	.38	2.48	3.0	2.95	4.02	.35	2.28		2
75	232	735 798 827		1	.57	3.15	3.6	3.50	4.78	.39	2.56		2 1/2
90	232	735 798 678		1	1.04	3.15	4.3	4.13	5.24	.43	3.07		3
110	232	735 798 629		1	1.38	3.15	5.3	4.92	6.22	.47	3.78		4

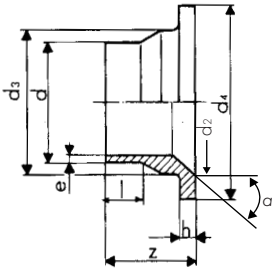
PVDF HP

125	150	735 798 590		1	1.15	3.23	3.9	5.20	6.22	.55	4.49		5
140	150	735 798 591		1	1.74	3.50	4.4	6.10	7.40	.59	5.00		5 1/2
160	150	735 798 592		1	2.15	3.62	4.9	6.89	8.35	.63	5.75		6
200	150	735 798 594		1	4.92	3.94	6.2	9.13	10.55	.71	7.20		8
225	150	735 798 595		1	4.07	3.94	7.0	9.25	10.55	.79	8.15		9
160	232	735 798 642		1	2.43	3.62	7.7	6.89	8.35	.63	5.51		6
200	232	735 798 644		1	4.08	3.94	9.6	9.13	10.55	.71	6.97		8
225	232	735 798 645		1	4.51	3.94	10.8	9.25	10.55	.79	7.83		9

****NOTE:** See "Special Flange Adaptors" (next page) for connection to butterfly valves.

Special Flange Adaptor, with serrated face

Suitable for most Butterfly Valves. No post machining required.



PVDF Standard

d mm	psi	Part Number		SP	lbs./ each	z inch	e mm	d ₃ inch	d ₄ inch	h inch	d ₂ inch	angle α	Closest inch size
110	232	735 798 814		1	1.39	3.15	5.3	4.92	6.22	0.47	3.94	30°	4
160	232	735 798 817		1	2.65	3.62	7.7	6.89	8.35	0.63	6.02	20°	6
200	232	735 798 819		1	4.19	3.94	9.6	9.13	10.55	0.71	8.03	20°	8
225	232	735 798 820		1	4.41	3.94	10.8	9.25	10.55	0.79	8.15	20°	9
160	150	735 798 867		1	2.20	3.62	4.9	6.89	8.35	0.63	6.02	20°	6
200	150	735 798 869		1	3.75	3.94	6.2	9.13	10.55	0.71	8.03	20°	8

PVDF HP

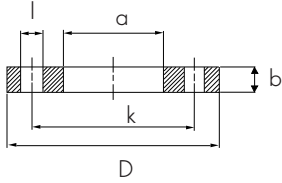
110	232	735 798 839		1	1.39	3.15	5.3	4.92	6.22	0.47	3.94	30°	4
160	232	735 798 842		1	2.65	3.62	7.7	6.89	8.35	0.63	6.02	20°	6
200	232	735 798 844		1	4.19	3.94	9.6	9.13	10.55	0.71	8.03	20°	8
225	232	735 798 845		1	4.41	3.94	10.8	9.25	10.55	0.79	8.15	20°	9
160	150	735 798 892		1	2.20	3.62	4.9	6.89	8.35	0.63	6.02	20°	6
200	150	735 798 894		1	3.75	3.94	6.2	9.13	10.55	0.71	8.03	20°	8

Note: Please consult butterfly valve manufacturer to ensure flange adaptor clearance with maximum chordal dimension of valve.

Flange Ring

Material: Galvanized steel. For use with all type flange adapters.

Bolt holes drilled in accordance with ANSI B16.5, Class 150 pattern.



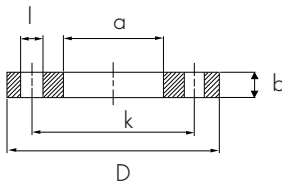
d mm	ANSI bolt pattern	Part Number	SP	lbs./ each	D inch	a inch	k inch	b inch	l inch	Bolt holes
20	1/2	724 701 806	1	.50	3.50	1.10	.236	.28	.63	4
25	3/4	724 701 807	1	.75	3.86	1.34	.276	.28	.63	4
32	1	724 701 808	1	.75	4.25	1.65	.311	.28	.63	4
40	1 1/4	724 701 809	1	1.13	4.61	2.01	.350	.32	.63	4
50	1 1/2	724 701 810	1	1.31	5.00	2.44	.386	.32	.63	4
63	2	724 701 811	1	2.13	5.98	3.07	.476	.39	.75	4
75	2 1/2	724 701 812	1	2.94	7.01	3.62	.551	.39	.75	4
90	3	724 701 813	1	3.19	7.48	4.33	.598	.39	.75	4
110	4	724 703 814	1	4.56	9.02	5.24	.748	.39	.75	8
140	5	724 701 916	1		10.00	6.22	.850	.50	.88	8
160	6	724 701 917	1	7.34	10.98	7.05	.948	.50	.88	8
200	8	724 701 919	1	13.12	13.50	9.30	11.73	.63	.88	8
225	8	724 701 920	1	12.64	13.50	9.42	11.73	.63	.88	8

Use 4" ring with 125mm flange adapter

Flange Ring

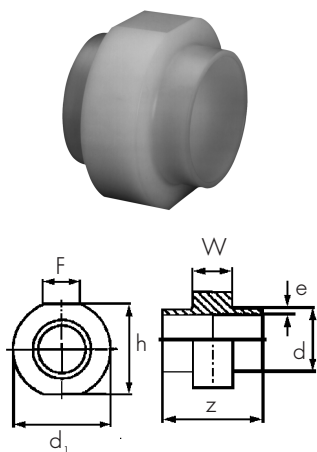
Material: PVDF coated steel. For use with socket fusion type flange adapters.

Bolt holes drilled in accordance with ANSI B16.5, Class 150 pattern.



d mm	ANSI bolt pattern	Part Number	SP	lbs./ each	D inch	a inch	k inch	b inch	l inch	Bolt holes
20	1/2	155 701 806	1	.50	3.50	1.10	.236	.28	.63	4
25	3/4	155 701 807	1	.75	3.86	1.34	.276	.28	.63	4
32	1	155 701 808	1	.75	4.25	1.65	.311	.28	.63	4
40	1 1/4	155 701 809	1	1.13	4.61	2.01	.350	.32	.63	4
50	1 1/2	155 701 810	1	1.31	5.00	2.44	.386	.32	.63	4
63	2	155 701 811	1	2.13	5.98	3.07	.476	.39	.75	4
75	2 1/2	155 701 812	1	2.94	7.01	3.62	.551	.39	.75	4
90	3	155 701 813	1	3.19	7.48	4.33	.598	.39	.75	4
110	4	155 703 814	1	4.56	9.02	5.24	.748	.39	.75	8
140	5	155 701 916	1		10.00	6.22	.850	.50	.88	8
160	6	155 701 917	1	7.34	10.98	7.05	.948	.50	.88	8
200	8	155 701 919	1	13.12	13.50	9.30	11.73	.63	.88	8
225	8	155 701 920	1	12.64	13.50	9.42	11.73	.63	.88	8

Use 4" ring with 125mm flange adapter



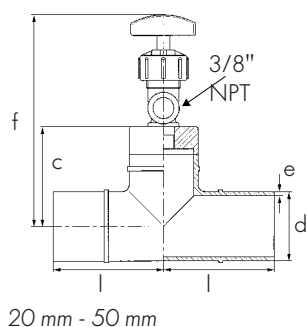
Sampling Port Fitting, IR spigot ends

Designed to accommodate insertion of sensors, probes, etc.

d mm	psi	Part Number		SP	lbs./each	W inch	F inch	z inch	e mm	d1 inch	h inch	LT	Closest size
63	232	735 918 611		1	1.09	1.57	1.57	3.94	3.0	4.13	3.82	5	2
75	232	735 918 612		1	1.21	1.57	1.57	3.54	3.6	4.53	4.25	5	2 1/2
90	232	735 918 613		1	1.43	1.57	1.57	3.54	4.3	5.04	4.76	5	3
110	232	735 918 614		1	1.72	1.57	1.57	3.54	5.3	5.71	5.47	5	4
160	150	735 918 567		1	2.54	1.57	1.57	4.33	4.9	7.64	7.48	5	6
200	150	735 918 569		1	3.27	1.57	1.57	4.33	6.2	9.09	8.98	5	8
225	150	735 918 570		1	6.94	1.57	1.57	4.33	7.0	10.00	9.88	5	9

Note:

- Hole needs to be milled, HAND HELD DRILLING MUST NOT BE DONE.
- Specify at time of ordering if factory is to mill hole (max. hole diameter is 3/4")



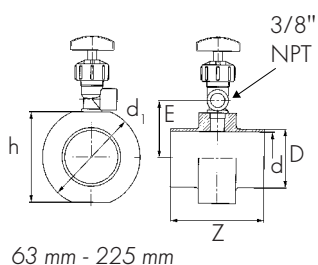
Pressure Gauge Assembly

PVDF HP

d mm	psi	Part Number		SP	lbs./each	d mm	l inch	e mm	c inch	f inch		LT	Closest inch size
20	200	735 991 401		1		20	2.17	1.9	2.40	5.51		10	1/2
25	200	735 991 402		1		25	2.17	1.9	2.40	5.51		10	3/4
32	200	735 991 403		1		32	2.17	2.4	2.40	5.91		10	1
40	200	735 991 404		1		40	3.15	2.4	2.48	5.91		10	1 1/4
50	200	735 991 405		1		50	3.15	3.0	2.83	6.30		10	1 1/2

