Bray CONTROLS

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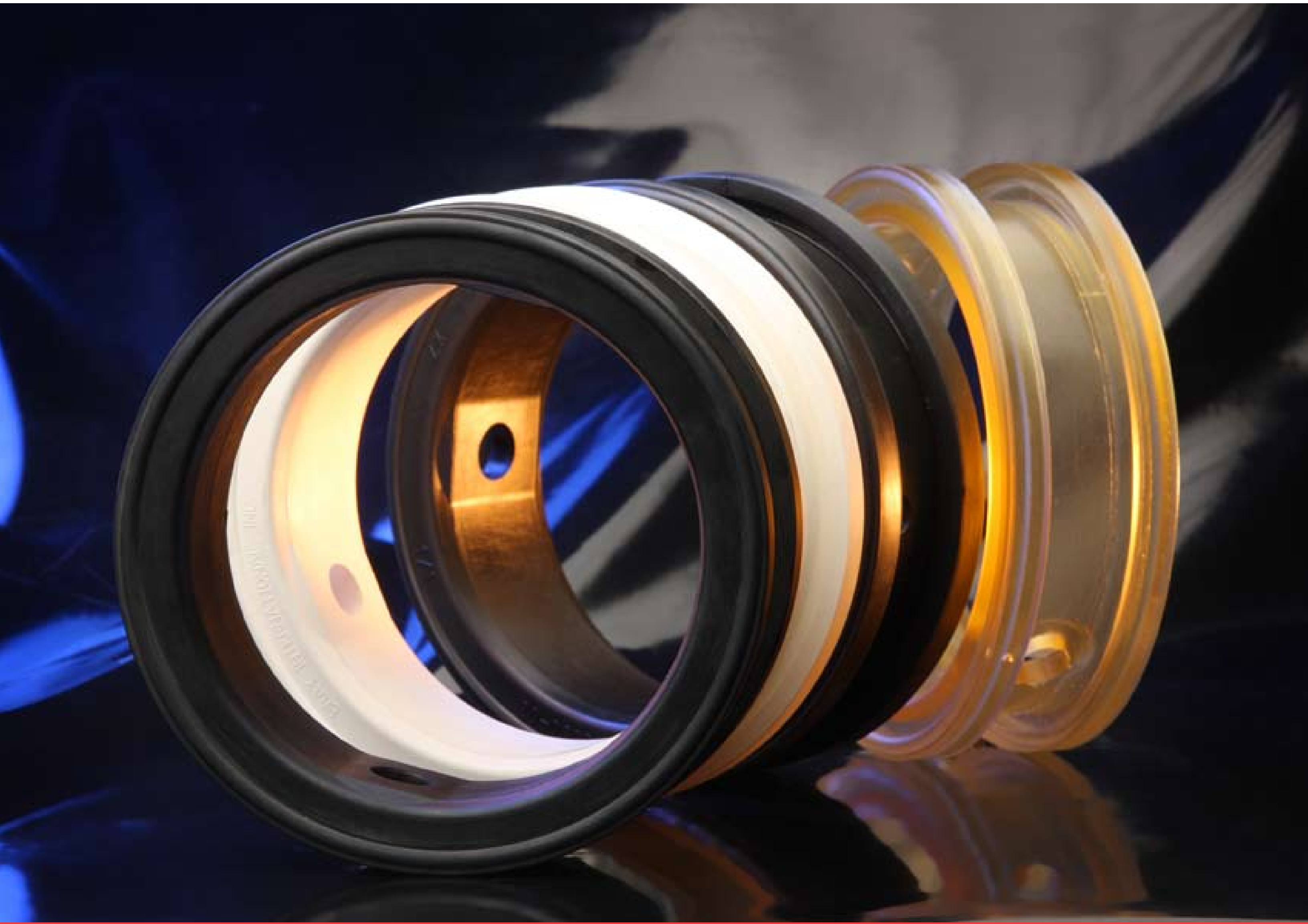


Seat Materials

Technical Manual

TM1051 - 03/31/2010

Seat Materials

Technical Manual - Table of Contents

All statements, technical information, and recommendations in this bulletin are for general use only. Consult Bray representatives or factory for the specific requirements and material selection for your intended application. The right to change or modify product design or product without prior notice is reserved.

Elastomer Designations

ASTM D1418, Rubber and Rubber Lattices - Nomenclature describes the various types of elastomers by their chemical composition. A lettered designation is assigned to each type of rubber. Some designations, such as NR for Natural Rubber, appear to be acronyms. Others, such as FKM for Fluorinated Hydrocarbon (like DuPont's Viton®) are not as straightforward.

ASTM D1566, Standard Definitions of Terms Relating to Rubber helps to maintain unambiguous communication between suppliers and users.

ASTM D2000, Standard Classification System for Rubber Parts in Automotive Classifications is not limited to automotive parts. This classification system, also called SAE J200, is based on the premise that properties of all rubber compounds can be arranged into characteristic material designations.

The two characteristics used in ASTM D2000 are

Type - based on resistance to aging in heat
Class - based on resistance to swelling in oil

The Type designation is determined by a thermal test, which establishes a maximum service temperature. Letters indicate the service temperature range of 158°F (70°C) to 572°F (300°C), in approximately 77°F (25°C) increments, with A being the lowest resistance (lowest service temperature).

The service temperature ranges for the Type designation are:

Type	A	B	C	D	E	F	G	H	J	K
°C	70	100	125	150	175	200	225	250	275	300
°F	158	212	257	302	347	392	437	482	527	572

The Class designation is determined by maximum volume swell with immersion in a prescribed ASTM #3 oil test. Letters A through K represent the 10 classes, with K being the highest resistance (lowest volume swell).

The oil resistance ranges for the Class designation are:

Class	A	B	C	D	E	F	G	H	K
%Volume Swell Allowed	None	170%	120%	100%	80%	60%	40%	20%	10%

Type and Class designations are written together. For example, HK would define a rubber that can be used at 482°F (200°C) continuously and will not swell more than 10% when immersed in ASTM #3 reference oil.

