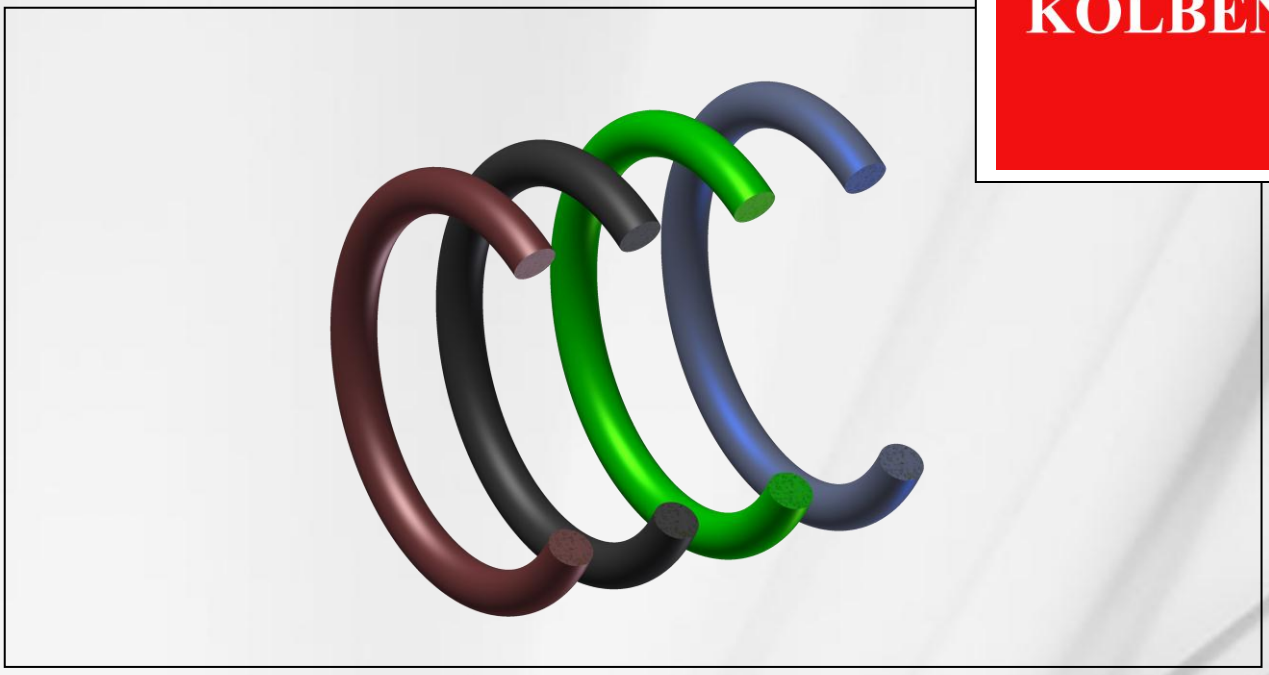
O-Ring

KOLBEN

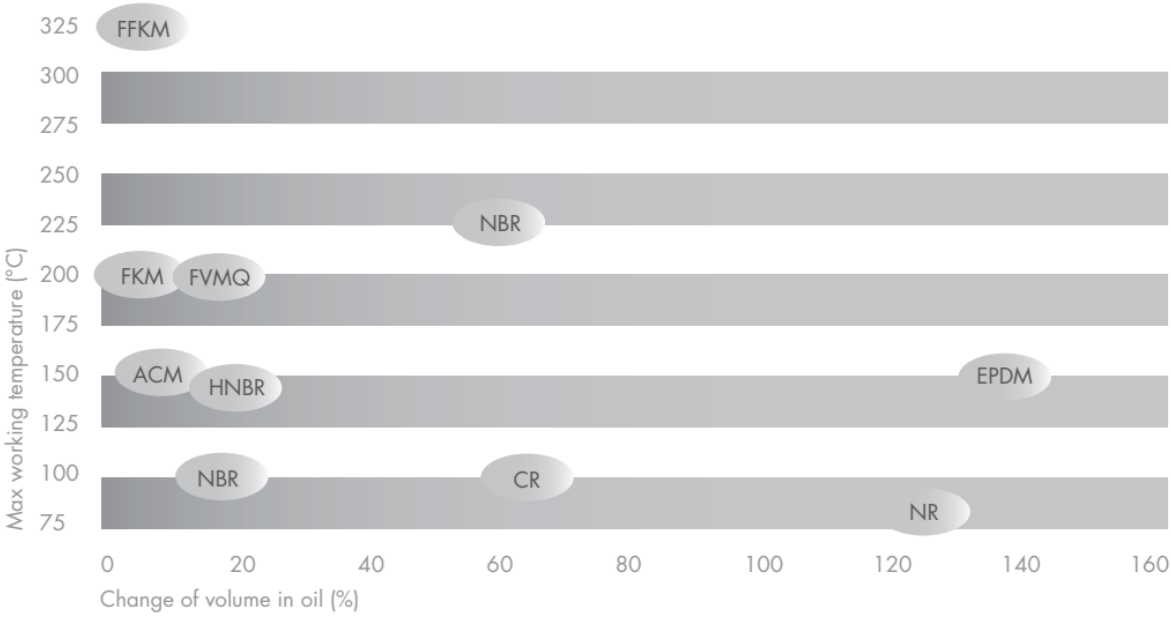


Quick Guide for O-ring Selection

The most important characteristics of material to be selection are :

- Temperature resistance
- Chemical resistance

The figure below shows the heat and oil resistance of various elastomers. For specific resistance to



NBR – N70N00L			
Trade name	Temperature range	Chemical resistance	Applications
Nitrile,	-30 / +108°C	hydraulic and lubricating oils	Hydraulic oils, Vegetable oils,
Buna N®,			Animal fats, Acetylene, Alcohols,
Perbunan®		animal and vegetable oils	Water, Air, Fuels.
Chemigum®		aliphatic hydrocarbons:	
		(LPG gases, butane, propane,	
		petroleum oil,petrol, kerosene,	
		diesel fuels) water	
		not compatible with:	
		aromatic hydrocarbons	
		(benzene) chlorinated	
		hydrocarbons (trichloroethylene)	
		polar solvents (ketone, acetone,	
		acetic acid) strong acids	
		brake fluid ozone, weather and	
		atmospheric aging	

Table 2-1: Main characteristics NBR – N70N00L

FKM – V70N00E			
Trade name	Temperature range	Chemical resistance	Applications
Viton®,	-20 / +204°C	hydraulic fluids	high temperature to oils, fats
Fluorel®		mineral and vegetable oils	and fuels
Tecnoflon®		aliphatic hydrocarbons:	chemical industry
		(fuel, butane, propane, natural	vacuum applications
		gas)	
		aromatic hydrocarbons	
		(benzene, toluene)	
		chlorinated hydrocarbons	
		(trichloroethylene, carbon tetra-	
		chloride fuels, also with metha-	
		nol content vacuum	
		ozone, weather and aging	
		resistant	
		not compatible with:	
		glycol based brake fluids,	
		ammonia gas, amines, alkalis	
		superheated steam	

Table 2-2: Main characteristics FKM – V70N00E

HNBR – H70N00C			
Trade name	Temperature range	Chemical resistance	Applications
Therban®,	-25 / +150°C	aliphatic hydrocarbons:	oil and fuel resistant components
Zetpol®		(fuel, butane, propane,	automotive industry
		natural gas)	
		animal and vegetable oils	
		hydraulic fluids	
		water and steam up to	
		150°C	
		ozone, aging resistant	
		not compatible with:	
		chlorinated hydrocarbons	
		(trichloroethylene, carbon	
		tetrachloride	
		polar solvents (ketone,	
		acetone, acetic acid)	
		strong acids	

Table 2-3: Main characteristics HNBR – H70N00C

EPDM – E70N00L			
Trade name	Temperature range	Chemical resistance	Applications
Nordel®,	-50 / +150°C	hot water and steam	brake fluid components
Keltan®,		(up to 150 °C)	window profiles
Buna EP®		glycol based brake fluids	
		organic and inorganic acids	hot water applications
		cleaning agents, soda and pot-	
		assium alkalis	
		phosphate-ester based	
		hydraulic fluids	
		polar solvents (alcohol,	
		ketones, esters)	
		ozone, weather and ageing	
		resistant	
		not compatible with:	
		mineral oils	

VMQ – S70R00E			
Trade name	Temperature range	Chemical resistance	Applications
Silicone,	-60 / +230°C	engine and transmission oil	electrical insulation
Elastosil®,		animal and vegetable oils	medical and food industry.
Silastic®		moderate water resistance	for extremely high or low tempera-
		diluted salt solutions	ture range, air, oxygen, dry heat,
		hot air	ozone, hot water to 150°C, and
		excellent ozone, weather and	glycol based brake fluids
		aging resistant	
		not compatible with:	
		superheated steam over 121°C	
		acids and alkalis	
		aromatic mineral oils	
		hydrocarbon based fuels	
		aromatic hydrocarbons	
		(benzene, toluene)	

Table 2-5: Main characteristics VMQ – S70R00E

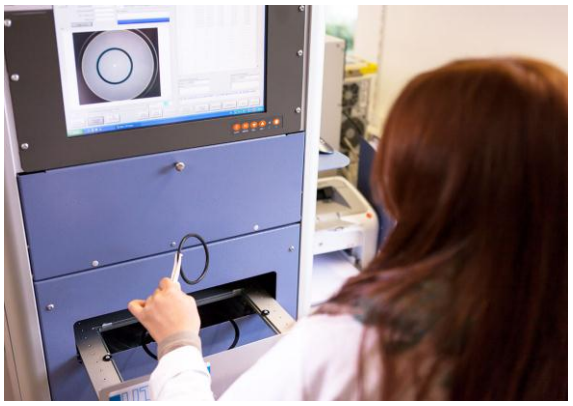
FFKM – X70N00T			
Trade name	Temperature range	Chemical resistance	Applications
Kalrez®,	-15 / +316°C	hydraulic fluids oils	superior material, chemical
Chemraz®,		most hydrocarbons	resistance equal to PTFE.
Simriz®		majority of chemicals	very expensive material
Parafluor®			
		not compatible with:	
		perfluorinated hydrocarbons,	
		molten alkali metals	

Table 2-6: Main characteristics FFKM – X70N00T

Select The Hardness

The hardness of 70 Shore A is most common and it gives a good sealing performance.
If the pressures is higher >5MPa a hardness of 90 Shore A can be chosen to prevent extrusion of the O-Ring. For pressures of more than 10 MPa (100 bar) we recommend the use of Back-Up rings. Of course, depending on the application, the material, cross-section and the clearance are important.

For construction details see the more detailed information in the next sections.