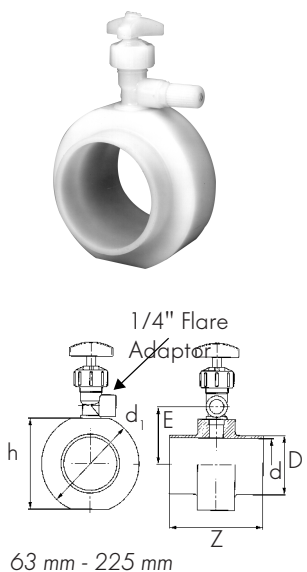
PVDF HP

d mm	psi	Part Number		SP	lbs./each	d mm	d1 mm	D mm	h inch	Z inch	E inch	LT	Closest inch size
63	200	735 991 406		1		57.0	105.0	63.0	3.82	3.94	2.42	10	2
75	200	735 991 407		1		67.8	115.0	75.0	4.25	3.54	2.64	20	2 1/2
90	200	735 991 408		1		81.4	128.0	90.0	4.76	3.54	2.89	10	3
110	200	735 991 409		1		99.4	145.0	110.0	5.47	3.54	3.25	10	4
160	150	735 991 412		1		150.2	194.0	160.0	7.48	4.33	4.25	10	6
225	150	735 991 413		1		211.0	254.0	225.0	9.88	4.33	5.45	10	8

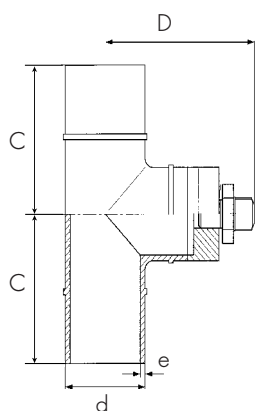


with 1/4" Flare Adapter

d mm	psi	Part Number		SP	lbs./each	d mm	d1 mm	D mm	h inch	Z inch	E inch	LT	Closest inch size
63	200	735 991 406F		1		57.0	105.0	63.0	3.82	3.94	2.42	10	2
75	200	735 991 407F		1		67.8	115.0	75.0	4.25	3.54	2.64	20	2 1/2
90	200	735 991 408F		1		81.4	128.0	90.0	4.76	3.54	2.89	10	3
110	200	735 991 409F		1		99.4	145.0	110.0	5.47	3.54	3.25	10	4
160	150	735 991 412F		1		150.2	194.0	160.0	7.48	4.33	4.25	10	6
225	150	735 991 413F		1		211.0	254.0	225.0	9.88	4.33	5.45	10	8



NPT Tee Fitting



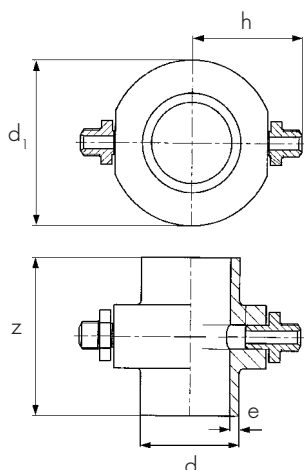
PVDF HP

d mm x inch	psi	Part Number	SP	LT	d mm	e mm	C inch	D inch	Closest inch size
20 x $\frac{3}{8}$	232	735 991 667	1	20	20	1.9	2.17	3.50	$\frac{1}{2}$ x $\frac{3}{8}$
25 x $\frac{3}{8}$	232	735 991 668	1	20	25	1.9	2.17	3.50	$\frac{3}{4}$ x $\frac{3}{8}$
32 x $\frac{3}{8}$	232	735 991 669	1	20	32	2.4	2.17	3.50	1 x $\frac{3}{8}$
40 x $\frac{3}{8}$	232	735 991 670	1	20	40	2.4	3.15	4.49	$1\frac{1}{4}$ x $\frac{3}{8}$
50 x $\frac{3}{8}$	232	735 991 671	1	20	50	3.0	3.15	4.49	$1\frac{1}{2}$ x $\frac{3}{8}$
63 x $\frac{3}{8}$	232	735 991 672	1	20	63	3.0	3.15	5.67	2 x $\frac{3}{8}$
20 x $\frac{1}{2}$	232	735 991 674	1	20	20	1.9	2.17	3.86	$\frac{1}{2}$ x $\frac{1}{2}$
25 x $\frac{1}{2}$	232	735 991 675	1	20	25	1.9	2.17	3.86	$\frac{3}{4}$ x $\frac{1}{2}$
32 x $\frac{1}{2}$	232	735 991 676	1	20	32	2.4	2.17	3.86	1 x $\frac{1}{2}$
40 x $\frac{1}{2}$	232	735 991 677	1	20	40	2.4	3.15	4.84	$1\frac{1}{4}$ x $\frac{1}{2}$
50 x $\frac{1}{2}$	232	735 991 678	1	20	50	3.0	3.15	4.84	$1\frac{1}{2}$ x $\frac{1}{2}$
63 x $\frac{1}{2}$	232	735 991 679	1	20	63	3.0	3.15	4.84	2 x $\frac{1}{2}$

4

Dual NPT Instrument Fitting

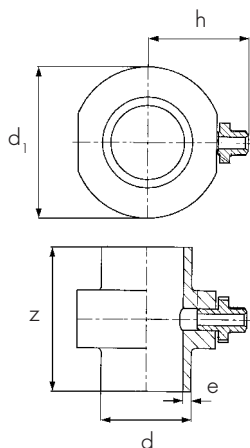
PVDF HP



d mm x inch	psi	Part Number	SP	LT	d mm	e mm	d ₁ inch	z inch	h inch	Closest inch size
63 x $\frac{3}{8}$ x $\frac{3}{8}$	232	735 991 689	1	20	63	3.0	4.13	3.94	2.78	2 x $\frac{3}{8}$ x $\frac{3}{8}$
75 x $\frac{3}{8}$ x $\frac{3}{8}$	232	735 991 690	1	20	75	3.6	4.53	3.54	2.99	$2\frac{1}{2}$ x $\frac{3}{8}$ x $\frac{3}{8}$
90 x $\frac{3}{8}$ x $\frac{3}{8}$	232	735 991 691	1	20	90	4.3	5.04	3.54	3.25	3 x $\frac{3}{8}$ x $\frac{3}{8}$
110 x $\frac{3}{8}$ x $\frac{3}{8}$	232	735 991 692	1	20	110	5.3	5.71	3.54	3.60	4 x $\frac{3}{8}$ x $\frac{3}{8}$
160 x $\frac{3}{8}$ x $\frac{3}{8}$	150	735 991 695	1	20	160	4.9	7.64	4.33	4.61	6 x $\frac{3}{8}$ x $\frac{3}{8}$
225 x $\frac{3}{8}$ x $\frac{3}{8}$	150	735 991 697	1	20	225	7.0	10.0	4.33	5.81	9 x $\frac{3}{8}$ x $\frac{3}{8}$
63 x $\frac{3}{8}$ x $\frac{1}{2}$	232	735 991 698	1	20	63	3.0	4.13	3.94		2 x $\frac{3}{8}$ x $\frac{1}{2}$
75 x $\frac{3}{8}$ x $\frac{1}{2}$	232	735 991 699	1	20	75	3.6	4.53	3.54		$2\frac{1}{2}$ x $\frac{3}{8}$ x $\frac{1}{2}$
90 x $\frac{3}{8}$ x $\frac{1}{2}$	232	735 991 700	1	20	90	4.3	5.04	3.54		3 x $\frac{3}{8}$ x $\frac{1}{2}$
110 x $\frac{3}{8}$ x $\frac{1}{2}$	232	735 991 701	1	20	110	5.3	5.71	3.54		4 x $\frac{3}{8}$ x $\frac{1}{2}$
160 x $\frac{3}{8}$ x $\frac{1}{2}$	150	735 991 704	1	20	160	4.9	7.64	4.33		6 x $\frac{3}{8}$ x $\frac{1}{2}$
225 x $\frac{3}{8}$ x $\frac{1}{2}$	150	735 991 706	1	20	225	7.0	10.0	4.33		9 x $\frac{3}{8}$ x $\frac{1}{2}$
63 x $\frac{1}{2}$ x $\frac{1}{2}$	232	735 991 716	1	20	63	3.0	4.13	3.94	3.01	2 x $\frac{1}{2}$ x $\frac{1}{2}$
75 x $\frac{1}{2}$ x $\frac{1}{2}$	232	735 991 717	1	20	75	3.6	4.53	3.54	3.23	$2\frac{1}{2}$ x $\frac{1}{2}$ x $\frac{1}{2}$
90 x $\frac{1}{2}$ x $\frac{1}{2}$	232	735 991 718	1	20	90	4.3	5.04	3.54	3.48	3 x $\frac{1}{2}$ x $\frac{1}{2}$
110 x $\frac{1}{2}$ x $\frac{1}{2}$	232	735 991 719	1	20	110	5.3	5.71	3.54	3.84	4 x $\frac{1}{2}$ x $\frac{1}{2}$
160 x $\frac{1}{2}$ x $\frac{1}{2}$	150	735 991 722	1	20	160	4.9	7.64	4.33	4.84	6 x $\frac{1}{2}$ x $\frac{1}{2}$
225 x $\frac{1}{2}$ x $\frac{1}{2}$	150	735 991 724	1	20	225	7.0	10.0	4.33	6.04	9 x $\frac{1}{2}$ x $\frac{1}{2}$