The ASTM Designation system can be used to describe rubber materials in a precise manner, such as FKM, without using tradenames such as Dupont's Viton® or 3M's Flourel®.

Figure 1. Some Common Elastomers used in the Valve Industry

Common or Tradename	Chemical Type	ASTM D1418 Designation	ASTM D2000 Type/Class
Natural rubber	Natural polyisoprene	NR	**A/A**
Nordel®	Ethylene Propylene Diene Monomer	EPDM	**A/A, B/A, C/A**
BUNA-N or Nitrile	Nitrile butadiene	NBR	**B/F, B/G, B/K, C/H**
Silicone	Polysiloxane	VMQ, PVMQ, MQ, PMQ	**F/C, F/E, G/E, E/F**
Viton®	Fluorinated hydrocarbon	FKM	**H/K**
Hypalon®	Chlorosulfonated Polyethylene	CSM	**C/E, D/E**
Neoprene	Chloroprene	CR	**B/C, B/E**
Chlorobutyl	Chlorinated isobutene isoprene	CIIR	**A/A, B/A**
Kalrez®	Perfluoroelastomer	FFKM	**at least H/K**

® Registered DuPont trade names

Fluoroplastic Materials

Fluoroplastic materials such as PTFE, PFA and FEP are commonly used in the valve industry. These materials are stable at high temperatures and resistant to chemical attack.

All of these materials contain fluorine, which is the most reactive element known. Pure fluorine gas is not found in a free state, since it readily combines with so many other natural elements, especially carbon. In fact, pure fluorine was unknown until the French chemist Moissan isolated it in a laboratory in 1886.

The resulting bond between a fluorine atom and a carbon atom is so strong that almost no other type of atom can break this attraction and destroy the bond. Once they have been joined, they are very difficult to separate. Even high temperature will not easily split a fluorine atom from a carbon atom. As a general rule, the more fluorine a material contains, the higher the temperature and chemical resistance of the material.

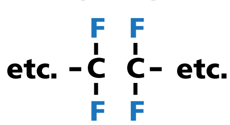
Fluorine remained a laboratory curiosity until 1930. In 1931, a trademarked compound of carbon, chlorine and flourine called Freon was announced, and was used as a refrigerant. In 1938, a DuPont researcher noticed a waxy white powder that had formed inside a steel cylinder containing some ethylene and fluorine gas. This material was solid, unlike Freon gas, and led to the development of a number of commercial fluoroplastics.

The adjective plastic means “pliable and capable of being shaped by heat and/or pressure.” Plastic is also used as a noun to describe a material containing carbon that is solid in the finished state, but is liquid at some stage of manufacture, so that it may be formed into various shapes by the application, either singly or together, of heat and pressure.

Polytetrafluoroethylene (PTFE)

PTFE is composed entirely of carbon and fluorine:

Polytetrafluoroethylene (PTFE)



PTFE is a highly crystalline, waxy thermoplastic material that accounts for nearly 90 percent (by volume) of all of the fluoroplastics produced. A familiar trade name for PTFE made by DuPont is **Teflon®**. There are almost no solvents or chemicals that will react with this material, although it may be chemically etched and adhesive-bonded with contact or epoxy adhesives. Parts covered with PTFE have low coefficients of friction, slide easily, and require no lubrication.

The major advantages of PTFE are:

- Outstanding chemical and solvent resistance
- Low coefficient of friction
- Wide thermal service range
- Very good electrical insulation properties
- Nonflammable.

The major limitations of PTFE are:

- Expensive
- Not moldable by conventional thermoplastic techniques
- Low resistance to creep
- Low resistance to abrasion.

Because fluorine has 19 times the atomic mass of hydrogen, fluorocarbons have greater mass than hydrocarbons. Therefore, fluoroplastics are heavier than other plastics. Typical specific gravities range from 2.0 to 2.3.

The high bonding strength and compact interlocking of fluorine atoms about the carbon backbone prevent processing PTFE by the usual thermoplastic molding methods. Most of the material is shaped by sintering.

Sintering is a special fabrication technique where powdered material is pressed into a mold at a temperature just below its melting point until the particles are fused (sintered) together. The mass as whole does not actually melt in this process. The resulting product can then be machined into a final shape. This process is similar to technique used for making powdered metal.

Ideally, all the powdered particles will fuse together during sintering. However, if a few particles in the mass remain unfused, there may be a very small porosity between these two particles where liquids or gases may flow. Consequently, guidelines must be observed in PTFE parts to insure that these small porosities are not grouped together in such a way to allow a flow path completely through the part. The most common guideline is to maintain a minimum PTFE thickness.

In butterfly valves, PTFE is used as a covering for discs as well as a seat material. Since it is not an elastomer, PTFE will not return to its original shape once it has been displaced. Therefore, when PTFE is used as a seat material, it must be supported by an elastomer backing such as EPDM or Silicone. The PTFE must also be thin enough to flex when the elastomer backing pushes it. This conflicts with the general requirement to make the PTFE thick enough to avoid porosity.

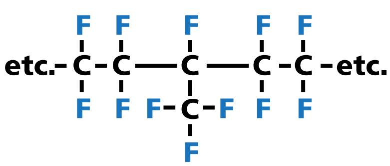
Creep is the permanent deformation of a material due to prolonged application of a stress below the elastic limit. A plastic part subjected to a load for a period of time tends to deform more than it would from the same load released immediately after application. The degree of the deformation is dependent upon the load duration. Creep at room temperature is sometimes called cold flow.

Creep resistance is another important property of fluoroplastics used in butterfly valve seats. The stress applied by a disc pushing against the seat will remain as long as the valve is closed. This stress can remain for many days, or even months. The fluoroplastic seat must not creep, or cold flow, so much that the sealing capability of the valve is affected.