Hardness (IRHD)	Pressure (MPa)
70	<5
90	5-10
Back-Up rings necessary	>10

Figure 2-2: Hardness/pressure table

Select The O-Ring Dimensions

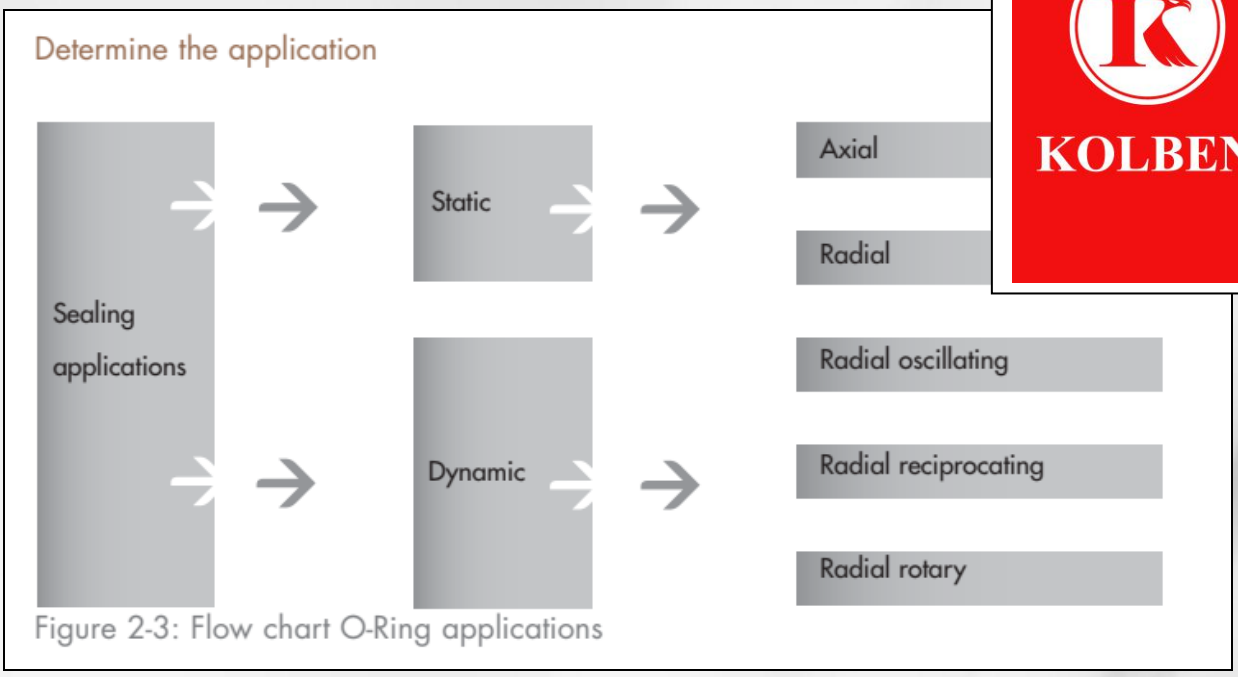


Figure 2-3: Flow chart O-Ring applications

Figure 2-4: O-Ring

Axial installation (static):

• When the pressure is from the inside, the outside diameter of the O-Ring should be 1-2% larger than the outside groove diameter.

• When the pressure is from the outside, the inside diameter of the O-Ring should be 1-3% smaller than the inside groove diameter.

Radial installation (static and dynamic):

• Outer sealing (piston seal)

The O-Ring inside diameter should be equal or max. 5% smaller than the inside groove diameter.

• Inner sealing (rod seal)

The O-Ring inside diameter should not differ much, if at all, from the rod diameter, the exception being the O-Ring used as a rotary seal. In this case the O-Ring inside diameter needs to be 3% larger than the rod diameter.

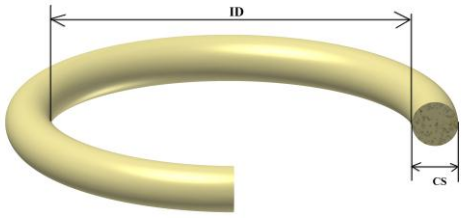
Select the cross-section (d2)

In general an O-Ring with a larger cross-section generally has a better compression set, less swell and accepts larger tolerances. Disadvantages are the larger supporting structure and increased friction. Consequently a smaller cross-section is usually preferred for dynamic applications. The table on the next page can be used as a rough guideline for the cross-sections.

Introduction O-Ring

What is an O-Ring?

An O-Ring is the most commonly used part for static and dynamic seals, with world production
amounting to billions per year.
In 1937 Niels A Christensen, a Danish emigrant to the USA was awarded a patent for this ring
with the perfect geometrical shape.
The O-Ring is an efficient, cost-effective sealing element for a great diversity of applications.
It is extensively used virtually in all branches of industry.
Elastomer materials in different formulations ensure that almost any medium can be reliably
sealed off. The O-Ring is torus, providing an endless round sealing with a circular cross-section.



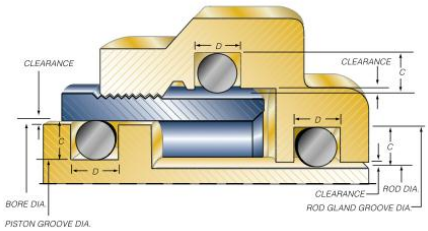
O-Ring dimensions:

• Inside diameter ID

From approx. 0.74 mm to 1500 mm

• Cross-section CS

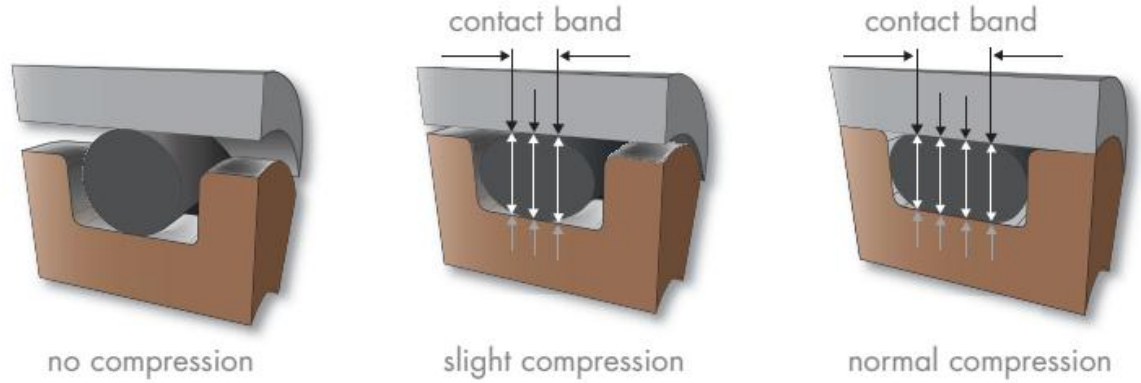
From approx. 0.35 mm to 20 mm



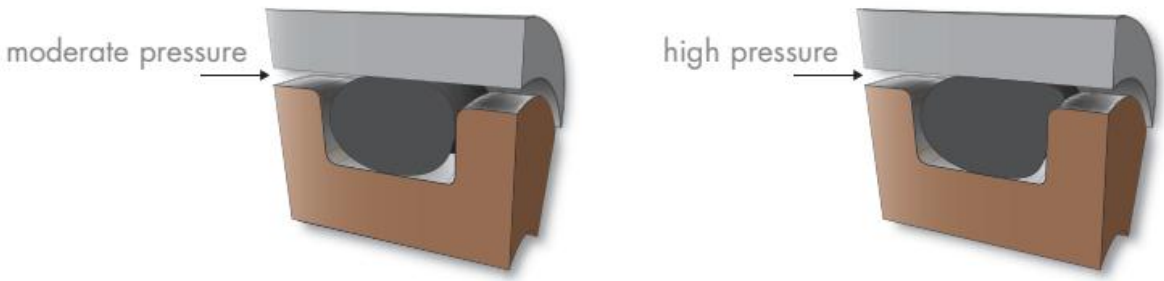
How do O-Rings seal?

An O-Ring seals by blocking any potential leak path of a fluid (liquid or gas) between two closely spaced
surfaces. The O-Ring is usually installed in a machined groove in one of the surfaces to be sealed.
As the two surfaces are brought together, they squeeze the cross-section of the O-Ring.
This results in a deformation of the O-Ring cross-section. The greater the squeeze, the larger the deformation.

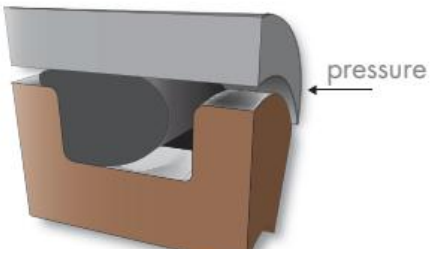
It is the unique characteristics of the elastomer material used in O-Rings that makes the O-Ring such a good seal. The elastomer, a highly viscous, incompressible fluid with high surface tension, has a capacity to remember its original shape for a long time.
In low pressure applications (in which the confined fluid exerts little or no pressure on the O-Ring), the tendency of the elastomer to maintain its original shape creates the seal. As the O-Ring is deformed when the mating surfaces are brought together, it exerts a force against the mating surfaces equal to the force necessary to squeeze it, as illustrated in the figure. The areas of contact between the O-Ring and the mating surfaces (contact bands) act as a barrier that blocks the passage of the fluid.



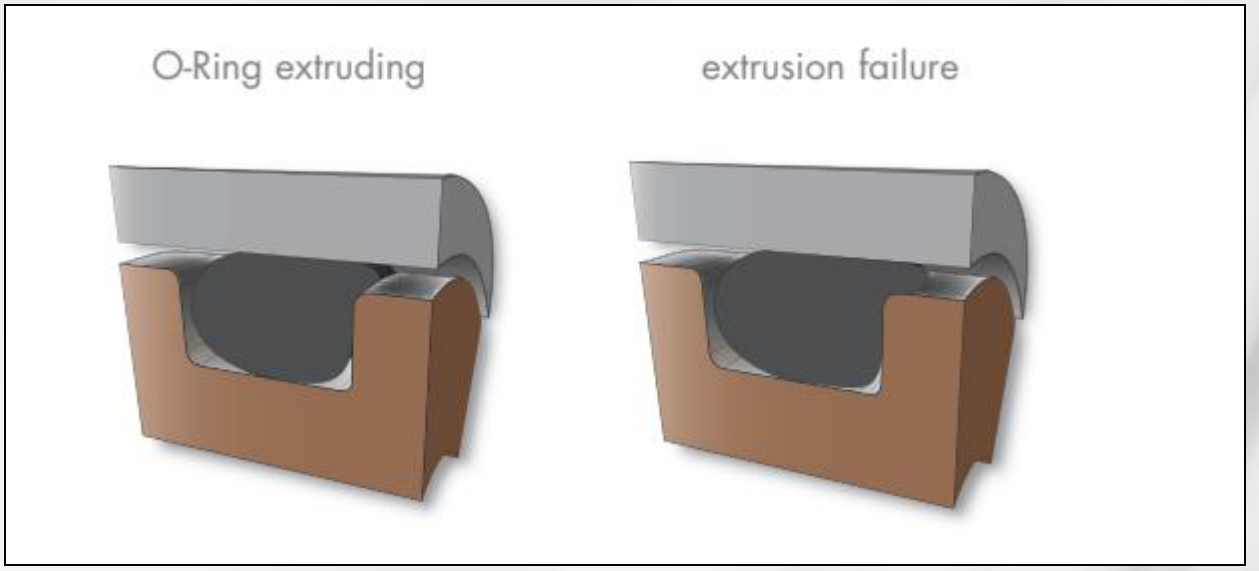
In applications in which higher pressure is exerted by the confined fluid, the sealing action of the O-Ring caused by the squeeze of its cross-section is augmented by fluid pressure, transmitted through the elastomer. The O-Ring is forced to the side of the groove, away from the pressure. As it is pressed against the side, the O-Ring cross-section is deformed into a 'D' configuration as shown in the Figure. The elastomer exerts equal force in all directions and is forced up to (but not into) the gap between the mating surfaces.