NPT Instrument Fitting

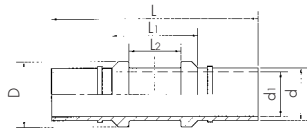
PVDF HP



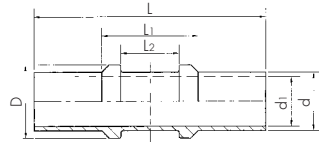
d mm x inch	psi	Part Number	SP	LT	d mm	e mm	d ₁ inch	z inch	h inch	Closest inch size
63 x $\frac{3}{8}$	232	735 991 680	1	20	63	3.0	4.13	3.94	2.78	2 x $\frac{3}{8}$
75 x $\frac{3}{8}$	232	735 991 681	1	20	75	3.6	4.53	3.54	2.99	$2\frac{1}{2}$ x $\frac{3}{8}$
90 x $\frac{3}{8}$	232	735 991 682	1	20	90	4.3	5.04	3.54	3.25	3 x $\frac{3}{8}$
110 x $\frac{3}{8}$	232	735 991 683	1	20	110	5.3	5.71	3.54	3.60	4 x $\frac{3}{8}$
160 x $\frac{3}{8}$	150	735 991 686	1	20	160	4.9	7.64	4.33	4.61	6 x $\frac{3}{8}$
225 x $\frac{3}{8}$	150	735 991 688	1	20	225	7.0	10.0	4.33	5.81	9 x $\frac{3}{8}$
63 x $\frac{1}{2}$	232	735 991 707	1	20	63	3.0	4.13	3.94	3.01	2 x $\frac{1}{2}$
75 x $\frac{1}{2}$	232	735 991 708	1	20	75	3.6	4.53	3.54	3.23	$2\frac{1}{2}$ x $\frac{1}{2}$
90 x $\frac{1}{2}$	232	735 991 709	1	20	90	4.3	5.04	3.54	3.48	3 x $\frac{1}{2}$
110 x $\frac{1}{2}$	232	735 991 710	1	20	110	5.3	5.71	3.54	3.84	4 x $\frac{1}{2}$
160 x $\frac{1}{2}$	150	735 991 713	1	20	160	4.9	7.64	4.33	4.84	6 x $\frac{1}{2}$
225 x $\frac{1}{2}$	150	735 991 715	1	20	225	7.0	10.0	4.33	6.04	9 x $\frac{1}{2}$

Restraint Fitting

PVDF HP



20 mm - 63 mm (BCF)

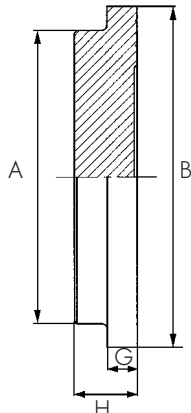


75 mm - 110 mm (IR)

d mm	psi	Part Number		SP	lbs./ each	d ₁ mm	D inch	L inch	L ₁ inch	L ₂ inch		LT	Closest inch size
20	232	735 918 656		1		16.2	1.10	5.00	2.09	1.26		20	1/2
25	232	735 918 657		1		21.2	1.30	5.00	2.09	1.26		20	3/4
32	232	735 918 658		1		27.2	1.57	5.00	2.09	1.26		20	1
40	232	735 918 659		1		35.2	1.89	5.71	2.09	1.26		20	1 1/4
50	232	735 918 660		1		44.0	2.28	5.71	2.09	1.26		20	1 1/2
63	232	735 918 661		1		57.0	2.80	5.71	2.09	1.26		20	2
75	232	735 918 662		1		67.8	3.43	5.12	2.76	1.57		20	2 1/2
90	232	735 918 663		1		81.4	4.13	5.12	2.55	1.57		20	3
110	232	735 918 664		1		99.4	5.00	5.12	2.76	1.57		20	4

Blind Flange

PVDF HP



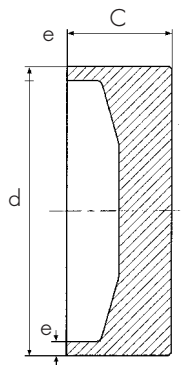
*Requires Backing Ring.
See page 45.

d mm	ANSI bolt pattern	psi	Part Number		SP	lbs./ each	A mm	B mm	G inch	H inch	LT	
20	1/2	232	735 991 362		1		26.5	34.0	.24	.67	5	
25	3/4	232	735 991 363		1		32.5	40.5	.28	.67	5	
32	1	232	735 991 364		1		40.4	49.8	.28	.67	5	
40	1 1/4	232	735 991 365		1		49.3	60.4	.31	.83	5	
50	1 1/2	232	735 991 366		1		60.3	72.2	.31	.83	5	
63	2	232	735 991 367		1		75.0	89.2	.35	.83	5	
75	2 1/2	232	735 991 368		1		90.0	106.0	.39	.87	5	
90	3	232	735 991 369		1		107.5	125.0	.43	.91	5	
110	4	232	735 991 370		1		130.7	150.0	.47	.94	5	
160	6	150	735 991 372		1		175.0	212.0	.63	1.18	5	
200/225	8	150	735 991 373		1		235.0	268.0	.79	1.57	5	

PVDF HP IR Cap

Note: for smaller dimensions see BCF Cap on page 4.45.

PVDF HP



d mm	psi	Part Number		SP	lbs./ each	C inch	e mm					LT	Closest inch size
75	232	735 991 657		1		1.57	3.6					5	2 1/2
90	232	735 991 658		1		1.57	4.3					5	3
110	232	735 991 659		1		1.57	5.3					5	4
160	150	735 991 661		1		1.97	4.9					5	6
200	150	735 991 662		1		1.97	6.2					5	8
225	150	735 991 663		1		1.97	7.0					5	9

For complete technical information see the Valves Section.

SYGEF® Valves for IR/Butt Fusion Joining

Diaphragm Valve Type 314, true union design, IR/butt fusion ends



Diaphragm Valve Type 315, IR/butt fusion ends



Zero Static Diaphragm Valve Type 319, IR/butt fusion ends



Diaphragm Valve Type 317, flanged, class 150 ANSI bolt pattern



Ball Valve Type 346, true union design, IR/butt fusion ends



3-way Ball Valve Type 343, horizontal, IR/butt fusion ends



Ball Check Valve Type 360, true union design, IR/butt fusion ends



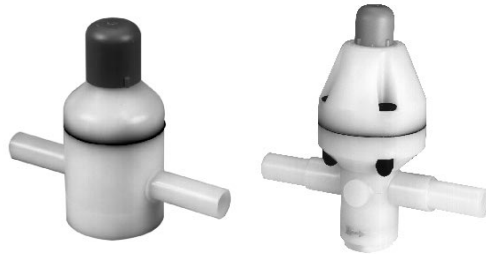
Butterfly Valve Type 367, wafer style for ANSI B16.5 class 150 flanges



For complete technical information see the Pressure Regulating Valves Section.

SYGEF® Pressure Regulating Valves for IR/Butt Fusion Joining

Pressure Reducing Valve Type V82 and Type V782



Pressure Relief Valve Type V85



Pressure Retaining Valve Type V86 and Type V786



For complete technical information see the Rotameters Section.

Rotameters for IR/Butt Fusion Joining



For complete technical information see the Actuated Valves Section.

Electrically and Pneumatically Actuated Valves for IR/Butt Fusion Joining

Type 113 Electrically Actuated Ball Valve



Type 346 ball valve with Type EA 20 actuator (also available as 3-way).

Type 222 Pneumatically Actuated Ball Valve



Type 346 ball valve with Type PA 10/PA 20 actuator (also available as 3-way).

4

Type 035 Electrically Actuated Butterfly Valve



Type 367 butterfly valve with Type EA 30/EA 41/EA 50 actuator.

Type 036 Pneumatically Actuated Butterfly Valve



Type 367 butterfly valve with Type PA 40/50/60/70 actuator.

Pneumatically Actuated Diaphragm Valve DIASTAR



Pneumatically Actuated Zero Static Diaphragm Valve DIASTAR



Pneumatically Actuated Diaphragm Valve Type 018

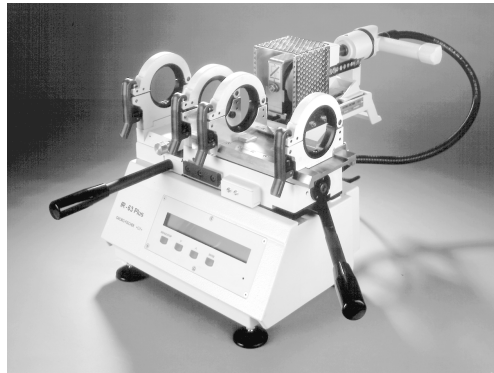


Equipment is for sale or rent (also used equipment when available). Please contact George Fischer Customer Service at (800) 854-4090.

For complete technical information see the Equipment for Plastic Fusion Joining Section.

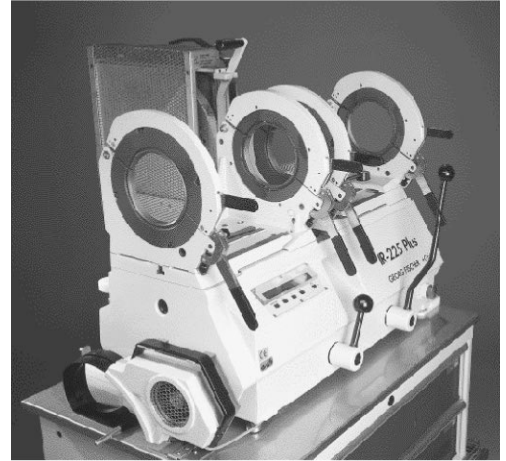
Fusion Joining Equipment

IR-63 Plus Infrared Fusion Joining Machine



For IR fusion of pipes and fittings in sizes 20 – 63 mm.

IR-225 Plus Infrared Fusion Joining Machine



For IR fusion of pipes and fittings in sizes 63 – 225 mm.

Specification Guide for Standard Grade SYGEF® PVDF Piping System for CPI Applications

Part 1 General

1.1 Work Included

- A. This section provides the requirements for materials, fabrication, and installation of polyvinylidene fluoride (PVDF) socket fusion piping systems that are to be used for chemical service.
- B. This section establishes requirements for work to be performed by the contractor whether on-site or performed in the permanent facility. Work shall be performed in a dedicated area for PVDF assembly.
- C. In the event of conflict regarding requirements for PVDF piping systems between this Section and any other section, the provisions of this Section shall govern.

1.2 Quality Assurance of Materials

- A. Any deviation from the materials, packaging and inspection requirements of this section must be approved in writing by QAR (Quality Assurance Representative), or the owner.
- B. Manufacturer shall select at random a minimum of one pipe and one fitting per lot (or 10% whichever is greater) and test for dimensional tolerances.
- C. Random samples from each lot may be selected by QAR or the owner for testing. Failure of test or inspection shall be grounds for rejection of entire lot.
- D. Results of quality assurance tests shall be stored by the supplier for a period of one year and made available to QAR or owner upon request.

1.3 Installation Training

- A. The Contractor and his field personnel shall be certified by the manufacturer for the installation of the PVDF system. The certification shall be current (within two years of date of issue) and each welder shall display a laminated badge identifying the individual by name, date of certification and type of fusion machine for which certification is granted.