Fluorinated Ethylene Propylene (FEP)

In 1965, DuPont announced another fluoroplastic wholly composed of fluorine and carbon atoms. FEP is a copolymer of tetrafluoroethylene (TFE) with hexafluoropropylene (HFP) and is marketed under the trade name **Teflon®**.

FluoroEthylenePropylene (FEP)



The partial disruption of the polymer chain by the propylene-like groups reduces the melting point and viscosity of FEP compared to PTFE. This allows FEP to be processed by normal thermoplastic molding methods. The low friction coefficient of FEP is similar to that of PTFE. However, the chemical resistance and temperature range are not quite as high as pure PTFE.

The major advantages of FEP are:

- Moldable by conventional thermoplastic techniques
- Good chemical and solvent resistance
- Low coefficient of friction
- Good electrical insulation properties
- Nonflammable

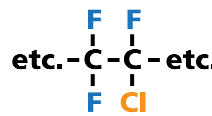
The major limitations of FEP are:

- Comparatively high cost
- Low resistance to creep
- Low resistance to abrasion

Polychlorotrifluoroethylene (PCTFE)

PCTFE is produced by substituting chlorine atoms for some fluorine atoms in the carbon chain. The 3M version of PCTFE is trade-named **Kel-F®**. The addition of the chlorine atoms allows processing by normal thermoplastic molding methods, and lowers the permeability. However, the weaker chlorine to carbon bond allows selected chemicals to attack and break the polymer chain.

PolychorotrifluoroEthylene (PCTFE)



PCTFE is harder, more flexible, and possesses a higher tensile strength than PTFE. It is more expensive than PTFE and has a lower service temperature range. Introduction of the chlorine atom lowers the electrical properties and raises the coefficient of friction. PCTFE can be produced in an optically clear form depending on the degree of crystallinity, and therefore finds use in chemically resistant films.

PCTFE is commonly used in cryogenic valve applications because it is able to retain its properties down to -250 °C (-418 °F)

The major advantages of PCTFE are:

- Moldable by conventional thermoplastic techniques
- Can be made in an optically clear film
- Low permeability
- Better creep resistance than PTFE or FEP

The major limitations of PCTFE are:

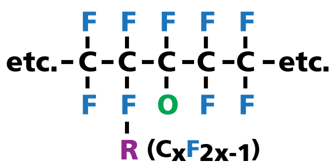
- More difficult to mold than FEP
- Lower electrical insulation properties than PTFE
- Higher cost than FEP and PTFE
- Less solvent resistance than FEP and PTFE
- Higher coefficient of friction than FEP and PTFE

PCTFE is sometimes called polytrifluorochloroethylene, or PTFCE.

Perfluoroalkoxy (PFA)

PFA is a newer grade of moldable fluoroplastic that has a higher service temperature than PCTFE and FEP, and better creep resistance than PTFE. The chemical resistance approaches that of PTFE.

Perfluoroalkoxy (PFA)



In 1972, DuPont offered PFA under the trade name of Teflon®. PFA may be processed by conventional thermoplastic molding.

The major advantages of PFA are:

- Higher temperature capability than PCTFE and FEP
- Very good chemical and solvent resistance (almost as good as PTFE)
- Low coefficient of friction
- Moldable by conventional thermoplastic techniques
- Nonflammable

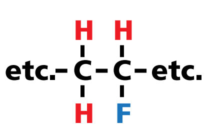
The major limitations of PFA are:

- Comparatively high cost
- Low resistance to creep
- Low resistance to abrasion

Polyvinyl Fluoride (PVF)

PVF was first introduced by DuPont in 1958 under the trade name **Tedlar®**. It has three hydrogen atom for every fluorine atom connected to the carbon backbone:

Polyvinyl Fluoride (PVF)



PVF is not as chemical or heat resistant as PTFE, PCTFE, FEP or PFA, but it has better melt processability. It is commonly used for wire insulation where flexibility is a prime requirement, as well as a protective coating for metal parts, house siding, and automotive parts.

The major advantages of PVF are:

- Easily moldable by conventional thermoplastic techniques
- Low permeability
- High flexibility
- Can be made transparent for coating purposes

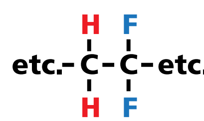
The major limitations of PVF are:

- Lower service temperature range than PTFE, PCTFE, FEP or PFA
- Lower chemical resistance than PTFE, PCTFE, FEP or PFA (especially with strong acids)

Polyvinylidene Flouride (PVDF)

PVDF was first produced in 1961 by Pennwalt Chemical Corporation under the trade name **Kynar®**. PVDF closely resembles PVF, but with one hydrogen atom for every fluorine atom connected to the carbon backbone:

Polyvinylidene Fluoride (PVDF)



PVDF does not have the chemical resistance of PTFE or PCTFE. The presence of the hydrogen atoms reduces the chemical resistance and allows attack by solvents. The alternating CH2 and CF2 groups in the backbone contribute to its tough, flexible characteristics. PVDF may be processed by conventional thermoplastic methods, and finds wide use in film and coatings. It has better abrasion resistance than PTFE.

The major advantages of PVDF are:

- Moldable by conventional thermoplastic techniques
- Better creep resistance than PTFE
- Better abrasion resistance than PTFE
- Excellent weatherability

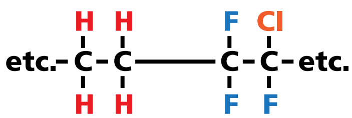
The major limitations of PVDF are:

- Lower chemical resistance than PTFE and PCTFE
- Lower temperature service range than PTFE or PCTFE

Ethylene Chlorotrifluoroethylene (ECTFE)

ECTFE is similar to FEP in moldability and uses. It has better abrasion resistance than PTFE. Ausimont manufactures ECTFE under the trade name **Halar**®. ECTFE is essentially a 1:1 alternating copolymer of ethylene and chlorotrifluoroethylene:

Ethylene Chlorotrifluoroethylene (ECTFE)



The major advantages of ECTFE are:

- Better abrasion resistance than PTFE
- Moldable by conventional thermoplastic techniques
- Lower permeability than PTFE
- Better creep resistance than PTFE
- Lower specific gravity than PTFE

The major limitations of ECTFE are:

- Comparatively high cost
- Lower chemical and solvent resistance than PTFE
- Slightly lower service temperature range than PTFE

Ethylene Tetrafluoroethylene (ETFE)

ETFE is a copolymer of ethylene and PTFE that has excellent moldability. It also has better abrasion resistance than PTFE and FEP. However, the maximum service temperature is much lower than PTFE. ETFE is produced by DuPont under the trade name Tefzel®.