When pressure is released, the O-Ring returns to approximately its original shape on installation, ready for the next application of pressure. The O-Ring is also able to seal in both directions. In a doubly acting system in which pressure application changes form one side of the O-Ring to the other, the O-Ring moves, seating itself in the opposite side of the groove.



If pressure exceeds the limits of the O-Ring, or if the gap that the O-Ring must block is too large, the elastomer will enter the narrow gap between the inner and outer surfaces. This may result in extrusion failure, causing the fluid to leak. Extrusion resulting from high pressure and other causes is explained in the section O-Ring failures.



Advantages of O-Rings

- They seal over a wide range of pressure, temperature and tolerance.
- Ease of service or re-tightening.
- O-Rings require very little room and are light in weight.
- In many cases an O-Ring can be reused, an advantage over non-elastic flat seals and crush-type gaskets.
- O-Ring failure is usually gradual and easily identified.
- They are cost-effective.

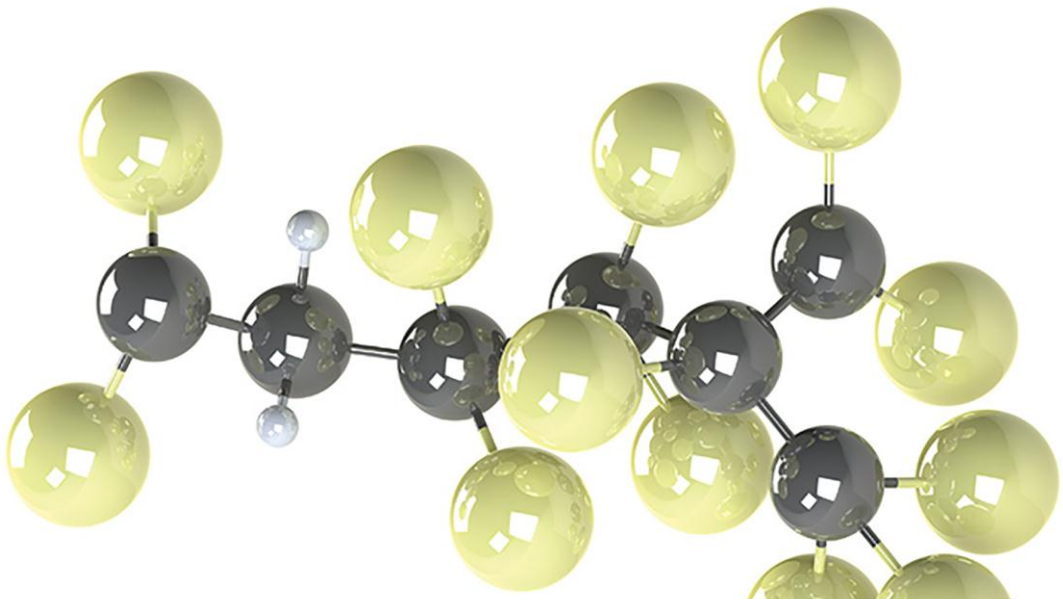
Materials

List of synthetic elastomers

Many elastomer types have been developed to create the best mechanical and chemical properties for specific applications. Elastomers are classified into groups as per IS0 1629 or ASTM D 1418. The following tables provide a summary of the various elastomers and material groups..

Designation	Trade Name	Abbreviation ISO 1629	ASTM D 1418
Acrylonite-Butadiene Elastomer (Nitrile Rubber)	Perbunan® Buna-N®	NBR	NBR
Fluorocarbon Elastomer	Viton® Fluorel® Tecnoflon®	FKM	FKM
Ethylene Propylene Diene Elastomer	Dutral® Keltan® Nordel®	EPDM	EPDM
Silicone Elastomer	Elastosil® Rhodorsil® Silastic® Silopren®	VMQ	VMQ
Fluorosilicone Elastomer	Silastic®	FVMQ	FVMQ
Tetrafluorethylene-Propylene Copolymer Elastomer	Aflas®	FEPM	TFE / P
Hydrogenated Acrylonitrile-Butadiene Elastomer	Therban® Zetpol®	HNBR	HNBR
Chloroprene Elastomer	Neoprene® Baypren®	CR	CR
Butyl Elastomer	Esso Butyl®	IIR	IIR
Styrene-Butadiene Elastomer	Buna S® Europrene®	SBR	SBR
Natural Elastomer		NR	WR
Perfluoro Elastomer	Kalrez® Zalak® Chemraz®	FFKM	FFKM

Table 4-1: Elastomers



Chemical name	Abbreviation DIN/ISO 1629	ASTM D 1418
M – Group		
(saturated carbon molecules in main macro-molecule-chain)		
• Polyacrylate Rubber	ACM	ACM
• Ethylene Acrylate Rubber	AEM	
• Chlorosulphonated Polyethylene Rubber	CSM	CSM
• Ethylene Propylene Diene Rubber	EPDM	EPDM
• Ethylene Propylene Rubber	EPM	EPM
• Fluorocarbon Rubber	FKM	FKM
• Perfluoro Rubber	FFKM	FFKM
O – Group		
(with oxygen molecules in the main macro-molecule chain)		
• Epichlorohydrin Rubber	CO	CO
• Epichlorohydrin Copolymer Rubber	ECO	ECO
R – Group		
(unsaturated hydrogene carbon chain)		
• Chloroprene Rubber	CR	CR
• Butyl Rubber	IIR	IIR
• Acrylonitrile Butadiene Rubber	NBR	NBR
• Natural Rubber	NR	NR
• Styrene Butadiene Rubber	SBR	SBR
• Hydrogenated Nitrile Butadiene Rubber	HNBR	HNBR
Q – Group		
(with Silicone in the main chain)		
• Fluorosilicone Rubber	FVMQ	FVMQ
• Methyl Vinyl Silicone Rubber	VMQ	VMQ
U - Group		
(with carbon, oxygen and nitrogen in the main chain)		
• Polyester Urethane	AU	AU
• Polyether Urethane	EU	EU

Table 4-2: The most important types of synthetic rubber, their grouping and abbreviations

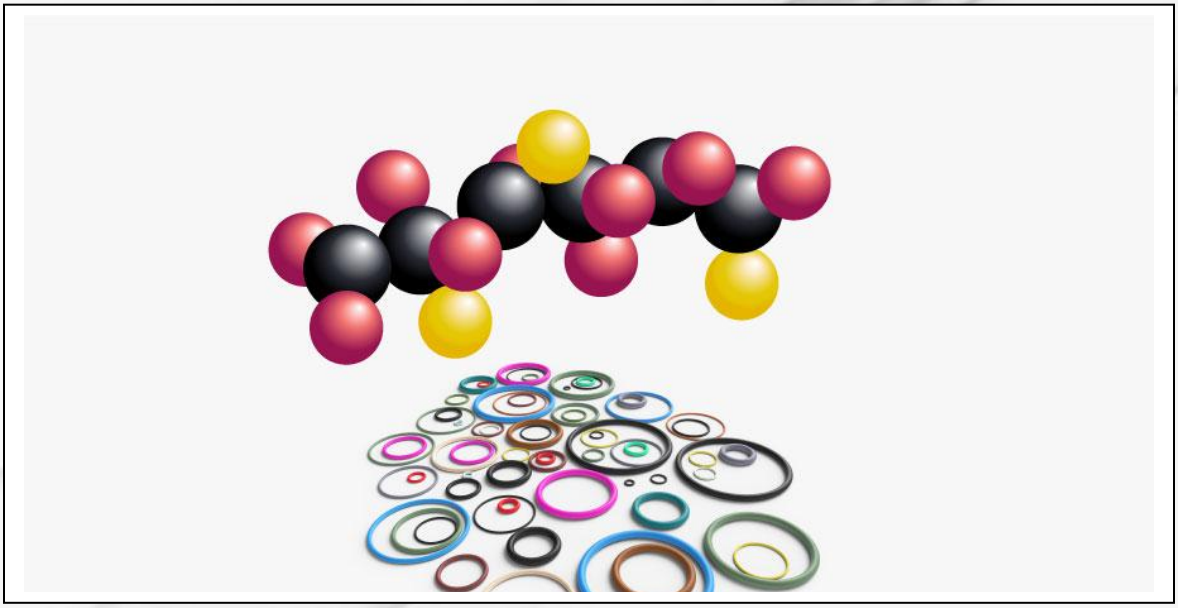
Main properties of elastomers

Elastomers are complex materials that exhibit unique combinations of useful properties.
The first and foremost property is elasticity. All elastomers have the ability to deform substantially by stretching, compression or torsion and then, after removal of the force causing the deformation, snap back to almost their original shape.
Besides elastic recovery, the majority of elastomers possess other useful properties, including:

- Low permeability to air, several gases, water and steam
- Good electrical and thermal insulation
- Good mechanical properties
- The capability of adhering to metals and plastics

By proper selection of compound ingredients, products with improved or specific properties can be designed to meet a wide variety of service conditions.
Main properties:

- Specific weight
- Hardness
- Tensile strength
- Elongation
- Modulus
- Tear strength
- Compressions set
- Resistance to fluids
- Chemical resistance
- Resistance to ozone
- Resistance to low temperatures
- Resistance to accelerating ageing



Basic elastomers for O-Rings

The following paragraph briefly reviews various elastomers currently available for use in O-Rings and other seals.