1.4 Submittals

- A. The installing contractor shall submit the following:
 - 1. A detailed description of the Contractor pre-fabrication facility whether on-site, at the Contractor's site, or both.
 - 2. Contractor's proposed protocol for all work to be performed by Contractor's personnel in the pre-fabrication facility
 - 3. Installation Quality Control and Field Quality Assurance procedures for review and approval by Facilities Engineering or QAR representative.
 - 4. Provide catalog and operating information for all equipment submitted.
 - 5. Documentation shall be submitted for the materials supplied to show their compliance with the Piping Specification Sheet.
 - 6. Contractor training plan for material handling protocol for all contractor personnel involved in the installation of the PVDF piping system.

**(Specification Guide for Standard Grade SYGEF®
PVDF Piping System for CPI Applications cont.)**

Part 2 Products

2.1 General

- A. This specification is for the installation of socket fusion PVDF pipe, fittings and valves required for chemical processing equipment and distribution systems.
- B. Acceptable manufacturer of socket fusion PVDF pipe, valves and fittings is:
 - a) George Fischer's SYGEF PVDF products or other products of equal quality.

2.2 Pipe, Fittings and Valves - Raw Material

- A. In general, all PVDF pipe, fittings and valves shall be in accordance with these specifications and approved submittals. All materials shall be designed, fabricated and prepared for chemical processing applications.
- B. SYGEF® Capped & Bagged (C&B) PVDF pipe shall be manufactured from Solef 1010 natural, unpigmented, virgin PVDF homopolymer conforming to the standards of ASTM D-3222. SYGEF® PVDF valves and fittings shall be manufactured from Solef 1008 natural, unpigmented, virgin PVDF homopolymer conforming to the standards of ASTM D-3222. This PVDF material shall have a tensile strength of 6815 psi (470 bar) and a flexural strength of 11165 psi (770 bar) when tested at 73°F (23°C) according to ASTM D-638 and ASTM D-790. Each lot of resin shall be inspected for proper melt flow index, color, and density: melting point per ASTM D3222; vicat softening per ASTM D1525.

2.3 Pipe, Fittings and Valves - Dimension and Pressure Rating

- A. SYGEF® PVDF pipe, fittings and valves shall be a Standard Dimensions Ratio (SDR) series which defines the outer pipe diameter, wall thickness and tolerances. The pressure rating for all pipe sizes through 4" (110mm) diameter shall be 232 psi (16 bar) when measured at 68°F.
- B. All SYGEF® PVDF diaphragm and butterfly valves shall have a minimum pressure rating of 150 psi at 68°F (10 bar at 23°C). Flanged valves shall have ANSI bolt pattern for Class 150 rating. All threaded valves connection for sample ports, instrumentation or venting shall have NPT outlets.
- C. All SYGEF® PVDF valves in sizes through 2" (63mm) shall be Type 314/315 Diaphragm Valves as manufactured by George Fischer. All PVDF valves in sizes 2-1/2" (75mm) through 4" (110mm) shall be George Fischer Type 317 Diaphragm Valves with flanged connections. All diaphragm valves shall be weir style with PTFE Teflon® diaphragm seals backed with EPDM or FPM.

2.4 PVDF Pipe - Manufacturing

- A. Environment:
SYGEF® C&B PVDF pipe shall be extruded in a dedicated PVDF production line used exclusively for the production of PVDF pipe. Pipe dimensions and tolerances shall be continually monitored by use of ultra-sonic equipment.
- B. Stress Relieving:
Extrusion stresses shall be relieved by use of a continuous in-line annealing oven. Stress relief shall be measured and relate to a maximum 0.8% dimensional change when tested according to ISO Draft #10931-2

**(Specification Guide for Standard Grade SYGEF®
PVDF Piping System for CPI Applications cont.)**

- C. Pipe Identification:
SYGEF® C&B PVDF pipe shall be identified on the pipe outer surface with the production lot, pipe diameter and wall thickness.

- D. Surface Finish:
SYGEF® C&B PVDF pipe shall have samples taken which are measured for mean roughness of the interior pipe surface.

Using SEMASPEC 92010950B,
SYGEF® C&B (PVDF) pipe shall have profilometer mean roughness values, Ra, as follows:

Ra longitudinal: 0.50 micron or less
Ra diagonal: 0.65 micron or less

- E. SYGEF® C&B PVDF pipe interior shall also be fitted with protective polyethylene end caps and double bagged in heat sealed polyethylene liners immediately after production.
- F. Pipe Dimensional tolerance (mm) shall be according to the following:

Size	Tolerance	Ovality	Wall	Tolerance
20	+0.3, -0.0	0.3	1.9	+0.4, -0.0
25	+0.3, -0.0	0.4	1.9	+0.4, -0.0
32	+0.3, -0.0	0.5	2.4	+0.5, -0.0
40	+0.3, -0.0	0.5	2.4	+0.5, -0.0
50	+0.3, -0.0	0.6	3.0	+0.6, -0.0
63	+0.4, -0.0	0.8	3.0	+0.6, -0.0
75	+0.4, -0.0	0.9	3.6	+0.6, -0.0
90	+0.4, -0.0	1.1	4.3	+0.7, -0.0
110	+0.5, -0.0	1.3	5.3	+0.8, -0.0
160	+1.0, -0.0	2.0	4.9	+0.8, -0.0
200	+1.2, -0.0	2.5	6.3	+0.9, -0.0
225	+1.4, -0.0	2.7	6.9	+0.9, -0.0

2.5 PVDF Fittings and Valves - Manufacturing

- A. Environment:
All SYGEF® PVDF fittings and valves shall be manufactured on equipment dedicated exclusively to the manufacture of PVDF components.
- B. Fitting and Valve Identification:
All SYGEF® PVDF fittings and valves shall be molded with permanent identification to allow traceability to production lot and resin batch.

**(Specification Guide for Standard Grade SYGEF®
PVDF Piping System for CPI Applications cont.)**

- C. Fabricated Components:
Machined components made from semi-finished PVDF block and rod used in this fabrication of parts or sub-assemblies shall be inspected, clean and packaged similar to fittings and valves. Final inspection is made prior to packaging by 100% visual inspection of every weld. Pressure test for welded assemblies as required.

Surface finish for any machined component shall be:

$R_a = 0.62\mu$ or better

- D. Traceability of Machined Components:
Welding of sub-components shall only be done by manufacturer's certified technicians. All finished parts and assemblies shall be heat embossed with a serial number for traceability which links incoming material, production dates, machines used and welding personnel.

2.6 Fusion Equipment

- A. All socket fusion PVDF pipe, valves and fittings shall be joined in accordance with ASTM D-2657 using George Fischer Fusion Joining Equipment as supplied by George Fischer.
- B. The socket fusion equipment shall be compatible with the PVDF pipe and fittings being installed and allow for operator control of fusion temperature and pressure as well as alignment and penetration control of the socket depths.

- C. The socket fusion equipment utilized shall be either the George Fischer Bench Fusion Machine (part #790.350.195), the George Fischer SG 110 Socket Fusion Machine (part #790.310.003) or the George Fischer SG 160 Combo Machine (part #790.103.003A). Teflon® coated heater bushings with dimensions and tolerances corresponding to the requirements of SYGEF® (PVDF) pipe, valves and fittings are to be used as required by the manufacturer's written instructions.

2.7 Fusion Training and Certification

- A. SYGEF® PVDF piping installation shall only be performed by factory trained and certified installers in accordance with the manufacturer's written procedures. Each installer shall complete the manufacturer's Certification Course including written test examinations and submittal of fusion test welds to the manufacturer for weld evaluation. All PVDF pipe, valves and fittings shall be properly prepared in accordance with the manufacturer's written instructions. Each certified welder shall display at all times a permanent certification card showing name, type of fusion machine, certification number and date of certification. Installation practices, including support spacing and expansion considerations, shall be in compliance with the manufacturer's certification course and written recommendations.

(Specification Guide for Standard Grade SYGEF®
PVDF Piping System for CPI Applications cont.)

Part 3 Execution

3.1 Delivery, Storage and Handling

- A. Any Material that becomes damaged and/or contaminated in transit handling or storage shall not be used. It will be rejected by the QAR representative and returned to the manufacturer/distributor.
- B. All material and equipment shall be handled and stored in an indoor location throughout the progress of the job in such a manner as to prevent damage and/or contamination. Room shall be maintained dry and dust free. Room shall be kept at a temperature between 60 and 85 degrees F.
- C. Piping, fittings, and valves shall be stored in their original factory packaging. Use nylon or polypropylene rope or soft strand for slings and tie-downs used to let, load, or transport pipe bundles. Do not stack pipe higher than 2 feet.
- D. Fabricated spool pieces shall be supported and padded to prevent damage during transport.

SYGEF® Pipe, Valves, and Fittings for Socket Fusion Joining

Marking

SYGEF system pipes and fittings are marked as follows:

- +GF+
- Pipe o.d. and nominal bore
- SYGEF®

Dimensions

All pipe sizes are given in mm or equivalent closest inch size. Subject to alteration resulting from modifications in design.

Pressure Rating

George Fischer SYGEF and SYGEF HP is a constant rated system, 232 psi (16 bar) up to 110 mm (4") and either 150 psi (10 bar) or 232 psi (16 bar) for sizes 160 mm (6") and above. The pipe wall is proportioned to pipe O.D. based on the standard dimensional rating (SDR).

List of abbreviations

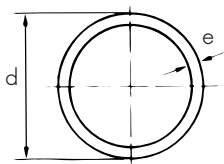
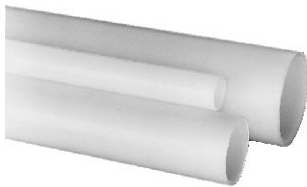
PVDF	Polyvinylidene Fluoride
®	Registered trademark
d	Pipe o. d.
lbs	Weight in pounds
e	Wall thickness, mm
z	z-dimension, inches
SP	Standard packaging

Orders

Always quote the George Fischer part number when placing orders.