The major advantages of ETFE are:

- Moldable by conventional thermoplastic techniques
- Better abrasion resistance than PTFE
- Better creep resistance than PTFE
- Lower specific gravity than PTFE

The major limitations of ETFE are:

- Comparatively high cost
- Lower chemical and solvent resistance than PTFE
- Much lower maximum service temperature than PTFE

Other Fluoroplastics

There are numerous other fluorine-containing polymers and copolymers, but they are essentially modified versions of the foregoing fluoroplastics. The modifications include alloying, blends with other polymers, and reinforcements. Typical reinforcement materials are glass fiber, graphite or bronze, all of which increase the hardness of the fluoroplastic.

EPDM

EPDM is the abbreviated name for Ethylene Propylene Diene Monomer. In general industry, one may see other abbreviations or trade names used in lieu of EPDM such as EPT, Nordel, ECD, or EPR. All of these are the same materials as EPDM.

EPDM is a standard seat material offered in Bray resilient-seated butterfly valves. It is the most universal and economical of seat materials offered by Bray; that is, it may be used in a wider range of applications than BUNA-N (hydrocarbons are EPDM's main Achilles' heel.) Of important significance also is the fact all EPDM seat materials sold by Bray are Food Grade. Bray's EPDM Food Grade seats are perfectly suitable for sanitary applications as well as standard industrial uses. Note: EPDM is also available as a covering for Series 20 disc stems.

Temperature Range:

-40°F (-40°C) to 250°F (121°C). Durometer increases when temperature is consistently below 0°F (-17.8°C)

Resistance To:

Abrasion:	Excellent
Acid:	Good
Compression Set Resistance:	Excellent
Gas Permeability:	Consult Factory
Hydrocarbon:	Poor (Swells Severely)
Tearing:	Good

General Comments – EPDM

1. **Food Grade:** Conforms to FDA 21 CFR 177.2600 © (4) Regulations and is suitable for sanitary services. Tested for minimum effects of odor and taste.
2. **EPDM Seats are peroxide cured**
3. **Generally recommended for the following media:**
   - Alcohols
   - Acidic Salts
   - Alkaline Salts
   - Alkaline Solutions
   - Beverages
   - Bleach
   - Hot Air
   - Inorganic Acids (Dilute,)
   - Neutral Salts
   - Water (cooling, brackish, salt.)

   Please go to the Software area and download the Bray Material Selection Guide - for further information on compatibility.
4. **Generally not recommended for the following media:**
   - Chlorinated Hydrocarbons
   - Hydrocarbon solvents & oils,
   - Petroleum based oils
   - Turpentine.

Note: Please refer to the Bray Material Selection Guide on the Bray Controls Website for further information on compatibility.

BUNA-N

BUNA-N is the commonly used name for Nitrile synthetic rubber. Nitrile is a copolymer of acrylonitrile and butadiene. BUNA-N is sometimes referred to as NBR, Nitrile, or Hycar.

BUNA-N is an excellent general purpose seat material which is particularly suitable for hydrocarbon service. BUNA-N is a standard Bray seat material and is Food Grade; thus suitable for sanitary applications.

Note: BUNA-N is also available as a covering for Series 20 disc stems.

Temperature Range:

0°F (-17°C) to +212°F (100°C)
Durometer hardness increases in those services where the temperature is consistently above +180°F (82°C), or where it is below +32°F (0°C)

Resistance To:

Abrasion:	Good
Acid:	Consult Factory
Compression Set Resistance:	Excellent
Gas Permeability:	Fair
Hydrocarbon:	Excellent
Tearing:	Fair

General Comments – BUNA-N

1. **Food Grade:** Conforms to FDA Regulations and is suitable for sanitary services. Tested for minimum effects of odor and taste
2. **White BUNA-N food grade** is available for required service applications such as sugar, flour, etc.
3. **Generally recommended for following media:**
   - Alcohols
   - Alkaline Salts
   - Automobile Gasoline (except unleaded)
   - Butane,
   - Dry Bulk Materials
   - Food Medias
   - Fuel Oils
   - L-P Gases
   - Petroleum Oils and Greases
   - Propane.

Note: Please refer to the Bray Material Selection Guide on the Bray Controls Website for further information on compatibility.

FKM

FKM is the ASTM D1418 designation for Fluorinated Hydrocarbon Elastomers (Fluoroelastomers) such as Viton® (DuPont) and FDA requirements to be qualified as a food grade seat. Bray's FKM has some outstanding characteristics such as acid resistance (equal or superior to EPDM), oil resistance (better than BUNA-N), and temperature resistance. However, due to its higher cost, FKM is generally used on those food grade applications such as citric acid where BUNA-N or EPDM is not acceptable.

Temperature Range:

0ºF (-17.8 °C) to 400ºF (204 °C).
IF TEMPERATURE WILL EXCEED 300ºF (149 °C),
VALVE PRESSURE RATING MAY BE REDUCED. CONSULT FACTORY

Resistance To:

Abrasion:	Fair
Acid:	Good
Compression Set Resistance:	Good
Gas Permeability:	Good
Hydrocarbon:	Excellent
Tearing:	Fair

General Comments – FKM

1. **Food Grade:** Conforms to FDA Regulations and is suitable for sanitary services. Tested for minimum effects of odor and taste

2. **Generally FKM is recommended for the following media:**
   - Alcohols
   - Aliphatic, aromatic and halogenated hydrocarbons
   - Aromatic and aliphatic ethers
   - Dilute and concentrated mineral acids
   - Esters or aromatic acids
   - Hot hydrocarbons, hydrocarbons with CO2 and H2S
   - Long chained aliphatic acids
   - Phosphoric acid.