NBR (Acrylonitrile-Butadiene Rubber)

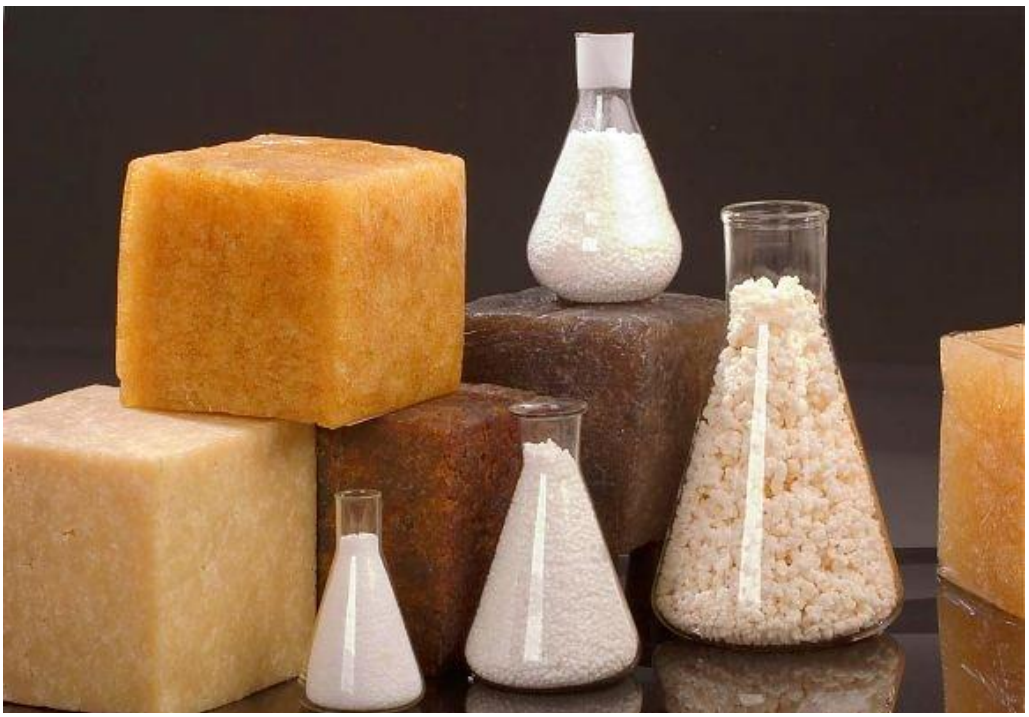
Acrylonitrile-butadiene or nitrile rubbers are copolymers of butadiene and acrylonitrile. The acrylonitrile content of these compounds varies considerably - from 18% to 50% - and influences the physical properties of the finished material. As the acrylonitrile content is increased the following changes in the vulcanizate properties occur:

- Resistance to petroleum-based fluids and hydrocarbon fuels increases
- Low-temperature flexibility decreases
- Rebound resilience decreases
- Compression set decreases
- Gas permeability decreases
- Heat resistance improves
- Ozone resistance improves
- Abrasion resistance improves
- Tensile strength increases
- Hardness increases
- Density increases

The standard NBR compounds have a medium content of ACN (33%) and are a compromise between the opposing properties of the material. In comparison with other elastomers NBR has good mechanical properties and high wear resistance. NBR is not resistant to weathering and ozone. NBR vulcanizates are the most widely used elastomers for sealing applications because NBR is resistant to a wide range of petroleum-based greases and fluids, vegetable and animal oils, silicone greases and oils, water and aqueous solutions of non oxidizing chemicals. Specially formulated compounds extend the range of applications in which NBR can be used. The operating temperatures range between -30°C and +108°C.

EPM, EPDM (Ethylene-Propylene Rubber)

There are two types of the ethylene-propylene rubbers:
• EPM, a fully saturated copolymer of ethylene and propylene and
• EPDM, a terpolymer of ethylene, propylene and a small percentage of a non-conjugated diene
The EPM rubbers, being completely saturated, require organic peroxides or radiation for vulcanization.
The EPDM terpolymers can be vulcanized with peroxides, sulphur or radiation.
The properties of EPM and EPDM rubbers are basically the same. EPDM is the most common sealing material. It has a fair tensile strength over a wide range and excellent resistance to ozone, weathering and chemical attack. Furthermore, EPM and EPDM rubbers exhibit very good electrical insulation properties. Sulphur-cured compounds have a higher compression set and are less resistant to high temperatures. Peroxide-cured compounds exhibit excellent heat ageing properties and resistance to compression set up to 150°C. EPDM compounds are resistant to: hot water and steam, non petroleum-based automotive brake fluids, aqueous solutions of inorganic acids, alkalis and salts, alcohols, glycols, ketones (acetone, MEK) and low molecular weight esters.
Their resistance to animal and vegetable oils and fats is moderate.
EPDM is not resistant to mineral oil based fluids and greases, synthetic hydrocarbon lubricants, organic ester based lubricants and hydrocarbon fuels.



FKM (Fluorocarbon Rubber)

Fluoroelastomers were introduced in 1957 (DuPont-Viton®) to meet the need of the aerospace industry for a high-performance seal elastomer. Since then, the use of fluoroelastomers has expanded to many other industries, especially the automotive, fluid power, appliance sectors, and many chemical fields. With over 50 years of proven performance, fluoroelastomer has developed a reputation for outstanding
performance in high temperature and extremely corrosive environments.

Fluoroelastomers are highly fluorinated hydrocarbon polymers. In general, all highly fluorinated polymers are very stable and possess exceptional resistance to oxidation, weather, flame, chemical attack and swelling in a wide range of liquids. This stability is mainly due to the high strength of the C-F bond as compared to the C-H bond.
FKM rubbers are available in various grades, which differ mainly in the polymer composition and fluorine content. In combination with the cure system (diamines, bisphenol or peroxides) the properties of the compound can be influenced to meet the requirements of the application.
In general FKM has an outstanding resistance to high temperatures, it's elastomeric properties in hot air are maintained up to 204°C with peak temperatures up to 300°C. FKM elastomers exhibit excellent resistance to swelling in a wide variety of oils, fuels, solvents and chemicals.
They are recommended for:
• Petroleum oils and hydrocarbon fuels
• Organic ester based lubricants
• Silicate ester based lubricants
• Aromatic hydrocarbons (benzene, toluene, xylene)
• Halogenated hydrocarbons (trichloroethylene, carbon tetrachloride)

Despite their excellent resistance to a wide variety of fluids, there are certain chemicals that severely attack FKM compounds. The use of FKM elastomers is not recommended for:
• Polar solvents, ketones (acetone, MEK) and esters (ethyl acetate)
• Low molecular weight organic acids (formic acid, acetic acid)
• Hot water and steam, unless compounded with lead oxide
• Skydrol fluids
• Glycol based automotive brake fluids
• Anhydrous ammonia and amines
• Hot hydrofluoric or chlorosulphonic acids
The fluid resistance of FKM types improves with increasing fluorine levels. However, as the fluorine content increases the low-temperature flexibility of the polymer decreases, and a compromise must be made between fluid resistance and low temperature flexibility of the final vulcanizate. The low-temperature properties of conventional FKM elastomers are, in general, moderate. For low-temperature applications special FKM types have been developed.

HNBR (Hydrogenated Acrylonitrile-Butadiene Rubber)

Hydrogenated acrylonitrile-butadiene rubbers are produced by selective and controlled hydrogenation of NBR. The highly saturated polymethylene chains demonstrate excellent heat and ozone resistance whereas the nitrile groups provide oil and fuel resistance. Increasing the degree of hydrogenation results in improved heat and ozone resistance.

As would be expected, increasing the nitrile content in HNBR results in reduced swelling in mineral oils, but with hardly any loss in low temperature flexibility compared to the regular NBR. The operating temperature range of HNBR is -25 to +150°C.

HNBR is resistant to:

- Aliphatic hydrocarbons
- Vegetable and animal fats and oils
- HFA, HFB and HFC fluids
- Dilute acids, bases and salt solutions at moderate temperatures
- Water and steam up to 150°C
- Ozone, ageing and weathering

HNBR is not compatible with:

- Chlorinated hydrocarbons
- Polar solvents (ketone and ester)
- Strong acids

HNBR elastomers fill a gap between NBR and FKM in many areas of application. In general they are used to replace NBR whenever the resistance to excessive heat or aggressive environments is critical. In contrast to conventional FKM compounds, HNBR elastomers can withstand basic additives such as amine-based corrosion inhibitors. For this reason, HNBR compounds are used in oil-field operations. They maintain their performance in difficult conditions, whereas NBR and most of the conventional FKM elastomers show a certain amount of degradation.

VMQ (Silicone Rubber)

Silicone rubbers have a backbone that consists of alternating silicon and oxygen atoms (-Si-O-Si-). This is unusual compared to other elastomers which have an organic backbone (-C-C-). Silicone rubber shows excellent heat resistance, cold flexibility, dielectric properties and especially good resistance to oxygen and ozone. Silicone has a high physiological inertness, it is odourless, tasteless and non-toxic. The mechanical properties, however, are poor to moderate. The material should only be used in static applications. Depending on the material the operating temperatures range between -60°C and +200°C (and for a short period of time even up to +230°C).

VMQ is resistant to:
• Engine and transmission oil (for example ASTM oil No.1)
• Animal and vegetable oil and grease
• Brake fluid (non-petroleum base)
• Fire-resistant hydraulic fluid, HFD-R and HFD-S
• High molecular weight chlorinated aromatic hydrocarbons
(including flame-resistant insulators and coolant for transformers)
• Moderate water resistance
• Diluted salt solutions
• Ozone, ageing and weather
VMQ is not compatible with:
• Superheated water steam over 121°C (250°F)
• Acids and alkalis
• Low molecular weight chlorinated hydrocarbons (trichloroethylene)
• Aromatic mineral oil
• Hydrocarbon based fuels
• Aromatic hydrocarbons (benzene, toluene)

FFKM (Perfluoro rubber)

Perfluoroelastomer is produced by the copolymerization of tetrafluoroethylene (TFE) and a perfluorinated ether, e.g. perfluoromethylvinylether (PMVE).
The cured polymer does not contain hydrogen atoms in the molecule. The absence of hydrogen increases the heat and chemical resistance as compared to FKM.
Perfluoroelastomers show broad chemical resistance similar to PTFE (DuPont–Teflon®) as well as good heat resistance. They show low swelling with almost all media. Depending on the material the operating temperatures range between -25°C and +300°C. This high-end material has been on the market since 1968 and is the most expensive elastomer available, comparable to gold.
FFKM parts provide reliable, long-term service with a wide range of aggressive industrial and electronic grade chemicals. It is used in highly aggressive chemical processing, semiconductor wafer processing, pharmaceutical applications, oil and gas recovery, aerospace and petroleum applications.

FEPM (Tetrafluoroethylene-Propylene rubber)

This elastomer is a copolymer of tetrafluoroethylene (TFE) and propylene, also known by its trade name Aflas®. It is an improved ethylene-propylene rubber in which the hydrogen atoms of ethylene are replaced by fluorine. The C-F bond and the saturated polymer chain are responsible for the excellent chemical and heat resistance of the elastomer. The operating temperatures range between -25°C and +300°C. FE/P is resistant to:

- Amines
- Steam and hot water
- Sour oil and gas
- Hydraulic fluids
- Petroleum oils and greases
- Alcohols
- Acids, alkalis and oxidizing chemicals
- Ozone and weather
- Aromatic and chlorinated hydrocarbons
- Ketones

The compression set resistance is not as good as that of FKM elastomers and the low-temperature flexibility is poor.

AU/EU/PU/HTPU/HHPU (Polyurethane rubber)

One must differentiate between polyester urethane (AU) and polyether urethane (EU). AU type urethanes exhibit better resistance to hydraulic fluids. Polyurethane elastomers, as a class, have excellent wear resistance, high tensile strength and high elasticity in comparison with any other elastomers. The operating temperatures range between -25°C and +160°C.