Ordering Example

PVDF HP pipe 175 481 669
45° elbow Standard 735 158 516



SYGEF® Pipe for Socket Fusion Joining

PVDF Capped and Bagged

Supplied in 5 meter (16.4 ft.) lengths, clean, capped and bagged.

d m m	psi	Part Number			lbs./ meter	e m m					Closest inch size
16	232	175 480 202			.30	1.5					1/2
20	232	175 480 203			.45	1.9					3/4
25	232	175 480 204			.60	1.9					1
32	232	175 480 205			.95	2.4					1 1/4
40	232	175 480 206			1.20	2.4					
50	232	175 480 207			1.85	3.0					1 1/2
63	232	175 480 208			2.40	3.0					2
75	232	175 480 209			3.40	3.6					2 1/2
90	232	175 480 210			4.90	4.3					3
110	232	175 480 211			7.30	5.3					4

PVDF HP

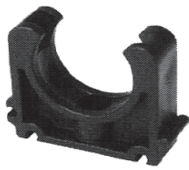
Supplied in 5 meter (16.4 ft.) lengths, clean, capped and double bagged.

d m m	psi	Part Number			lbs./ meter	e m m					Closest inch size
16	232	175 481 202			.30	1.5					3/8
20	232	175 481 203			.45	1.9					1/2
25	232	175 481 204			.60	1.9					3/4
32	232	175 481 205			.95	2.4					1
40	232	175 481 206			1.20	2.4					1 1/4
50	232	175 481 207			1.85	3.0					1 1/2
63	232	175 481 208			2.40	3.0					2
75	232	175 481 209			3.40	3.6					2 1/2
90	232	175 481 210			4.90	4.3					3
110	232	175 481 211			7.30	5.3					4

Pipe Bracket, Type 061 for mm pipes

Material: Bracket: PP Safety clip: PP

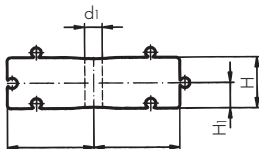
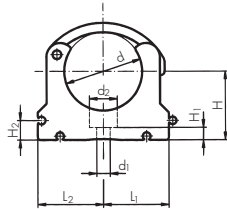
Not recommended for applications where pipe surface temperatures exceed 60°C.



d 20 - 32 *



d 40 - 63



*Without safety clip

Spacer, Type 061

to PP pipe Bracket, Type 061

d mm	Part Number	SP	lbs./ each	d ₁ inch	L ₁ inch	L ₂ inch	H inch	H ₁ inch	b inch
16	167 061 155	10	.01	0.22	0.55	0.65	.79	.39	.63
20	167 061 156	10	.01	0.22	0.65	0.75	.79	.39	.63
25	167 061 157	10	.02	0.22	0.75	0.85	.79	.39	.63
32	167 061 158	10	.02	0.22	0.94	1.04	.79	.39	.63
40	167 061 159	10	—	0.26	1.32	1.32	.79	.39	.87
50	167 061 160	10	—	0.26	1.46	1.46	.79	.39	.87
63	167 061 161	10	.06	0.33	1.75	1.75	.79	.39	.93
75	167 061 162	10	—	0.33	2.05	2.05	.79	.39	.98

Pipe Bracket, Type 060 for mm pipes

Material:

Clip and safety clip PP

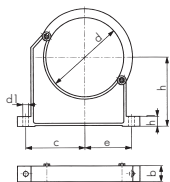
Minimum order quantity:

Only standard packings (SP) are delivered.

Clip and safety clip are not assembled in packaging.

Technical features:

Accidental opening of the safety clip is not possible.

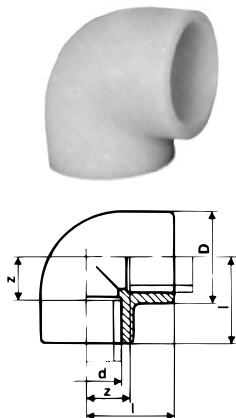


d mm	Part Number	SP	lbs./ each	h inch	h ₁ inch	d ₁ inch	b inch	c inch	e inch	Closest inch size
90	167 060 038	10	.36	4.13	.59	.35	1.28	3.50	2.80	3
110	167 060 039	10	.39	4.53	.59	.35	1.28	3.70	3.13	4

SYGEF® Fittings for Socket Fusion Joining

90° Elbow

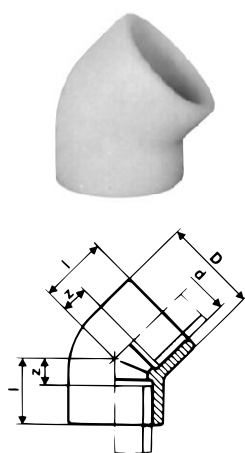
PVDF Standard



d mm	psi	Part Number		SP	lbs./ each	D inch	I inch	z inch					Closest inch size
16	232	735 100 105		10	.07	1.02	.98	.47					3/8
20	232	735 100 106		10	.08	1.20	1.10	.55					1/2
25	232	735 100 107		10	.12	1.42	1.26	.63					3/4
32	232	735 100 108		10	.20	1.71	1.50	.79					1
40	232	735 100 109		10	.32	2.11	1.73	.95					1 1/4
50	232	735 100 110		10	.54	2.60	2.01	1.10					1 1/2
63	232	735 100 111		2	.94	3.23	2.44	1.38					2
75	232	735 100 112		1	1.35	3.64	2.97	1.75					2 1/2
90	232	735 100 113		1	2.13	4.33	3.47	2.09					3
110	232	735 100 114		1	3.89	5.28	4.17	2.56					4

45° Elbow

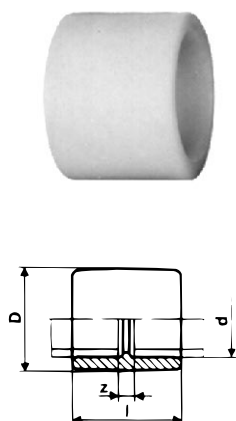
PVDF Standard



d mm	psi	Part Number		SP	lbs./ each	D inch	I inch	z inch					Closest inch size
16	232	735 150 105		10	.04	.91	.79	.28					3/8
20	232	735 150 106		10	.09	1.20	.83	.28					1/2
25	232	735 150 107		10	.11	1.42	.95	.32					3/4
32	232	735 150 108		10	.17	1.71	1.10	.39					1
40	232	735 150 109		5	.25	2.09	1.30	.51					1 1/4
50	232	735 150 110		5	.34	2.52	1.42	.55					1 1/2
63	232	735 150 111		5	.62	3.11	1.69	.67					2
75	232	735 150 112		1	1.00	3.64	2.01	.79					2 1/2
90	232	735 150 113		1	1.76	4.49	2.28	.91					3
110	232	735 150 114		1	2.62	5.28	2.68	1.06					4

Coupling

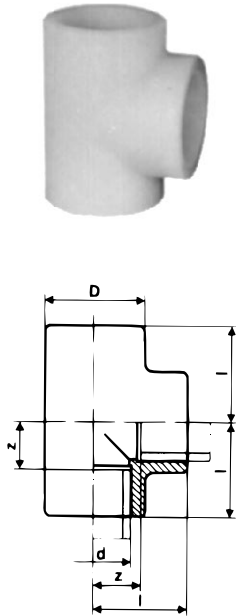
PVDF Standard



d mm	psi	Part Number		SP	lbs./ each	D inch	I inch	z inch					Closest inch size
16	232	735 910 105		10	.04	1.02	1.30	.28					3/8
20	232	735 910 106		10	.06	1.20	1.38	.28					1/2
25	232	735 910 107		10	.08	1.42	1.54	.28					3/4
32	232	735 910 108		10	.12	1.71	1.69	.28					1
40	232	735 910 109		10	.18	2.11	1.89	.32					1 1/4
50	232	735 910 110		10	.31	2.60	2.13	.32					1 1/2
63	232	735 910 111		2	.56	3.23	2.44	.32					2
75	232	735 910 112		2	.60	3.67	2.74	.32					2 1/2
90	232	735 910 113		1	.99	4.41	3.17	.41					3
110	232	735 910 114		1	1.78	5.30	3.78	.47					4

Tee

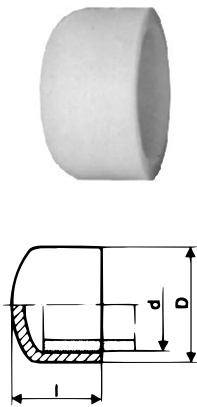
PVDF Standard



d mm	psi	Part Number	SP	lbs./ each	D inch	L inch	z inch						Closest inch size
16	232	735 200 105	10	.09	1.02	.98	.47						³ / ₈
20	232	735 200 106	10	.12	1.20	1.10	.55						¹ / ₂
25	232	735 200 107	10	.16	1.42	1.26	.63						³ / ₄
32	232	735 200 108	10	.25	1.71	1.50	.79						1
40	232	735 200 109	10	.44	2.11	1.73	.95						1 ¹ / ₄
50	232	735 200 110	10	.68	2.60	2.01	1.10						1 ¹ / ₂
63	232	735 200 111	1	1.15	3.23	2.44	1.38						2
75	232	735 200 112	1	1.78	3.64	2.97	1.73						2 ¹ / ₂
90	232	735 200 113	1	3.04	4.33	3.47	2.09						3
110	232	735 200 114	1	4.75	5.28	4.17	2.56						4

Cap

PVDF Standard



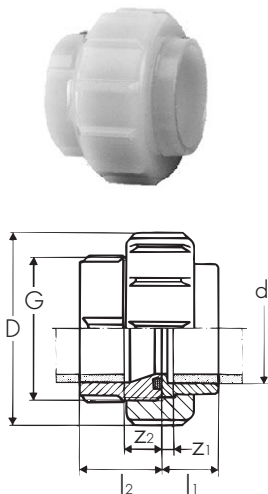
d mm	psi	Part Number	SP	lbs./ each	D inch	L inch							Closest inch size
16	232	735 960 105	10	.03	.98	.95							³ / ₈
20	232	735 960 106	10	.04	1.18	1.06							¹ / ₂
25	232	735 960 107	10	.06	1.42	1.18							³ / ₄
32	232	735 960 108	10	.10	1.73	1.34							1
40	232	735 960 109	10	.15	2.09	1.50							1 ¹ / ₄
50	232	735 960 110	10	.25	2.56	1.73							1 ¹ / ₂
63	232	735 960 111	5	.48	3.15	2.01							2
75	232	735 960 112	2	.67	3.54	2.60							2 ¹ / ₂
90	232	735 960 113	2	1.16	4.33	3.03							3
110	232	735 960 114	1	1.76	5.35	3.54							4

Union

Supplied with: FPM* O-Ring.