3. **Generally FKM is not recommended for the following media:**

   Hot Water and Steam Services:.
   - Will become gummy and deteriorate, do not use.

   Amine compounds such as:
   - N-butylamine
   - Anhydrous ammonia
   - Unsymmetrical diphenyl hydrazine

   Ketones such as:
   - Acetone
   - Methyl-ethyl-ketone;

   Low molecular weight esters such as:
   - Ethyl acetate
   - N-propyl nitrate;

   Strong basic solutions such as:
   - Caustic soda
   - Potassium hydroxide.

Note: Please refer to the Bray Material Selection Guide on the Bray Controls Website for further information on compatibility.

Polyurethane

Polyurethane (more commonly referred to as "urethane") has successfully been used to line pipelines for a wide range of industries because of its ability to resist abrasive wear in many applications such as slurries, pneumatic conveying, hopper isolation, sediment, dry powder, dust extraction, mineral sands, mining, potash and fertilizer.

Urethane seats are primarily used for their ability to resist abrasive wear. Urethane can be used on a reasonably broad range of services. Urethane will withstand severe impact, recover its original shape after distortion and resist abrasion better than other elastomers such as EPDM and BUNA-N.

Temperature Range:		
Dry Heat	+80°C(+176°F)	-40°C(-40°F)
Wet Heat	+50°C(+122°F)	-40°C(-40°F)

Resistance To:	
Abrasion:	Excellent
Acid:	Consult Factory
Compression Set Resistance:	Consult Factory
Gas Permeability:	Consult Factory
Hydrocarbon:	Consult Factory
Tearing:	Excellent

General Comments – Polyurethane

Note: Please refer to the Bray Material Selection Guide on the Bray Controls Website for further information on compatibility.

Silicone

Silicone elastomers are part of a large group of siloxane polymers, based on a structure consisting of alternate silicon and oxygen atoms with various organic radicals attached to the silicon.

Compared to other elastomers, silicone possesses exceptional resistance to dry heat and extremely low temperatures. However, silicone rubber also has low tensile strength, poor tear resistance, and poor abrasion resistance. For this reason, silicone is not a standard Bray seat material. It is only offered because some customers request silicone seats for specific applications. Typically, these applications involve hot dry air and non-corrosive gasses.

Many samples of silicone elastomers have been exposed to outdoor weathering for 15 years with no significant loss of physical properties. This demonstrates excellent resistance to temperature extremes, sunlight, ozone, and the low concentrations of acids, bases and salts found in surface water. For this reason, some customers may think it will make an excellent general purpose butterfly valve seat material.

However, the movement of the disc against the seat is abrasive in nature and silicone seats last significantly less cycles than standard EPDM or BUNA-N seats. Furthermore, the coefficient of friction between the seat and the disc is higher, so that silicone seats should always be considered a Class C torque when sizing actuators.

The poor strength of the material makes it necessary to limit the use of silicone seats only to low pressure (60 psi, 4 Bar) and low cycling (on-off) applications.

Temperature Range:

-60 °F (-51 °C) to 350 °F (177 ° C) continuous.

Emergency Temperature Limit:

480° F (-284 °C) at 30 psig (2 bar) for one hour,
575 °F (302° C) at 30 psig (2 bar) for 30 minutes.

Resistance To:

Abrasion:	Poor. Use for low cycling applications only - Repeated cycling will cause damage.
Acid:	Consult Factory
Compression Set Resistance:	Good
Gas Permeability:	Good
Hydrocarbon:	Consult Factory
Tearing:	Very Poor

General Comments – Silicone

1. **Food Grade:** Not available
2. **Torque Characteristics:** Coefficient of friction between the seat and the disc in high. Silicone seats should always be considered a Class C torque when sizing actuators.
3. **Generally recommended for the following media:**
   - Hot, dry air
   - Non-corrosive gases
4. **Generally NOT recommended for the following media:**
   - Most petroleum fluids
   - Ketones
   - Water and Steam

Note: Please refer to the Bray Material Selection Guide on the Bray Controls Website for further information on compatibility.

PTFE Lined EPDM

PTFE lined EPDM seat consists of a PTFE liner which forms the faces and the flow way of the seat and is molded on to an EPDM elastomer backing. Only the inert non-stick PTFE liner surface is exposed to the line media. The EPDM backing acts as a resilient support to the relatively rigid PTFE.

PTFE/EPDM seats are generally used where BUNA-N and EPDM seats are not chemically suitable, especially in acids and alkalis.

Bray's PTFE complies with the Standard CFR 177.1550 of the FDA regulations governing the use of perfluorocarbon resins for articles used for producing, manufacturing, packing, processing, preparing, treating, packaging or holding food.

Note: PTFE also offered as a covering for the Series 20 disc stems.

Temperature Range:	
Standard:	-20°F (-29 °C) to 250°F (121 °C)
High-Temp.:	-20°F (-29 °C) to 302°F (150 °C)
Resistance To:	
Abrasion:	Poor for PTFE
Acid:	Consult Factory
Compression Set Resistance:	Fair (Due to EPDM backing)
Permeability:	Fair to Poor (due to relative thickness of PTFE Liner)
Chemical:	Excellent
Hydrocarbon:	Excellent
Tearing:	Very Poor

General Comments – PTFE Lined EPDM

1. **Food Grade:** Conforms to FDA Regulations and is suitable for sanitary services. Tested for minimum effects of odor and taste. Complies with CFR 177.1550 of the FDA regulations and is suitable for sanitary services including food and beverage, pure water, and antiseptic services.
2. **Torque Characteristics**: Rigidity of PTFE liner causes an increase in seating/unseating torques of PTFE/EPDM seat. **Always use category "C" torque when sizing valve actuators.**
3. **Generally is recommended for the following media:**
   - **All except for abrasive media.** Bray's seat design fully isolates the EPDM elastomer from contact with the flow media. For this reason, the PTFE lining alone should be considered when determining the seat's compatibility with the flow media.