Polyurethane is resistant to:

- Aliphatic hydrocarbons (propane, butane, fuel)
- Mineral oil and grease
- Silicone oil and grease
- Water up to 50°C (EU type)
- Ozone and ageing resistant

Polyurethane is not compatible with:

- Ketones, esters, ethers, alcohols, glycols
- Hot water, steam, alkalis, amines, acids

Selection of the base compound

System operating temperatures and compatibility with the media to be sealed are the two most important parameters that must be considered when selecting a base polymer. Only when these two factors are identified (together with any lubricants and potential cleaning fluids), can a reliable recommendation be given concerning selection of the proper elastomer base.

Temperature

The application temperatures refer to long-term exposure to non-aggressive media. At higher temperatures, new cross-link sites may be formed between the polymer chains and lead to a loss of seal flexibility.

The stiffness in the polymer chains may be observed as excessive compression set in highly filled (loaded) compounds. This condition prevents an O-Ring cross-section from returning to its original, pre-compressed shape after deformation forces are removed. During compression, a seal changes its original shape to effect a seal. And over time, and at excessive temperature, elastic memory loss in the elastomer seal element can cause leakage. Exceeding the normal maximum temperature limit for a given compound always results in reduced service life.

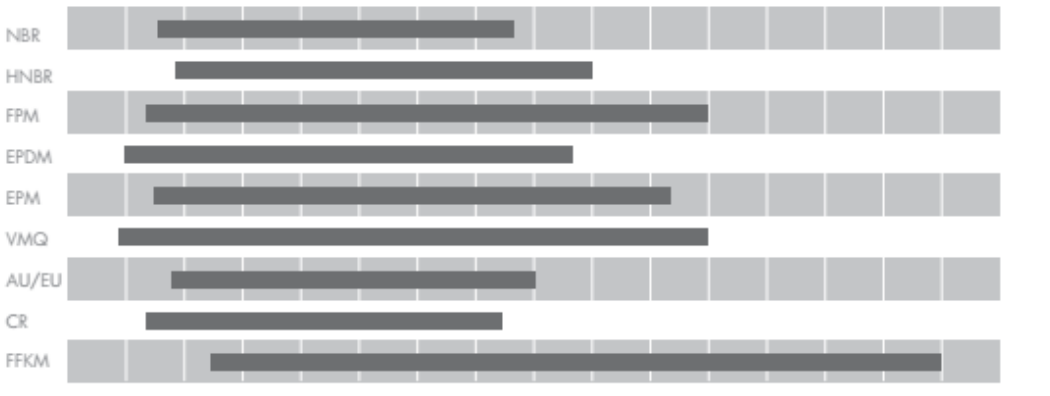


Table 4-3: Temperature ranges of various elastomer materials (medium: air)

Chemical compatibility

Practically all elastomers undergo a physical or chemical change when in contact with a sealed medium. The degree of change depends on the chemical characteristics of the medium and on the system temperature. An aggressive medium becomes more active with increasing temperature.
Physical changes are caused by two mechanisms which can work concurrently when:

- The elastomer absorbs a medium
- Plasticizers and other components of the compound are dissolved and extracted or leached out by the media

The result is a volume change, i.e. swelling or shrinkage of the elastomer seal. The degree of the volume change depends on the type of medium, molecular structure of the rubber compound, system temperature, geometrical seal shape (material thickness), and the stressed condition of the rubber part (compression or stretch). When deformed and exposed to a medium, rubber, when confined in a groove, swells significantly less than in a free state (up to 50%) due to a number of factors including reduced surface area in contact with the medium. The limit of permissible volume change varies with the application.
For static seals, a volume change of 25% to 30% can be tolerated. Swelling leads to some deterioration of the mechanical properties and, in particular, those properties which improve extrusion resistance. In dynamic applications, swelling leads to increased friction and a higher wear rate. Therefore, a maximum swell of 10% should generally not be exceeded. Shrinkage should also be prevented because the resulting loss of compressive force will increase the risk of leakage.
The extraction of plasticizer from a seal material is sometimes compensated for by partial absorption of the contact medium. However, this situation, can still lead to unexpected shrinkage and resultant leakage if an elastomer dries out and the absorbed fluids evaporate. A chemical reaction between sealed or excluded medium and the elastomer can bring about structural changes in the form of further cross-linking or degrading. The smallest chemical change in an elastomer can lead to significant changes in physical properties, such as embrittlement.

The suitability of an elastomer for a specific application can be established only when the properties under typical working conditions of both, the medium and the elastomer, are known.
If a particular seal material suits a medium, it is referred to as being ‘compatible’ with that medium.
See the next table for a comparison of the properties of commonly used elastomers.

Elastomer	NR	SBR	EPDM	CR	NBR
Hardness (degrees Shore A)	30 - 95	40 - 95	30 - 85	30 - 90	40 - 90
Colour (standard)	Black	Black	Black	Black	Black
Heat resistance					
Constant max. (°C)	75	85	130	95	100
Peak max. (°C)	105	115	150	125	130
Resistance to low temperatures (°C)	-60	-55	-50	-35	-20
Resistance to					
Oxidation	fair	fair	excellent	very good	good
Ozone / weather	poor	poor	excellent	very good	fair
Ageing in oil					
Oil ASTM no.1 at 20°C	poor	poor	fair	excellent	excellent
Oil ASTM no.1 at 100°C	unsatisfactory	unsatisfactory	unsatisfactory	good	good
Oil ASTM no.3 at 20°C	unsatisfactory	unsatisfactory	unsatisfactory	good	excellent
Oil ASTM no.3 at 100°C	unsatisfactory	unsatisfactory	unsatisfactory	fair	good
Resistance to fuel ASTM 'B' at 40°C	unsatisfactory	unsatisfactory	unsatisfactory	poor	fair
Resistance to solvents (20°C)					
Alcohol	good	good	good	good	good
Acetone	fair	fair	good	fair	unsatisfactory
Benzene	unsatisfactory	unsatisfactory	unsatisfactory	unsatisfactory	unsatisfactory
Resistance to chemical products					
Acids	fair	fair	good	good	good
Bases	good	good	good	fair	fair
Physical strength	excellent	good	good	good	good
Compression set	good	good	good	fair	good
Tear strength / abrasion resistance	excellent	good	good	good	good
Resilience	excellent	good	very good	very good	good
Permeability to gas	fair	fair	fair	fair	good
Electrical properties	excellent	excellent	excellent	good	poor
Flame resistance	poor	poor	poor	self-extinguishing	poor
Water resistance	very good	good	excellent	good	good

Table 4-4: Compound properties

Elastomer	ACM	VMQ	HNBR	FKM	FMVQ
Hardness (degrees Shore A)	50 - 85	40 - 80	50 - 95	50 - 95	40 - 80
Colour (standard)	Black	Redbrown	Black	Black	Blue
Heat resistance					
Constant max. (°C)	150	180 / 200	125	205	170
Peak max. (°C)	180	200 / 300	150	300	220
Resistance to low temperatures (°C)	-20	-60	-30	-20	-60
Resistance to					
Oxidation	excellent	excellent	excellent	excellent	excellent
Ozone / weather	excellent	excellent	very good	excellent	excellent
Ageing in oil					
Oil ASTM no.1 at 20°C	excellent	excellent	excellent	excellent	excellent
Oil ASTM no.1 at 100°C	excellent	good	excellent	excellent	excellent
Oil ASTM no.3 at 20°C	excellent	good	fair	excellent	excellent
Oil ASTM no.3 at 100°C	excellent	fair	fair	excellent	excellent
Resistance to fuel ASTM 'B' at 40°C	poor	unsuitable	-	excellent	fair
Resistance to solvents (20°C)					
Alcohol	good	good	excellent	good	good
Acetone	unsatisfactory	fair	good	unsuitable	unsuitable
Benzene	unsatisfactory	unsatisfactory	fair	good	good
Resistance to chemical products					
Acids	poor	fair	good	excellent	good
Bases	poor	fair	good	good	fair
Physical strength	good	fair	good	good	poor
Compression set	good	good	good	good	good
Tear strength / abrasion resistance	good	poor	very good	good	poor
Resilience	poor	good	fair	fair	fair
Permeability to gas	good	poor	good	very good	poor
Electrical properties	fair	excellent	poor	good	excellent
Flame resistance	poor	good	poor	self-extinguishing	self-extinguishing
Water resistance	poor	good	very good	good	good

Table 4-4: Compound properties (Continued)

Chemical compatibility guide

This guide is intended to assist the user in determining the suitability of various elastomers for many different chemical environments. The ratings are based on a combination of published literature, laboratory tests, actual field experience, and informed judgments. As laboratory tests do not necessarily predict end-use performance, users of our products should conduct their own evaluations to determine application suitability.
Note: Volume swell is only one indicator of elastomer fluid compatibility and may be based on the solubility parameter alone. Fluid attack on the backbone of the polymer may show up as a change a in physical properties such as tensile strength, elongation at break, and hardness. High temperature and extended exposure times may create more aggressive conditions than cited in this guide.
In some cases, specific elastomer compounds within a material family may provide improved compatibility.

Rating system:
1 Little or no effect <10% elastomer may exhibit swelling and/or loss of physical properties under severe conditions.
2 Possible loss of 10–20% elastomer may exhibit swelling in addition to a change in physical properties. It may be suitable for static applications.
3 Noticeable change 20–40% elastomer exhibits a noticeable change in swelling and physical properties. Questionable performance in most applications.
4 Excessive change >40% elastomer not suitable for service.
0 Insufficient information available for rating.
The information given in this chemical compatibility guide is believed to be reliable, but no representation, guarantees or warranties of any kind are made as to its accuracy or suitability for any purpose