Individual components can be special ordered separately. (See pg. 4.91)

PVDF Standard

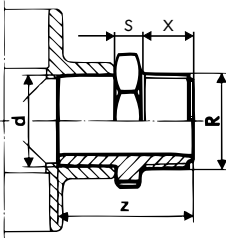


d mm	psi	Part Number	SP	lbs./ each	D inch	l ₁ inch	l ₂ inch	z ₁ inch	z ₂ inch				Closest inch size
16	232	735 510 105	10	.09	1.38	.71	.95	.20	.47				³ / ₈
20	232	735 510 106	10	.15	1.78	.75	1.02	.20	.47				¹ / ₂
25	232	735 510 107	10	.22	2.17	.83	1.10	.20	.47				³ / ₄
32	232	735 510 108	10	.27	2.44	.91	1.18	.20	.47				1
40	232	735 510 109	10	.42	2.95	.98	1.34	.20	.55				1 ¹ / ₄
50	232	735 510 110	2	.61	3.29	1.10	1.54	.20	.63				1 ¹ / ₂
63	232	735 510 111	2	.93	3.98	1.26	1.85	.20	.79				2
75	232	735 510 122	1	1.56	5.24	1.42	2.01	.20	.79				2 ¹ / ₂
90	232	735 510 123	1	2.35	6.10	1.65	2.17	.28	.79				3
110	232	735 510 124	1	3.64	7.28	1.93	2.13	.28	.47				4

*FPM seals are made of Viton® or equal materials. Viton® is a registered trademark of DuPont Dow Elastomers.

Male Threaded Adaptor

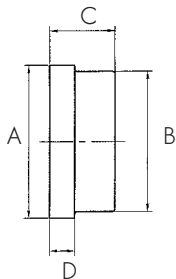
PVDF Standard



Male pipe thread x Metric spigot inch x mm R x d	psi	Part Number		SP	lbs./ each	z inch	s inch	(hex size) across flats inch	x inch			
$\frac{3}{8}$ x 16	150	735 914 505		10	.04	1.38	0.28	1.06	0.51			
$\frac{1}{2}$ x 20	150	735 914 506		10	.07	1.65	0.35	1.26	0.67			
$\frac{3}{4}$ x 25	150	735 914 507		10	.08	1.82	0.35	1.42	0.74			
1 x 32	150	735 914 508		10	.15	2.07	0.39	1.81	0.86			
$1\frac{1}{4}$ x 40	150	735 914 509		10	.21	2.22	0.39	2.17	0.94			
$1\frac{1}{2}$ x 50	150	735 914 510		10	.29	2.37	0.43	2.56	0.94			
2 x 63	150	735 914 511		5	.48	2.73	0.47	3.15	1.09			

PVDF Standard

Male pipe thread x Metric socket inch x mm	psi	Part Number		SP	lbs./ each	z inch	s inch	(hex size) across flats inch				
1 x 25	150	155 011 251		1								



Union Blank

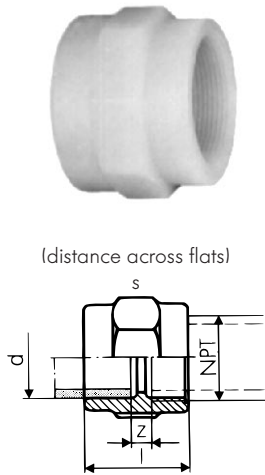
d mm	psi	Part Number		SP	lbs./ each	A inch	B inch	C inch	D inch				Closest inch size
20	232	175 482 101		1		1.18	1.08	0.51	0.20				$\frac{1}{2}$
25	232	175 482 102		1		1.53	1.42	0.59	0.20				$\frac{3}{4}$
32	232	175 482 103		1		1.76	1.63	0.67	0.22				1
40	232	175 482 104		1		2.22	2.08	0.71	0.24				$1\frac{1}{4}$
50	232	175 482 105		1		2.46	2.31	0.79	0.28				$1\frac{1}{2}$
63	232	175 482 106		1		3.43	2.90	0.87	0.30				2

Female Threaded Adaptor

with fusion socket and NPT taper female thread.

Connection to plastic thread.

PVDF Standard



Female pipe thd. x metric socket inch x mm	psi	Part Number		SP each	lbs./inch	l inch	z inch	s				
$\frac{3}{8}$ x 16	150	735 914 205		10	.04	1.14	.12	1.06				
$\frac{1}{2}$ x 20	150	735 914 206		10	.07	1.38	.28	1.26				
$\frac{3}{4}$ x 25	150	735 914 207		10	.08	1.54	.28	1.42				
1 x 32	150	735 914 208		10	.15	1.69	.28	1.81				
1 $\frac{1}{4}$ x 40	150	735 914 209		10	.21	1.89	.28	2.17				
1 $\frac{1}{2}$ x 50	150	735 914 210		10	.29	2.13	.35	2.56				
2 x 63	150	735 914 211		5	.48	2.44	.35	3.15				

with fusion spigot and NPT taper female thread.

Connection to plastic thread.

PVDF Standard

Female pipe thd. x metric spigot inch x mm	psi	Part Number		SP	lbs./each	l inch	z inch	s inch				
$\frac{1}{4}$ x 16	150	155 910 432		1	.03	.51	—	—				

Union Components-PVDF standard

Union End

d mm	Part Number
16	735 600 105
20	735 600 106
25	735 600 107
32	735 600 108
40	735 600 109
50	735 600 110
63	735 600 111
75	735 600 112
90	735 600 113
110	735 600 114

Union Nut

d mm	Part Number
16	735 690 405
20	735 690 406
25	735 690 407
32	735 690 408
40	735 690 409
50	735 690 410
63	735 690 411
75	735 690 412
90	735 690 413
110	735 690 414

Union Bush

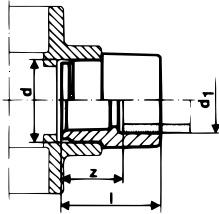
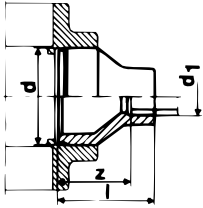
d mm	Part Number
16	735 640 105
20	735 640 106
25	735 640 107
32	735 640 108
40	735 640 109
50	735 640 110
63	735 640 111
75	735 640 112
90	735 640 113
110	735 640 114

O-Ring FPM

d mm	Part Number
16	749 410 005
20	749 410 006
25	749 410 007
32	749 410 008
40	749 410 009
50	749 410 010
63	749 410 011
75	749 410 014
90	749 410 015
110	749 410 016

Reducer Bushing

with fusion spigot and socket
PVDF Standard



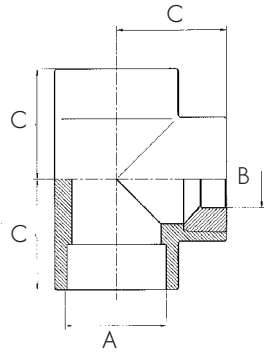
d – d1 mm	psi	Part Number	SP	lbs./ each	l inch	z inch						Closest inch size
20-16	232	735 910 334	10	.04	1.42	.95						$1/2 - 3/8$
25-20	232	735 910 337	10	.06	1.54	.98						$3/4 - 1/2$
32-20	232	735 910 342	10	.07	1.77	1.22						$1 - 1/2$
32-25	232	735 910 341	10	.09	1.77	1.14						$1 - 3/4$
40-20	232	735 910 348	10	.10	1.97	1.42						$1 1/4 - 1/2$
40-25	232	735 910 347	10	.12	1.97	1.34						$1 1/4 - 3/4$
40-32	232	735 910 346	10	.13	1.97	1.26						$1 1/4 - 1$
50-20	232	735 910 355	10	.15	2.17	1.61						$1 1/2 - 1/2$
50-25	232	735 910 354	10	.15	2.17	1.54						$1 1/2 - 3/4$
50-32	232	735 910 353	10	.18	2.17	1.46						$1 1/2 - 1$
50-40	232	735 910 352	10	.21	2.17	1.38						$1 1/2 - 1 1/4$
63-20	232	735 910 362		.24	2.52	1.97						$2 - 1/2$
63-25	232	735 910 361	5	.25	2.56	1.93						$2 - 3/4$
63-32	232	735 910 360	5	.28	2.56	1.85						$2 - 1$
63-40	232	735 910 359	5	.29	2.56	1.77						$2 - 1 1/4$
63-50	232	735 910 358	5	.37	2.56	1.69						$2 - 1 1/2$
75-63	232	735 910 364	5	.43	2.44	1.38						$2 1/2 - 2$
90-63	232	735 910 371	1	.79	3.47	2.44						$3 - 2$
90-75	232	735 910 370	2	.56	2.74	1.54						$3 - 2 1/2$
110-63	232	735 910 378	1	1.00	3.66	2.60						$4 - 2$
110-90	232	735 910 376	1	1.02	3.17	1.77						$4 - 3$

Reducer Tee Flush Style

Threaded outlet, multiple reducers and special fittings available upon request.