Note: Please refer to the Bray Material Selection Guide on the Bray Controls Website for further information on compatibility.

Elastomer Covered Disc-Stems

Standard metal disc-stems are identified by a three digit material code stamped into the flat section of the Double D stem. On Elastomer Covered Disc-Stems these three digit material codes are also used to identify the composition of the Disc-Stem insert. The Disc-Stem insert is the metal part that is covered by the elastomer.

Material codes for the Disc-Stem insert are:

580.........316 Stainless Steel

583.........17-4 PH Stainless Steel

The Elastomer Covering of the Disc-Stem is indicated by a colored dot, approximately 1/4" in diameter, placed in the center of one side of the disc.

Material codes for the Elastomer Covering are:

Blue ....BUNA-N

Green.....EPDM

Red ....FKM SA

Yellow ...FKM AAB

FKM is the ASTM D1418 Designation for Fluorinated Hydrocarbon Elastomers (also called Fluoroelastomers) such as Viton® (DuPont) and Fluorel® (3M).

PTFE

Virgin PTFE

All Bray PTFE seats and encapsulated discs are molded from pure, virgin PTFE material to the following specifications:

Item	Minimum
Thickness	3mm
Specific Gravity	2.16
Crystallinity	68%

PTFE's inherent molecular bonding strength gives an extremely good chemical, high temperature and tear resistance. These properties combined with Bray's stringent material specifications provide optimum protection against permeation of the line media. This protection is far superior to PFA or FEP materials offered by other manufacturers.

PTFE also features a low coefficient of friction, thus reducing valve operating torques. PTFE lined discs and seats are ideal for high pressure use in chemical, high purity water, food, pharmaceutical and other sanitary industries.

Conductive PTFE

Bray Conductive PTFE seats and discs are available for installation in areas of the plant where explosion protection is important. This material was designed to prevent harmful electrostatic discharge (ESD). For the ultimate in safety and reliability, Bray has combined ESD protection and the excellent chemical resistance properties of PTFE.

Conductive PTFE contains carbon filler which makes it black in color.

Conductive PTFE (black) Series 22 and 23 seats and discs are presently not considered as conforming to the FDA Standard CFR 177.1500 due to the carbon black pigment.

PTFE - FDA Approval

All pure (white) polytetrafluoroethylene (PTFE) homopolymers used in the manufacture of Bray Valves comply with United States of America Federal Standard CFR 177. 1550 of the FDA (Food and Drug Administration) regulations governing the use of perfluorocarbon resins in articles used for producing, manufacturing, packing, processing, preparing, treating, packaging or holding food.

The above statement applies in general to the following valve parts:

Series 20 and 21, Elastomer - Backed PTFE Seats
Series 20 and 21, PTFE - Coated Disc Stems
Series 22 and 23, PTFE Seats
Series 22 and 23, PTFE Coated Disc

Temperature Range:	
-40°F (-40 °C) to 392°F (200 °C).	
Resistance To:	
Abrasion:	Poor
Acid:	Consult Factory
Compression Set Resistance:	Consult Factory
Gas Permeability:	Excellent
Chemical:	Excellent
Hydrocarbon:	Consult Factory
Tearing:	Very Poor

General Comments – PTFE

1. **United States Department of Agriculture (USDA)** recognizes pure (white) PTFE as suitable for contact with meat and poultry products.

Note: Please refer to the Bray Material Selection Guide on the Bray Controls Website for further information on compatibility.

PTFE

CONDUCTIVE PTFE

UHMWPE

UHMWPE seats and discs feature exceptional chemical resistance and are the ideal choice for highly abrasive chemical applications. The natural ability of the UHMWPE's high molecular weight to repel solids prevents in-line particles from damaging the valve's seat surfaces. These properties and features combine to greatly extend the life of the valve, and make the UHMWPE seat and disc the economical and high performance choice for abrasive chemical services.

All seats are Mil certified per DIN S0049 3.1B and are marked for traceability.

Temperature Range:	
-0°F (-18 °C) to 185°F (85 °C)	
Resistance To:	
Abrasion:	Very Good - used in abrasive slurries such as chemical and industrial waste where a variety of mild corrosive and hydrocarbons may be present.
Acid:	Consult Factory
Compression Set Resistance:	Consult Factory
Permeability:	Consult Factory
Chemical:	Fair
Hydrocarbon:	Consult Factory
Tearing:	Consult Factory
General Comments – UHMWPE	

Note: Please refer to the Bray Material Selection Guide on the Bray Controls Website for further information on compatibility.

Series 22/23
Introduction to Fluorocarbons

Bray Series 22/23 PTFE Butterfly valves are designed and manufactured for installation in the most corrosive and chemically aggressive industrial applications. It uses the fluoropolymer, PTFE as an inert barrier between the corrosive or aggressive media and all metal parts.

The S22/23 valve is designed so that all wetted parts are fully lined with PTFE of 1/8” (3mm) minimum thickness. PTFE is an inert fluoropolymer that will easily resist attacks from nearly all industrial chemicals. The valve is a cost effective replacement for high alloy valves and valve trims such as Alloy 20, Hastelloy, Titanium, Zirconium, or even Stainless Steel. The design and the materials of construction will also make the S22/23 the valve of choice for ultrapure applications.