	ACM	CR	EPDM	FFKM	FKM	FMVQ	HNBR	NBR	NR	PTFE	SBR	TFE	VMQ
Acetaldehyde	4	3	2	2	4	4	3	4	2	1	3	4	2
Acetamide	4	1	1	1	2	1	1	1	4	1	4	2	2
Acetanilide	4	1	1	1	3	1	3	3	1	0	1	0	2
Acetic Acid Amide	4	1	1	1	3	1	1	1	4	1	4	2	2
Acetic Acid Ethyl Ester	0	2	2	1	4	0	2	4	0	1	0	4	0
Acetic Aid Methyl Ester	4	2	2	1	4	4	4	4	4	1	4	4	4
Acetic Acid, 25% to 60%	0	0	1	1	3	2	4	2	4	1	4	0	1
Acetic Acid, 5%	4	1	1	1	1	2	2	2	2	0	2	1	1
Acetic Acid, 85%	0	0	0	1	3	0	4	4	4	1	4	0	0
Acetic Acid, Glacial	4	4	2	1	4	4	2	2	4	1	4	3	1
Acetic Aldehyde	4	3	2	2	4	4	3	4	2	1	3	4	2
Acetic Anhydride	4	2	2	1	4	4	4	4	2	1	1	2	3
Acetic Ester	4	4	2	1	4	4	4	4	4	1	4	4	2
Acetoacetic Acid	4	1	1	1	4	1	3	3	1	0	1	0	2
Acetol	4	2	1	1	4	4	4	4	1	1	1	4	4
Acetone	4	4	1	1	4	4	4	4	1	1	1	4	4
Acetone Cyanohydrin	4	1	1	1	4	1	3	3	1	0	1	0	2
Acetonitrile	4	2	1	1	4	1	3	3	1	0	1	1	2
Acetophenetidine	4	4	4	1	1	2	2	2	4	0	4	0	0
Acetophenone	4	4	1	1	4	4	4	4	4	1	4	4	4
Acetotoluidide	4	4	4	1	1	2	2	2	4	0	4	0	0
Acetyl Acetone	4	4	1	1	4	4	4	4	4	0	4	4	4
Acetyl Benzene	4	4	1	1	4	4	4	4	4	1	4	4	4
Acetyl Bromide	4	4	1	1	1	4	4	4	4	0	4	2	4
Acetyl Chloride	4	4	4	1	1	1	4	4	4	1	4	1	3
Acetylene	1	2	1	1	1	1	1	1	2	1	2	1	2
Acetylene Dichloride	4	4	4	1	2	2	2	2	4	0	4	0	0
Acetylene Tetrabromide	0	2	1	1	1	2	4	4	0	0	4	1	4
Acetylene Tetrachloride	4	4	1	1	1	2	4	4	4	1	4	4	4
Acetylsalicylic Acid	4	4	4	1	1	2	2	2	4	0	4	0	0
Acrolein	4	1	1	1	4	1	3	3	1	0	1	0	2
Acryimide	4	1	1	1	3	1	1	1	4	1	4	2	2
Acrylic Acid, Ethyl Ester	4	4	3	1	4	4	4	2	4	1	4	4	4
Acrylonitrile	4	4	4	1	4	4	4	4	3	1	3	2	4
Adipic Acid	0	1	2	1	2	1	1	1	1	1	1	2	0
Aero Lubriplate	1	1	4	1	1	1	1	1	4	0	2	1	2
Aero Shell 17 Grease	1	2	4	1	1	1	1	1	4	0	4	1	2
Aero Shell 1AC Grease	1	2	4	1	1	1	1	1	4	0	4	1	2
Aero Shell 750	2	4	4	1	1	2	2	2	4	0	4	1	4
Aero Shell 7A Grease	1	2	4	1	1	1	2	2	4	0	4	1	2

1 Little or no effect - 2 Possible loss of physical properties - 3 Noticeable change - 4 Not suitable - 0 Insufficient info

Table 4-7: Chemical compatibility guide

	ACM	CR	EPDM	FFKM	FKM	FMVQ	HNBR	NBR	NR	PTFE	SBR	TFE	VMQ
Aerosafe 2300	4	4	1	1	4	3	4	4	4	0	4	3	3
Aerosafe 2300w	4	4	1	1	4	3	4	4	4	0	4	2	3
Aerozene 50,													
50% Hydrazine 50% UDMH	0	4	1	2	4	4	3	3	4	0	4	2	4
Air below 200°F	1	1	1	1	1	1	1	1	2	1	2	1	1
Air, 200–300° F	2	2	2	1	1	1	3	3	4	0	4	1	1
Air, 300–400° F	4	4	4	1	1	1	4	4	4	0	4	1	1
Air, 400–500° F	4	4	4	2	3	4	4	4	4	0	4	3	2
Air, Oil-Containing	1	1	4	1	1	1	1	1	4	1	2	0	1
Aliphatic Dicarboxylic Acid	4	4	4	1	1	2	2	2	4	0	4	0	0
Alkanes	1	2	4	1	1	1	1	1	4	0	4	0	2
Alkanesulfonic Acid	1	2	4	1	1	1	1	1	4	0	4	0	2
Alkazene	4	4	4	1	2	2	4	4	4	1	4	2	4
Alkenes	4	4	4	1	1	2	2	2	4	0	4	0	0
Alkyl Acetone	4	1	1	1	4	1	3	3	1	0	1	0	2
Alkyl Alcohol	1	2	4	1	4	1	1	1	4	0	4	0	2
Alkyl Amine	1	2	4	1	4	1	1	1	4	0	4	0	2
Alkyl Aryl Sulfonates	1	2	4	1	1	1	1	1	4	0	4	0	2
Alkyl Aryl Sulfonics	1	2	4	1	1	1	1	1	4	0	4	0	2
Alkyl Benzene	4	4	4	1	2	2	2	2	4	0	4	0	0
Alkyl Chloride	4	4	4	1	2	2	2	2	4	0	4	0	0
Alkyl Naphthalene Sulfonic Acid	1	2	4	1	1	1	1	1	4	0	4	0	2
Alkyl Sulfide	4	4	4	1	1	2	2	2	4	0	4	0	0
Allyl Alcohol	0	2	1	1	4	0	2	2	1	1	1	0	0
Allyl Chloride	0	1	1	1	2	0	2	2	0	0	0	2	0
Allylidene Diacetate	4	1	1	1	3	1	3	3	1	0	1	0	2
Alpha Picoline	4	1	1	1	3	1	3	3	1	0	1	0	2
Alum Potash	4	2	1	1	4	3	2	2	2	0	2	1	3
Aluminum Acetate	4	2	1	1	4	4	2	2	1	1	2	1	4
Aluminum Bromide	1	1	1	1	1	1	1	1	1	0	1	1	1
Aluminum Chlorate	4	1	1	1	3	1	3	3	1	0	1	0	2
Aluminum Chloride	1	1	1	1	1	1	1	1	1	1	1	1	2
Aluminum Fluoride	0	1	1	1	1	1	1	1	2	1	1	1	2
Aluminum Formate	4	1	1	1	4	1	3	3	1	0	1	0	2
Aluminum Hydrate	0	3	2	1	2	0	2	2	0	0	0	1	2
Aluminum Hydroxide	0	3	2	1	1	0	2	2	0	0	0	1	2
Aluminum Linoleate	1	2	4	1	1	1	1	1	4	0	4	0	2
Aluminum Nitrate	0	1	1	1	1	0	1	1	1	1	1	1	2
Aluminum Oxalate	4	1	1	1	3	1	3	3	1	0	1	0	2
Aluminum Phosphate	0	1	1	1	1	0	1	1	0	0	0	1	1
Aluminum Potassium Sulfate	4	1	1	1	1	1	3	3	1	0	1	0	2
Aluminum Salts	1	1	1	1	1	1	1	1	1	0	1	1	1
Aluminum Sodium Sulfate	4	1	1	1	1	1	3	3	1	0	1	0	2
Aluminum Sulfate	4	1	1	1	1	1	1	1	1	1	2	1	1

1 Little or no effect - 2 Possible loss of physical properties - 3 Noticeable change - 4 Not suitable - 0 Insufficient info

Table 4-7: Chemical compatibility guide (Continued)

	ACM	CR	EPDM	FFKM	FKM	FMVQ	HNBR	NBR	NR	PTFE	SBR	TFE	VMQ
Alums	4	1	1	1	1	4	1	1	4	1	1	2	1
Ambrex 33	1	2	4	1	1	3	1	1	4	0	4	1	4
Ambrex 830	1	2	3	1	1	1	1	1	4	0	4	1	2
Amines Mixed (Allyl, Ethyl, etc.)	4	2	2	1	4	4	4	4	2	0	2	2	2
Amino Benzene	4	4	2	1	2	3	4	4	4	1	4	2	4
Aminobenzoic Acid	0	4	2	1	2	0	4	4	0	0	0	1	0
Aminoethanol (2-Aminoethanol)	4	2	2	1	4	4	2	4	2	0	2	0	2
Aminomethane	4	1	1	1	4	1	4	4	2	1	2	0	2
Aminopyridine	0	4	2	1	4	0	4	4	0	0	0	3	0
Ammonia	4	1	1	2	4	4	2	2	1	1	1	2	2
Ammonia and Lithium Metal in Solution	4	4	2	4	4	4	2	4	4	0	4	4	4
Ammonia Gas, Cold	4	1	1	1	4	4	1	1	1	1	1	1	1
Ammonia Gas, Hot	4	2	2	1	4	4	4	4	4	1	4	2	1
Ammonia, Anhydrous Liquid	4	1	1	1	4	4	2	2	4	0	4	3	2
Ammonium Acetate	4	2	1	1	4	1	1	1	1	1	1	0	2
Ammonium Arsenate	4	1	1	1	3	1	3	3	1	0	1	0	2
Ammonium Benzoate	4	1	1	1	3	1	3	3	1	0	1	0	2
Ammonium Bicarbonate	4	1	1	1	4	1	3	3	1	0	1	0	2
Ammonium Bisulfite	4	1	1	1	3	1	3	3	1	0	1	0	2
Ammonium Bromide	0	1	1	1	1	0	1	1	1	0	1	1	0
Ammonium Carbamate	4	1	1	1	3	1	3	3	1	0	1	0	2
Ammonium Carbonate	4	1	1	1	1	0	1	4	1	1	1	1	3
Ammonium Chloride	1	1	1	1	1	4	1	1	1	1	1	1	3
Ammonium Citrate, Dibasic	4	1	1	1	3	1	3	3	1	0	1	0	2
Ammonium Dichromate	4	1	1	1	3	1	3	3	1	0	1	0	2
Ammonium Diphosphate	4	1	1	1	1	1	3	3	1	0	1	0	2
Ammonium Fluoride	0	2	1	1	1	0	1	1	4	1	1	1	0
Ammonium Formate	4	1	1	1	3	1	3	3	1	0	1	0	2
Ammonium Hydroxide, 3 Molar	4	1	1	2	3	1	1	1	2	0	2	2	1
Ammonium Hydroxide, Concentrated	4	1	1	1	2	1	4	4	3	1	3	1	1
Ammonium Hydroxide, Grade 2	0	1	1	1	2	0	3	3	0	0	0	1	0
Ammonium Iodide	0	1	1	1	1	0	1	1	1	0	1	1	0
Ammonium Lactate	4	1	1	1	3	1	3	3	1	0	1	0	2
Ammonium Metaphosphate	4	1	1	1	3	1	3	3	1	0	1	0	2
Ammonium Molybdenate	4	1	1	1	3	1	3	3	1	0	1	0	2
Ammonium Nitrate	2	1	1	1	1	3	1	1	4	1	1	1	2
Ammonium Nitrite	0	1	1	1	3	0	1	1	1	0	1	2	2
Ammonium Oxalate	4	1	1	1	3	1	3	3	1	0	1	0	2
Ammonium Perchlorate	4	1	1	1	3	1	3	3	1	0	1	0	2
Ammonium Persulfate	4	1	1	1	1	1	4	4	1	1	4	1	4
Ammonium Phosphate	0	1	1	1	1	0	1	1	1	1	1	2	1
Ammonium Phosphate, Dibasic	0	1	1	1	1	0	1	1	1	0	1	1	1

1 Little or no effect - 2 Possible loss of physical properties - 3 Noticeable change - 4 Not suitable - 0 Insufficient info

Table 4-7: Chemical compatibility guide (Continued)