PVDF Standard

Socket x Socket

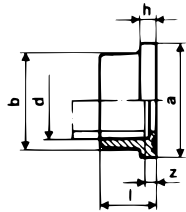


d mm	psi	Part Number	SP	A mm	B mm	C inch	LT	Closest inch size
25x25x20	232	155 200 337	1	25	20	1.26	10	$\frac{3}{4} \times \frac{3}{4} \times \frac{1}{2}$
32x32x20	232	155 200 342	1	32	20	1.50	10	$1 \times 1 \times \frac{1}{2}$
32x32x25	232	155 200 341	1	32	25	1.50	10	$1 \times 1 \times \frac{3}{4}$
40x40x20	232	155 200 348	1	40	20	1.73	20	$1\frac{1}{4} \times 1\frac{1}{4} \times \frac{1}{2}$
40x40x25	232	155 200 347	1	40	25	1.73	20	$1\frac{1}{4} \times 1\frac{1}{4} \times \frac{3}{4}$
40x40x32	232	155 200 346	1	40	32	1.73	20	$1\frac{1}{4} \times 1\frac{1}{4} \times 1$
50x50x20	232	155 200 355	1	50	20	2.01	10	$1\frac{1}{2} \times 1\frac{1}{2} \times \frac{1}{2}$
50x50x25	232	155 200 354	1	50	25	2.01	10	$1\frac{1}{2} \times 1\frac{1}{2} \times \frac{3}{4}$
50x50x32	232	155 200 353	1	50	32	2.01	10	$1\frac{1}{2} \times 1\frac{1}{2} \times 1$
50x50x40	232	155 200 352	1	50	40	2.01	20	$1\frac{1}{2} \times 1\frac{1}{2} \times 1\frac{1}{4}$
63x63x20	232	155 200 362	1	63	20	2.44	10	$2 \times 2 \times \frac{1}{2}$
63x63x25	232	155 200 361	1	63	25	2.44	10	$2 \times 2 \times \frac{3}{4}$
63x63x32	232	155 200 360	1	63	32	2.44	10	$2 \times 2 \times 1$
63x63x40	232	155 200 359	1	63	40	2.44	20	$2 \times 2 \times 1\frac{1}{4}$
63x63x50	232	155 200 358	1	63	50	2.44	10	$2 \times 2 \times 1\frac{1}{2}$
75x75x20	232	155 200 369	1	75	20	2.97	20	$2\frac{1}{2} \times 2\frac{1}{2} \times \frac{1}{2}$
75x75x25	232	155 200 368	1	75	25	2.97	20	$2\frac{1}{2} \times 2\frac{1}{2} \times \frac{3}{4}$
75x75x32	232	155 200 367	1	75	32	2.97	20	$2\frac{1}{2} \times 2\frac{1}{2} \times 1$
75x75x40	232	155 200 366	1	75	40	2.97	20	$2\frac{1}{2} \times 2\frac{1}{2} \times 1\frac{1}{4}$
75x75x50	232	155 200 365	1	75	50	2.97	20	$2\frac{1}{2} \times 2\frac{1}{2} \times 1\frac{1}{2}$
75x75x63	232	155 200 364	1	75	63	2.97	20	$2\frac{1}{2} \times 2\frac{1}{2} \times 2$
90x90x20	232	155 200 328	1	90	20	3.46	20	$3 \times 3 \times \frac{1}{2}$
90x90x25	232	155 200 375	1	90	25	3.46	20	$3 \times 3 \times \frac{3}{4}$
90x90x32	232	155 200 374	1	90	32	3.46	10	$3 \times 3 \times 1$
90x90x40	232	155 200 373	1	90	40	3.46	20	$3 \times 3 \times 1\frac{1}{4}$
90x90x50	232	155 200 372	1	90	50	3.46	10	$3 \times 3 \times 1\frac{1}{2}$
90x90x63	232	155 200 371	1	90	63	3.46	10	$3 \times 3 \times 2$
90x90x75	232	155 200 370	1	90	75	3.46	20	$3 \times 3 \times 2\frac{1}{2}$
110x110x20	232	155 200 331	1	110	20	4.17	20	$4 \times 4 \times \frac{1}{2}$
110x110x25	232	155 200 330	1	110	25	4.17	20	$4 \times 4 \times \frac{3}{4}$
110x110x32	232	155 200 381	1	110	32	4.17	10	$4 \times 4 \times 1$
110x110x40	232	155 200 380	1	110	40	4.17	20	$4 \times 4 \times 1\frac{1}{4}$
110x110x50	232	155 200 379	1	110	50	4.17	10	$4 \times 4 \times 1\frac{1}{2}$
110x110x63	232	155 200 378	1	110	63	4.17	10	$4 \times 4 \times 2$
110x110x75	232	155 200 377	1	110	75	4.17	20	$4 \times 4 \times 2\frac{1}{2}$
110x110x90	232	155 200 376	1	110	90	4.17	10	$4 \times 4 \times 3$

Flange Adaptor - serrated face

For use with flat gasket. Mates with another serrated face flange adaptor (also used with grooved face flange adaptors). **Note:** Flange Rings are found on page 45.

PVDF Standard



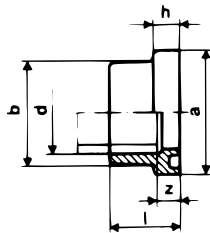
d mm	psi	Part Number		SP	lbs./ each	h inch	l inch	a inch	b inch	z inch			Closest inch size
20	232	735 790 206		10	.03	.24	.75	1.75	1.06	.20			1/2
25	232	735 790 257		10	.05	.28	.83	2.13	1.30	.20			3/4
32	232	735 790 258		10	.07	.28	.91	2.48	1.61	.20			1
40	232	735 790 259		10	.11	.32	.98	2.89	1.97	.20			1 1/4
50	232	735 790 260		10	.15	.32	1.10	3.23	2.40	.20			1 1/2
63	232	735 790 211		5	.25	.35	1.26	4.02	2.99	.20			2
75	232	735 790 212		2	.38	.39	1.38	4.78	3.56	.20			2 1/2
90	232	735 790 263		1	.58	.43	1.65	5.24	4.29	.28			3
110	232	735 790 214		1	.91	.47	1.93	6.22	5.16	.28			4

Flange Adaptor - grooved face

For use with O-ring. Mates with serrated face flange adaptor.

Note: Flange Rings are found on page 45.

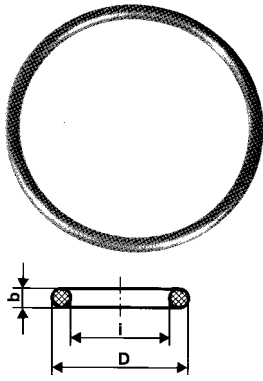
PVDF Standard



d mm	psi	Part Number		SP	lbs./ each	h inch	l inch	a inch	b inch	z inch			Closest inch size
20	232	735 810 106		10	.03	.35	.87	1.34	1.06	.32			1/2
25	232	735 810 107		10	.05	.39	.95	1.61	1.30	.32			3/4
32	232	735 810 108		10	.08	.39	1.02	1.97	1.61	.32			1
40	232	735 810 109		10	.13	.51	1.18	2.40	1.97	.39			1 1/4
50	232	735 810 110		10	.18	.51	1.30	2.87	2.40	.39			1 1/2
63	232	735 810 111		2	.30	.55	1.46	3.54	2.99	.39			2
75	232	735 810 112		2	.45	.59	1.58	4.17	3.56	.39			2 1/2
90	232	735 810 113		1	.69	.63	1.85	4.92	4.29	.47			3
110	232	735 810 114		1	1.08	.71	2.17	5.91	5.16	.51			4

O-Ring

Material: FPM. For use with one serrated and one grooved flange adaptor.

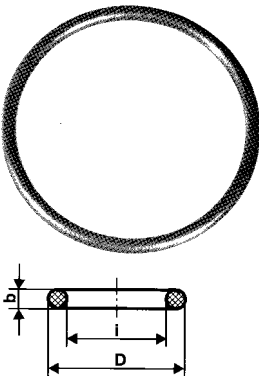


d mm	Part Number FPM	SP	i inch	D inch	b inch							Closest inch size
20	749 410 001	100	.92	1.20	.14							1/2
25	749 410 007	100	1.11	1.39	.14							3/4
32	749 410 002	100	1.42	1.70	.14							1
40	749 410 003	100	1.73	2.15	.21							1 1/4
50	749 410 012	100	2.10	2.52	.21							1 1/2
63	749 410 013	100	2.73	3.15	.21							2
75	749 410 014	100	3.23	3.65	.21							2 1/2
90	749 410 015	100	3.98	4.36	.21							3
110	749 410 016	50	4.73	5.28	.28							4

4

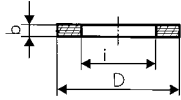
O-Ring

Material: EPDM. For use with one serrated and one grooved flange adaptor.



d mm	Part Number EPDM	SP	i inch	D inch	b inch							Closest inch size
20	748 410 001	100	.92	1.20	.14							1/2
25	748 410 007	200	1.11	1.39	.14							3/4
32	748 410 002	100	1.42	1.70	.14							1
40	748 410 003	100	1.73	2.15	.21							1 1/4
50	748 410 012	100	2.10	2.52	.21							1 1/2
63	748 410 013	100	2.73	3.15	.21							2
75	748 410 014	100	3.23	3.65	.21							2 1/2
90	748 410 015	100	3.98	4.36	.21							3
110	748 410 016	50	4.73	5.28	.28							4

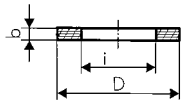
Flat Gasket



Material: FPM . For use with serrated faced flange adaptors.

d mm	Part Number FPM	SP	i inch	D inch	b inch	Closest inch size
20	749 400 015	100	.79	1.26	.08	1/2
25	749 400 016	100	.98	1.54	.08	3/4
32	749 400 017	100	1.26	1.89	.08	1
40	749 400 018	100	1.58	2.32	.12	1 1/4
50	749 400 019	100	1.97	2.80	.12	1 1/2
63	749 400 020	100	2.48	3.47	.12	2
75	749 400 021	50	2.95	4.09	.12	2 1/2
90	749 400 022	50	3.54	4.84	.12	3
110	749 400 023	150	4.33	5.83	.16	4

Flat Gasket



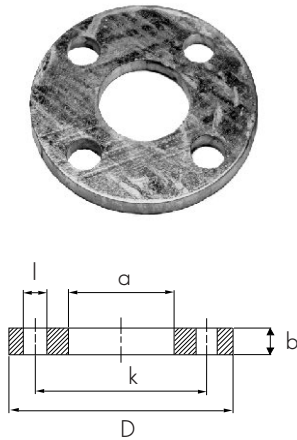
Material: EPDM. For use with serrated faced flange adaptors.

d mm	Part Number EPDM	SP	i inch	D inch	b inch	Closest inch size
20	748 400 015	100	.79	1.26	.08	1/2
25	748 400 016	100	.98	1.54	.08	3/4
32	748 400 017	100	1.26	1.89	.08	1
40	748 400 018	100	1.58	2.32	.12	1 1/4
50	748 400 019	100	1.97	2.80	.12	1 1/2
63	748 400 020	100	2.48	3.47	.12	2
75	748 400 021	50	2.95	4.09	.12	2 1/2
90	748 400 022	50	3.54	4.84	.12	3
110	748 400 023	150	4.33	5.83	.16	4

Flange Ring

Material: Galvanized steel. For use with all type flange adaptors.