There are 2 major design parameters a valve of this type must have:

1. It must provide tight shut off
2. The lining material must effectively resist the corrosion, temperature, and permeation effects of aggressive chemicals and/or applications

SHUT OFF CAPABILITY & DESIGN

The S22/23 is rated for bidirectional bubble-tight shut off at 150 psig. To achieve this tight, repeatable seal, the PTFE body liner is carefully machined to provide a seating surface that is concentric to the radius of the disc. The arc of the seating surface is identical to the arc on the entire disc edge circumference, including the disc hubs. Matching the entire sealing surface also greatly improves the cycle life of the valve by eliminating potential wear spots. While PTFE is an excellent sealing material, it has little memory and must depend on an elastomer energizer to provide resiliency and sealing energy. This is achieved by placing a silicone elastomer backing ring directly behind the body liner to create a mechanically energized interference fit seal. The disc outside diameter is larger than the seat inside diameter. When the disc is turned into the matching arc of the seat, the seat is displaced outwardly and the elastomer backing ring is compressed. The elastomer backing ring covers the entire circumference and provides a uniform sealing force around the disc edge and across the hubs, ensuring long term sealing capability.

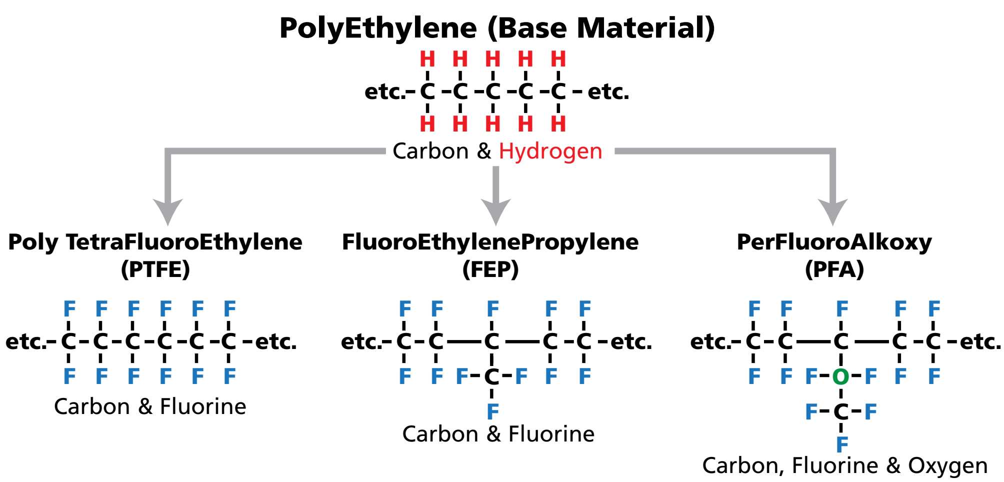
PTFE has a lower coefficient of friction than other fluoropolymers such as PFA or FEP. This property allows Bray to significantly enlarge the sealing surface by making the disc edge wider. The disc hubs are also enlarged to provide maximum sealing area. These large sealing surfaces ensure continued tight shut off while still achieving low operating torque.

Unlike most other designs, all line media is sealed inside the S22/23 valve and not in the valve stem journal or against the stem. To achieve this, Bray locates the primary interference seal across the entire surface of the disc hub by using the compressive energy from the elastomer seat energizer ring. A secondary stem seal is provided by Bray’s patented Stem Seal Capsule. This capsule, constructed of a FKM ring surrounded by a virgin PTFE “U” shaped cup, totally isolates the valve body and stem. When compressed between the disc and seat during assembly, the capsule becomes energized, exerting both downward and upward pressure on the disc and seat surfaces.

USE OF FLUOROPOLYMERS AS LINING MATERIALS

PTFE, FEP, and PFA are the fluoropolymers most commonly used as valve lining materials. The basic molecular structure common to all three is a backbone of carbon atoms surrounded by fluorine atoms. Fluorine provides the chemical resistance properties of all fluoropolymers. The fluorine bond to carbon is one of the strongest single bonds in organic chemistry. Since few chemicals can break this bond, the chemical resistance of fluoropolymers is extremely high.

Each of these fluoropolymers are made from the same feed stock, polyethylene. By replacing all of the hydrogen atoms in polyethylene with fluorine atoms, a fluorocarbon is produced. The molecular structure of each specific fluoropolymer is very different:



Many units of carbon atoms (with fluorine atoms attached) can be connected to produce long chain fluorocarbon polymers. The Greek word for many is "poly" and the word for unit is "mer". In English, "polymer" means many units. PTFE has a linear molecular structure of pure carbon and fluorine. Both PFA and FEP have branched molecular structures involving side chains of additional atoms. The molecular chains in PTFE are typically 10 times longer than any grade of PFA or FEP.

All three fluorocarbons begin processing as a solid in pellet or powder form and undergo the same solid-liquid-solid phase transitions during processing. PTFE is shaped by placing the powder in a mold and then applying compressive force. Bray uses an isostatic molding process to ensure that every section of the mold receives equal compression. Following shaping, the pre-formed powder is put in an oven under high temperatures in a process called sintering to melt, or fuse the component into an integral whole. PFA and FEP, as shown in the molecular structure drawings, have a carbon or an oxygen side chain, and shorter chain lengths, which produces a significantly lower viscosity when heated into a liquid. Hence, PFA and FEP are "melt processable". The pellets are melted and then injection molded to form the component part. Although they are initially more expensive per pound as a raw material, PFA and FEP injection molded parts can be produced very quickly and are much less expensive as finished components. They are melted and molded in the same production step. Parts which are difficult to mold, such as encapsulated discs, are much easier to produce with this processing method. Although PTFE will melt when heated, it remains too viscous to flow into a mold and therefore must be molded and melted in two separate steps.

The adding of the carbon-oxygen bond in PFA and the side carbon-carbon bond in FEP is what changes the characteristics of the materials enough to allow them to be melt processable. However, these bonds are weaker and are therefore easier to break when exposed to some chemicals than the exclusive bonding of carbon to fluorine atoms as found in PTFE.

Resistance to Permeation

Permeation occurs when the line media migrates through the fluoropolymer without necessarily disrupting the fluoropolymer itself. "Permeation is the product of two functions- the diffusion between molecular chains and the solubility of the permeant in the polymer." It allows the media to attack the parts behind the fluoropolymer and may eventually cause valve failure.