	ACM	CR	EPDM	FFKM	FKM	FMVQ	HNBR	NBR	NR	PTFE	SBR	TFE	VMQ
Ammonium Phosphate,													
Monobasic	0	1	1	1	1	0	1	1	1	0	1	2	1
Ammonium Phosphate, Tribasic	0	1	1	1	1	0	1	1	1	0	1	2	1
Ammonium Phosphite	4	1	1	1	3	1	3	3	1	0	1	0	2
Ammonium Picrate	4	1	1	1	3	1	3	3	1	0	1	0	2
Ammonium Polysulfide	4	1	1	1	3	1	3	3	1	0	1	0	2
Ammonium Salicylate	4	1	1	1	3	1	3	3	1	0	1	0	2
Ammonium Salts	3	1	1	1	3	3	1	1	1	0	1	1	1
Ammonium Sulfamate	4	1	1	1	4	1	3	3	1	0	1	0	2
Ammonium Sulfate	4	1	1	1	2	1	1	1	4	1	2	1	1
Ammonium Sulfate Nitrate	4	1	1	1	4	0	1	1	1	0	2	2	0
Ammonium Sulfide	4	1	1	1	2	0	1	1	4	1	2	1	0
Ammonium Sulfite	4	1	1	1	1	1	3	3	1	0	1	0	2
Ammonium Thiocyanate	4	1	1	1	1	1	3	3	1	0	1	0	2
Ammonium Thioglycollate	4	1	1	1	3	1	3	3	1	0	1	0	2
Ammonium Thiosulfate	4	1	1	1	1	1	3	3	1	0	1	0	2
Ammonium Tungstate	4	1	1	1	3	1	3	3	1	0	1	0	2
Ammonium Valerate	4	1	1	1	3	1	3	3	1	0	1	0	2
Amyl Acetate	4	4	1	1	4	4	4	4	1	1	4	4	4
Amyl Alcohol	4	2	1	1	2	1	2	2	1	1	2	1	4
Amyl Borate	0	1	4	1	1	0	1	1	4	1	4	1	4
Amyl Butyrate	1	2	4	1	2	1	1	1	4	0	4	0	2
Amyl Chloride	4	4	4	1	1	2	1	1	4	0	4	1	4
Amyl Chloronaphthalene	4	4	4	1	1	2	4	4	4	1	4	2	4
Amyl Cinnamic Aldehyde	4	4	4	1	4	2	2	2	4	0	4	0	0
Amyl Hydride	1	1	4	1	1	3	1	1	4	1	3	0	4
Amyl Laurate	4	4	4	1	2	2	2	2	4	0	4	0	0
Amyl Mercaptan	4	4	4	1	1	2	2	2	4	0	4	0	0
Amyl Naphthalene	2	4	4	1	1	1	4	4	4	0	4	2	4
Amyl Nitrate	4	1	1	1	3	1	3	3	1	0	1	0	2
Amyl Nitrite	4	1	1	1	3	1	3	3	1	0	1	0	2
Amyl Phenol	0	0	0	1	1	0	0	4	4	1	0	0	0
Amyl Propionate	1	2	4	1	2	1	1	1	4	0	4	0	2
Sn-0-3 Grade M	1	2	4	1	1	1	1	1	4	0	4	1	2
An-0-366	1	2	4	1	1	1	1	1	4	0	4	1	4
An-0-6	1	2	4	1	1	1	1	1	4	0	4	1	4
Anderol I-774 (Diester)	2	4	4	1	1	2	2	2	4	0	4	2	4
Anderol I-826 (Diester)	2	4	4	1	1	2	2	2	4	0	4	2	4
Anderol I-829 (Diester)	2	4	4	1	1	2	2	2	4	0	4	2	4
Ang-25 (Diester Base)	2	4	4	1	1	2	2	2	4	0	4	2	2
Ang-25 (Glyceral Ester)	4	2	1	1	1	2	2	2	2	0	2	2	2
Aniline	4	4	2	1	2	3	4	4	4	1	4	2	4
Aniline Dyes	4	2	2	1	2	2	4	4	2	0	2	1	3
Aniline Hydrochloride	4	4	3	1	2	2	4	4	4	1	4	1	4

1 Little or no effect - 2 Possible loss of physical properties - 3 Noticeable change - 4 Not suitable - 0 Insufficient info

Table 4-7: Chemical compatibility guide (Continued)

	ACM	CR	EPDM	FFKM	FKM	FMVQ	HNBR	NBR	NR	PTFE	SBR	TFE	VMQ
Aniline Oil	4	4	2	1	4	3	4	4	4	1	4	2	4
Aniline Sulfate	4	1	1	1	3	1	3	3	1	0	1	0	2
Aniline Sulfite	4	1	1	1	3	1	3	3	1	0	1	0	2
Animal Fats	1	2	2	1	1	1	1	1	4	1	4	1	2
Animal Oil	1	2	2	1	1	1	1	1	4	1	4	2	2
Anisole	0	4	0	1	3	0	4	4	4	1	4	0	0
Anon	0	4	4	1	0	0	4	4	4	1	4	0	0
Ansul Ether 161, 181	4	4	3	1	4	3	3	3	4	0	4	1	4
Ant Oil	4	4	2	2	4	4	4	4	4	1	4	4	4
Anthracene	4	4	4	1	1	2	2	2	4	0	4	0	0
Anthraquinone Sulphonic Acid	0	0	1	1	0	0	2	2	1	1	1	0	0
Antifreeze (Automotive)	4	1	1	1	2	1	1	1	1	1	1	0	1
Antimony Chloride	1	1	1	1	2	1	1	1	1	1	1	1	1
Antimony Pentachloride	1	2	4	1	2	1	1	1	4	0	4	1	4
Antimony Pentafluorides	0	4	0	2	0	0	0	4	4	1	0	0	0
Antimony Tribromide	1	2	4	1	1	1	1	1	4	0	4	1	4
Antimony Trichloride	1	2	1	1	1	1	1	1	1	1	1	1	4
Antimony Trifluoride	1	2	4	2	1	1	1	1	4	0	4	1	4
Antimony Trioxide	1	2	1	1	1	1	1	1	4	0	4	1	4
AN-VV-0-366B Hydraulic	2	2	4	1	1	1	1	1	4	0	4	1	4
Aqua Regia	4	4	3	2	2	3	3	4	4	1	4	3	4
Argon	1	1	1	1	1	2	1	1	1	1	1	1	2
Argon Gas	0	1	1	1	1	0	1	1	0	0	0	1	0
Aroclor 1248	4	4	2	1	1	2	3	3	4	0	4	1	2
Aroclor 1254	4	4	2	1	1	1	4	4	4	0	4	1	3
Aroclor 1260	4	1	2	1	1	1	1	1	1	0	1	1	1
Aromatic Fuel 50%	4	4	4	1	1	2	2	2	4	0	4	2	4
Aromatic Fuels	0	4	4	1	2	2	2	2	0	0	0	2	4
Arsenic Acid	3	1	1	1	1	1	1	1	1	1	1	1	1
Arsenic Trichloride	0	1	4	1	4	0	1	1	0	0	0	4	0
Arsenic Trioxide	0	1	4	1	4	0	1	1	0	0	0	0	0
Arsenic Trisulfide	0	1	4	1	4	0	1	1	0	0	0	0	0
Ascorbic Acid	4	1	1	1	1	1	3	3	1	0	1	0	2
Askarel Transformer Oil	4	4	4	1	1	2	2	2	4	1	4	1	4
Aspartic Acid	4	1	1	1	3	1	3	3	1	0	1	0	2
Asphalt	2	2	4	1	1	2	2	2	4	1	4	2	4
ASTM Fuel A	1	2	4	1	1	1	1	1	4	1	4	2	4
ASTM Fuel B	4	4	4	1	1	1	1	2	4	1	4	4	4
ASTM Fuel C	4	4	4	1	1	2	2	2	4	1	4	4	4
ASTM Fuel D	4	4	4	1	1	0	2	2	0	0	4	4	4
ASTM Oil No. 1	1	1	4	1	1	1	1	1	4	1	4	1	1
ASTM Oil No. 2	1	2	4	1	1	1	1	1	4	1	4	2	4
ASTM Oil No. 3	1	2	4	1	1	1	1	1	4	1	4	3	2
ASTM Oil No. 4	2	4	4	1	1	2	2	2	4	0	4	2	4

1 Little or no effect - 2 Possible loss of physical properties - 3 Noticeable change - 4 Not suitable - 0 Insufficient info

Table 4-7: Chemical compatibility guide (Continued)

	ACM	CR	EPDM	FFKM	FKM	FMVQ	HNBR	NBR	NR	PTFE	SBR	TFE	VMQ
ASTM Oil No. 5	0	2	4	1	1	0	1	1	0	0	0	1	0
ATL-857	2	4	4	1	1	2	2	2	4	0	4	1	4
Atlantic Dominion F	1	2	4	1	1	1	1	1	4	0	4	2	4
Atlantic Utro Gear-E	0	2	4	1	1	0	1	1	0	0	0	1	0
Atlantic Utro Gear-EP Lube.	1	2	4	1	1	1	1	1	4	0	4	2	4
Aurex 903R	1	2	4	1	1	4	1	1	2	0	4	1	4
Automatic Transmission Fluid	4	2	4	1	1	1	1	1	4	1	4	1	4
Automotive Brake Fluid	4	2	1	1	4	4	3	3	1	1	1	1	3
Azine	4	4	2	1	4	4	4	4	4	1	4	2	4
Baking Soda	4	1	1	1	1	1	1	1	1	1	1	1	1
Bardol B	4	4	4	1	1	2	4	4	4	0	4	2	4
Barium Carbonate	4	1	1	1	1	1	3	3	1	0	1	0	2
Barium Chlorate	4	1	1	1	1	1	3	3	1	0	1	0	2
Barium Chloride	1	1	1	1	1	1	1	1	1	0	1	1	1
Barium Cyanide	1	1	1	1	1	1	1	1	1	0	1	1	1
Barium Hydroxide	4	1	1	1	1	1	1	1	1	1	1	1	1
Barium Iodide	1	1	1	1	1	1	1	1	1	0	1	1	1
Barium Nitrate	4	1	1	1	1	1	3	3	1	0	1	0	2
Barium Oxide	4	1	1	1	1	1	1	1	1	0	1	1	1
Barium Peroxide	4	1	1	1	3	1	3	3	1	0	1	0	2
Barium Polysulfide	4	1	1	1	3	1	3	3	1	0	1	0	2
Barium Salts	1	1	1	1	1	1	1	1	1	1	1	1	1
Barium Sulfate	0	1	1	1	1	1	1	1	0	0	0	1	1
Barium Sulfide	4	1	1	1	1	1	1	1	1	0	2	1	1
Bayol 35	1	2	4	1	1	1	1	1	4	0	4	1	4
Bayol D	1	2	4	1	1	1	1	1	4	0	4	1	4
Beef Tallow Emulsion, Sulphonated	0	2	4	1	1	2	1	1	4	1	4	0	2
Beer	1	1	1	1	1	1	1	1	1	1	1	1	1
Beet Sugar Liquids	0	1	1	1	1	0	1	1	0	0	0	1	0
Beet Sugar Liquors	4	2	1	1	1	1	1	1	1	0	1	1	1
Benzaldehyde	4	4	1	2	4	4	4	4	2	1	2	2	4
Benzamide	4	4	4	1	1	2	2	2	4	0	4	0	0
Benzanthrone	4	4	4	1	2	2	2	2	4	0	4	0	0
Benzene	4	4	4	1	2	2	4	4	4	1	4	2	4
Benzene Carbonal	4	4	1	2	4	4	4	4	2	1	2	2	4
Benzene Carboxylic Acid	4	2	4	1	1	2	1	4	1	1	1	1	4
Benzene Sulfonic Acid	4	2	4	1	1	2	4	4	4	1	4	1	4
Benzidine	4	4	4	1	1	2	2	2	4	0	4	0	0
Benzidine 3 Sulfonic Acid	4	4	4	1	1	2	2	2	4	0	4	0	0
Benzil	4	4	4	1	1	2	2	2	4	0	4	0	0
Benzilic Acid	4	4	4	1	1	2	2	2	4	0	4	0	0
Benzine	1	2	4	1	1	1	1	1	4	1	4	2	4
Benzocatechol	4	4	4	1	1	2	2	2	4	0	4	0	0