Bolt holes drilled in accordance with ANSI B16.5, Class 150 pattern.



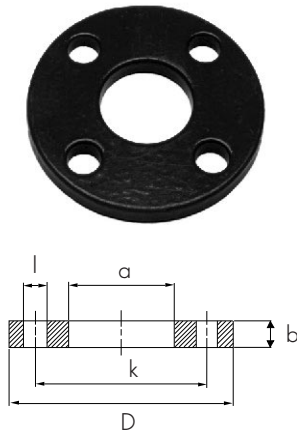
d mm	ANSI bolt pattern	Part Number		SP	lbs./ each	D inch	a inch	k inch	b inch	l inch	Bolt holes		
20	1/2	724 701 806		1	.50	3.50	1.10	.236	.28	.63	4		
25	3/4	724 701 807		1	.75	3.86	1.34	.276	.28	.63	4		
32	1	724 701 808		1	.75	4.25	1.65	.311	.28	.63	4		
40	1 1/4	724 701 809		1	1.13	4.61	2.01	.350	.32	.63	4		
50	1 1/2	724 701 810		1	1.31	5.00	2.44	.386	.32	.63	4		
63	2	724 701 811		1	2.13	5.98	3.07	.476	.39	.75	4		
75	2 1/2	724 701 812		1	2.94	7.01	3.62	.551	.39	.75	4		
90	3	724 701 813		1	3.19	7.48	4.33	.598	.39	.75	4		
110	4	724 703 814		1	4.56	9.02	5.24	.748	.39	.75	8		

4

Flange Ring

Material: PVDF blue coated steel. For use with all type flange adaptors.

Bolt holes drilled in accordance with ANSI B16.5, Class 150 pattern.



d mm	ANSI bolt pattern	Part Number		SP	lbs./ each	D inch	a inch	k inch	b inch	l inch	Bolt holes		
20	1/2	155 701 806		1	.50	3.50	1.10	.236	.28	.63	4		
25	3/4	155 701 807		1	.75	3.86	1.34	.276	.28	.63	4		
32	1	155 701 808		1	.75	4.25	1.65	.311	.28	.63	4		
40	1 1/4	155 701 809		1	1.13	4.61	2.01	.350	.32	.63	4		
50	1 1/2	155 701 810		1	1.31	5.00	2.44	.386	.32	.63	4		
63	2	155 701 811		1	2.13	5.98	3.07	.476	.39	.75	4		
75	2 1/2	155 701 812		1	2.94	7.01	3.62	.551	.39	.75	4		
90	3	155 701 813		1	3.19	7.48	4.33	.598	.39	.75	4		
110	4	155 703 814		1	4.56	9.02	5.24	.748	.39	.75	8		

For complete technical information see the Valves Section.

SYGEF® Valves for Socket Fusion Joining

Needle Valve Type 522, angle and globe body styles



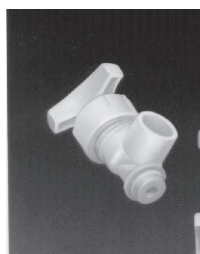
Diaphragm Valve Type 314, true union design, metric fusion socket ends



Diaphragm Valve Type 315, metric fusion spigot ends (for socket fusion)



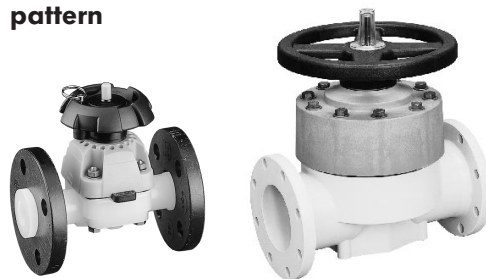
Sampling Valve Type 525



Zero Static Diaphragm Valve Type 319, metric fusion socket ends



Diaphragm Valve Type 317, flanged, class 150 ANSI bolt pattern



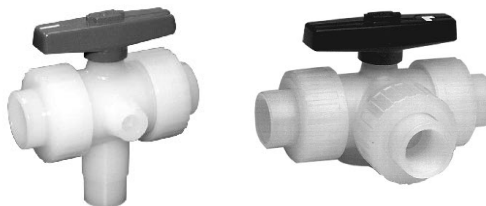
"Low Profile" Gauge Isolator Type 523



Ball Valve Type 346, true union design, metric fusion socket, NPT thread, or ANSI class 150 flanged ends



3-way Ball Valve Type 343, vertical and horizontal, metric fusion socket or NPT thread ends



Pure Fluid Dispenser



Ball Check Valve Type 360, true union design, metric fusion socket ends



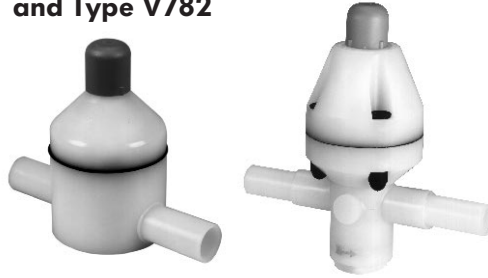
Butterfly Valve Type 367, wafer style for ANSI B16.5 class 150 flanges



For complete technical information see the Pressure Regulating Valves Section.

SYGEF® Pressure Regulating Valves for Socket Fusion Joining

Pressure Reducing Valve Type V82 and Type V782



Pressure Relief Valve Type V85



4

Pressure Retaining Valve Type V86 and Type V786



For complete technical information see the Rotameters Section.

Rotameters for Socket Fusion Joining



For complete technical information see the Actuated Valves Section.

Electrically and Pneumatically Actuated Valves for Socket Fusion Joining

Electrically Actuated Ball Valve Type 113/115



Type 346 ball valve with Type EA 20 actuator (also available as 3-way).

Pneumatically Actuated Ball Valve Type 222/215



Type 346 ball valve with Type PA 10/PA 20 actuator (also available as 3-way).

Electrically Actuated Butterfly Valve Type 035



Type 367 butterfly valve with Type EA 30/EA 41/EA 50 actuator.

Pneumatically Actuated Butterfly Valve Type 036



Type 367 butterfly valve with Type PA 40/50/60/70 actuator.

Pneumatically Actuated Diaphragm Valve DIASTAR



Pneumatically Actuated Zero Static Diaphragm Valve DIASTAR



Pneumatically Actuated Diaphragm Valve Type 018



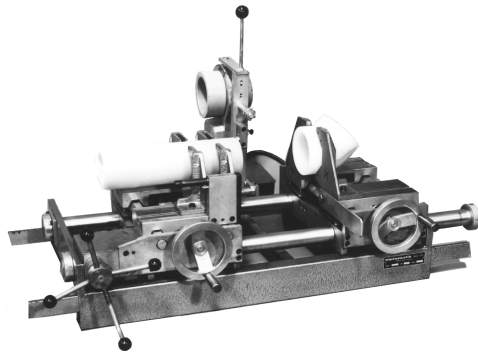
Equipment is for sale or rent (also used equipment when available).

Please contact George Fischer Customer Service at (800) 854-4090.

For complete technical information see the Equipment for Plastic Fusion Joining Section.

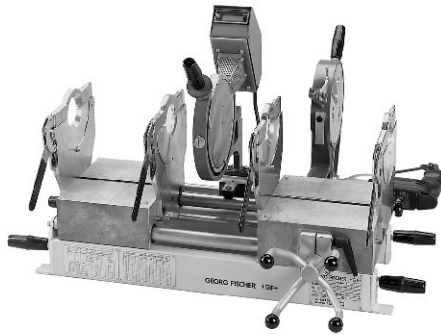
Fusion Joining Equipment

Bench Fusion Machine



For socket joining of pipes and fittings in sizes 20 – 110 mm.

Combo Fusion Machine SG 160

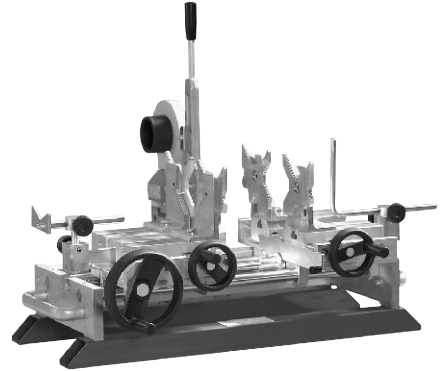


Combination machine for socket fusion joining of pipes and fittings in sizes 20 – 110 mm and butt fusion joining in sizes 32 – 160 mm.

Plastic Pipe Cutter PPC-250/PPC-250 HP

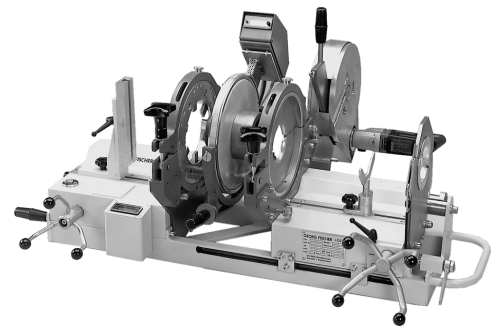


Socket Fusion SG 110



For socket joining of pipes and fittings in sizes 20 – 110 mm.

Combo Fusion Machine SG 250



Combination machine for socket fusion joining of pipes and fittings in sizes 40 – 110 mm and butt fusion joining in sizes 63 – 250 mm.