Several factors influence the rate of permeation that are process related. Increased line pressure, increased process temperature, and increased exposure time all influence the degrees of permeation.

Bray reduces the possibility of permeation by increasing the Density/Specific Gravity of PTFE to a minimum 2.16, increasing Crystallinity to a minimum of 68%, and making all PTFE components with a minimum of 1/8" (3mm) thickness. These manufacturing parameters make the PTFE used in Bray's S22/23 valve less permeable than the PFA, FEP, or even PTFE used by other manufacturers.

Density/Specific Gravity

PTFE 2.13 to 2.18 Depending on the compression and sintering process.

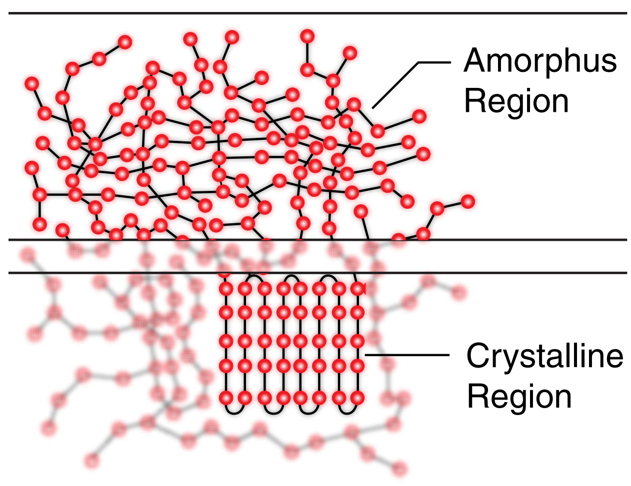
PFA 2.14

FEP 2.14

Note: PTFE used in the Bray 22/23 has a minimum Specific Gravity of 2.16

Crystallinity

Crystallinity levels are determined by the polymer type (PTFE, FEP, or PFA) and how tightly the temperature is controlled during the transition phase from liquid back to solid during the processing of the polymer. Polymer chains can fold over themselves in either an orderly manner like a fire hose in a cabinet, or in a disorderly manner, like a plate of spaghetti. An orderly structure is called "Crystalline". All three of the fluorocarbon polymers under discussion are two-phase materials, containing both crystalline (regular shape) and amorphous (irregular shape) regions:



As crystallinity increases, polymers become harder, more dense, less resilient, more heat and chemical resistant, and less transparent. Small increases in crystallinity produce large increases in permeation resistance. The penetration path for media becomes more difficult as crystallinity increases.

DuPont Company states "Higher levels of crystallinity provide a greater barrier to permeates because these ordered regions diminish the molecular volume available for passage. For example, amorphous regions are easier to permeate". The percent of crystallinity can be expressed as a rating.

Typical crystallinity ratings:

PTFE 65%
PFA 55%
FEP 50%

Note: PTFE used in the Bray S22/23 has a minimum Crystallinity of 68%. Due to substantially longer production times, PTFE with high Crystallinity and high Specific Gravity can take twice as long to make, and cost substantially more to produce than PTFE made with low Crystallinity and lower Specific Gravity.

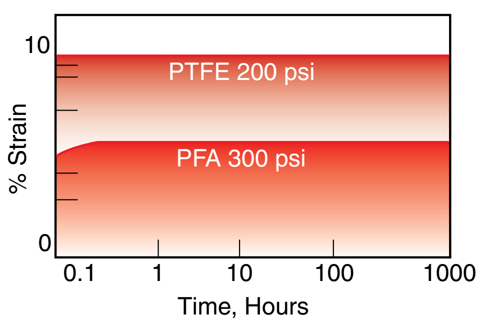
Thickness

Bray's S22/23 is manufactured with a minimum PTFE thickness of 1/8" (3mm). Per DuPont, increasing the thickness of the polymer reduces permeation at a geometric rate. Again, small increases in thickness make a tremendous difference in permeation protection.

Creep or "Cold Flow"

Per Dupont, creep, commonly referred to as cold flow is defined as the total deformation under stress after a specified time in a given environment beyond that instantaneous strain which occurs immediately upon loading. Independent variables which affect creep are time under stress, temperature, and the stress level.

All polymers cold flow to some degree. As shown previously, PTFE has a very linearly shaped molecule which allows it to strain or "slide" to a greater extent than materials with side chains in their molecular structure, such as FEP or PFA. However, for the stresses (pressure/temperature) that the Bray series 22/23, or any other fully lined valve is designed for, the degree of cold flow after the initial strain is virtually non-existent. This is shown on the following graph by the flat line which appears after the initial load (stress) is applied.



Cold Flow Properties of TEFLON® Fluorocarbon Resins
Compressive Creep at 392°F (200°C)
Data compiled from DuPont Publication 234398A

Due to the fact that the degree of cold flow is measurable and very predictable, it is an engineered factor in the design of the Bray S22/23 valve. After assembly, the Series 22/23 valve is exercised with several cycles to apply the initial load that will cold flow the seat and the disc to the engineered dimensions. This will conform the seat perfectly to the disc which is one of the many reasons for the exceptional sealing capabilities of the Series 22/23.

Bray Virgin PTFE Specifications

All Bray PTFE seats and encapsulated discs are molded from pure virgin PTFE material to the following specifications:

SPECIFICATION	MINIMUM
Thickness	1/8" (3mm)
Specific Gravity	2.16
Crystallinity	68%

PTFE's inherent molecular bonding strength gives extremely good chemical, temperature, and tear resistance. Bray provides unequaled protection against possible permeation by manufacturing PTFE components that follow the advice of the DuPont Company. PTFE Crystallinity is increased, PTFE Specific Gravity and Density are increased, and Liner Thickness is increased. Concerns about leakage, permeation, and cycle life were all considered and are effectively eliminated by the engineered features designed into the S22/23 valve.

Bray Valve & Controls has combined industry's best seal design with superior molding, sintering, and machining techniques to produce the first true High Performance PTFE lined butterfly valve