1 Little or no effect - 2 Possible loss of physical properties - 3 Noticeable change - 4 Not suitable - 0 Insufficient info

Table 4-7: Chemical compatibility guide (Continued)

	ACM	CR	EPDM	FFKM	FKM	FMVQ	HNBR	NBR	NR	PTFE	SBR	TFE	VMQ
Benzochloride	4	4	1	1	1	1	4	4	4	0	4	1	0
Benzoic Acid	4	2	4	1	1	2	1	4	1	1	1	1	4
Benzoin	4	4	4	1	1	2	2	2	4	0	4	0	0
Benzonitrile	4	1	1	1	3	1	3	3	1	0	1	0	2
Benzophenone	4	4	2	1	2	1	4	4	0	0	4	1	4
Benzoquinone	4	0	2	1	1	0	0	0	0	0	4	2	0
Benzotrichloride	0	4	1	1	1	0	4	4	0	0	0	3	0
Benzotrifluoride	0	4	1	1	1	0	4	4	0	0	0	1	0
Benzoyl Chloride	4	4	4	1	2	2	4	4	4	0	4	2	0
Benzoyl Sulfonilic Acid	4	4	4	1	1	2	2	2	4	0	4	0	0
Benzyl Acetate	4	1	1	1	4	1	3	3	1	0	1	0	2
Benzyl Alcohol	4	2	2	1	1	2	4	4	4	1	4	2	2
Benzyl Benzoate	4	4	2	1	1	1	4	4	4	1	4	3	4
Benzyl Bromide	4	4	4	1	1	1	4	4	4	0	4	2	4
Benzyl Butyl Phthalate	4	1	1	1	3	1	3	3	1	0	1	0	2
Benzyl Chloride	4	4	4	1	1	1	4	4	4	1	4	2	4
Benzyl Phenol	4	4	4	1	2	2	2	2	4	0	4	0	0
Benzyl Salicylate	4	4	4	1	1	2	2	2	4	0	4	0	0
Beryllium Chloride	3	3	1	1	1	3	1	1	3	0	3	1	3
Beryllium Fluoride	3	3	1	1	1	3	1	1	3	0	3	1	3
Beryllium Oxide	3	3	1	1	1	3	1	1	3	0	3	1	3
Beryllium Sulfate	4	1	1	1	3	1	3	3	1	0	1	0	2
Biphenyl	4	4	4	1	1	2	4	4	4	1	4	2	4
Bismuth Carbonate	4	1	1	1	1	1	3	3	1	0	1	0	2
Bismuth Nitrate	4	1	1	1	3	1	3	3	1	0	1	0	2
Bismuth Oxychloride	4	1	1	1	3	1	3	3	1	0	1	0	2
Bisulfite Lye	0	2	1	2	0	0	2	2	1	1	1	0	0
Bitumen	0	4	0	1	1	0	4	4	0	1	0	0	0
Black Liquor	0	1	2	3	1	0	2	2	0	0	0	2	0
Black Lye	0	2	1	1	1	0	2	2	2	1	2	0	0
Black Paint 77	3	3	1	1	1	3	1	1	3	0	3	1	3
Blast Furnace Gas	1	2	4	1	1	2	2	4	4	1	2	1	1
Bleach Liquor	4	2	1	1	1	2	2	3	3	1	3	1	2
Bleach Solutions	0	0	1	1	1	0	0	0	0	0	0	0	0
Bleaching Lye	0	2	1	1	2	0	4	4	4	1	2	0	0
Bone Oil	1	4	2	1	2	1	1	1	4	1	4	1	2
Borax	2	4	1	1	1	2	2	2	2	0	2	1	2
Borax Solutions	2	2	1	1	1	1	1	2	1	1	1	1	1
Bordeaux Mixture	4	2	1	1	1	2	2	2	2	0	2	1	2
Boric Acid	4	1	1	1	1	1	1	1	1	1	1	1	1
Boric Oxide	4	1	1	1	3	1	3	3	1	0	1	0	2
Borneol	4	4	4	1	2	2	2	2	4	0	4	0	0
Bornyl Acetate	4	4	4	1	4	2	2	2	4	0	4	0	0
Bornyl Chloride	4	4	4	1	1	2	2	2	4	0	4	0	0

1 Little or no effect - 2 Possible loss of physical properties - 3 Noticeable change - 4 Not suitable - 0 Insufficient info

Table 4-7: Chemical compatibility guide (Continued)

International standards

Table 7-1 shows the cross-sections as used in the various O-Ring standards.
The most common standards are the AS 568 B and the ISO 3601-1. The O-Ring dimensions as described in section 7.2 are constantly being kept in stock in the materials NBR70 and FKM70. Our on-line stock also includes metric and other sizes in many different materials.

American St. AS 568 B British Standard BS 1806	German Standard metric DIN 3771	Japanese Standard JIS B 2401	Swedish Standard SMS 1586	International Standard ISO 3601-1	French Standard NFT47-501	American Standard AS 568 A Series 990
1,78	1,00	1,90	1,60	1,80	1,90	1,02
2,62	1,50	2,40	2,40	2,65	2,70	1,42
3,53	2,00	3,10	3,00	3,55	3,60	1,63
5,33	2,50	3,50	5,70	5,30	5,30	1,83
6,99	3,00	5,70	8,40	7,00	7,00	1,98
	3,50	8,40				2,08
	4,00					2,20
	4,50					2,46
	5,00					2,95
	5,50					3,00
	6,00					
	7,00					
	8,00					
	10,00					
	12,00					

Table 7-1: Cross-section in mm according to various O-Ring standards

7.2 AS 568 B

	Nominal size (inches)			Actual size (inches)				Actual size (mm)			
Dash No.	Inside diameter d1	Outside diameter	Cross-section d2	Inside diameter d1	Tol. ±	CS	Tol. ±	Inside diameter	Tol. ±	Cross-section d2	Tol. ±
001	1/32	3/32	1/32	.029	.004	.040	.003	0,74	0,10	1,02	0.08
002	3/64	9/64	3/64	.042	.004	.050	.003	1,07	0,10	1,27	0.08
003	1/16	3/16	1/16	.056	.004	.060	.003	1,42	0,10	1,52	0.08
004	5/64	13/64	1/16	.070	.005	.070	.003	1,78	0,13	1,78	0.08
005	3/32	7/32	1/16	.101	.005	.070	.003	2,57	0,13	1,78	0.08
006	1/8	1/4	1/16	.114	.005	.070	.003	2,90	0,13	1,78	0.08
007	5/32	9/32	1/16	.145	.005	.070	.003	3,68	0,13	1,78	0.08
008	3/16	5/16	1/16	.176	.005	.070	.003	4,47	0,13	1,78	0.08
009	7/32	11/32	1/16	.208	.005	.070	.003	5,28	0,13	1,78	0.08
010	1/4	3/8	1/16	.239	.005	.070	.003	6,07	0,13	1,78	0.08
011	5/16	7/16	1/16	.301	.005	.070	.003	7,65	0,13	1,78	0.08
012	3/8	1/2	1/16	.364	.005	.070	.003	9,25	0,13	1,78	0.08
013	7/16	9/16	1/16	.426	.005	.070	.003	10,82	0,13	1,78	0.08
014	1/2	5/8	1/16	.489	.005	.070	.003	12,42	0,13	1,78	0.08
015	9/16	11/16	1/16	.551	.007	.070	.003	14,00	0,18	1,78	0.08
016	5/8	3/4	1/16	.614	.009	.070	.003	15,60	0,23	1,78	0.08
017	11/16	13/16	1/16	.676	.009	.070	.003	17,17	0,23	1,78	0.08
018	3/4	7/8	1/16	.739	.009	.070	.003	18,77	0,23	1,78	0.08
019	13/16	15/16	1/16	.801	.009	.070	.003	20,35	0,23	1,78	0.08
020	7/8	1	1/16	.864	.009	.070	.003	21,95	0,23	1,78	0.08
021	15/16	1- 1/16	1/16	.926	.009	.070	.003	23,52	0,23	1,78	0.08
022	1	1/8	1/16	.989	.010	.070	.003	25,12	0,25	1,78	0.08
023	1- 1/16	1- 3/16	1/16	1.051	.010	.070	.003	26,70	0,25	1,78	0.08
024	1- 1/8	1- 1/4	1/16	1.114	.010	.070	.003	28,30	0,25	1,78	0.08
025	1- 3/16	1- 5/16	1/16	1.176	.011	.070	.003	29,87	0,28	1,78	0.08
026	1- 1/4	1- 3/8	1/16	1.239	.011	.070	.003	31,47	0,28	1,78	0.08
027	1- 5/16	1- 7/16	1/16	1.301	.011	.070	.003	33,05	0,28	1,78	0.08
028	1- 3/8	1- 1/2	1/16	1.364	.013	.070	.003	34,65	0,33	1,78	0.08
029	1- 1/2	1- 5/8	1/16	1.489	.013	.070	.003	37,82	0,33	1,78	0.08
030	1- 5/8	1- 3/4	1/16	1.614	.013	.070	.003	41,00	0,33	1,78	0.08
031	1- 3/4	1- 7/8	1/16	1.739	.015	.070	.003	44,17	0,38	1,78	0.08
032	1- 7/8	2	1/16	1.864	.015	.070	.003	47,35	0,38	1,78	0.08
033	2	2- 1/8	1/16	1.989	.018	.070	.003	50,52	0,46	1,78	0.08
034	2- 1/8	2- 1/4	1/16	2.114	.018	.070	.003	53,70	0,46	1,78	0.08
035	2- 1/4	2- 3/8	1/16	2.239	.018	.070	.003	56,87	0,46	1,78	0.08

Table 7-2: AS 568 B

	Nominal size (inches)			Actual size (inches)				Actual size (mm)			
Dash No.	Inside diameter d1	Outside diameter	Cross-section d2	Inside diameter d1	Tol. ±	CS	Tol. ±	Inside diameter	Tol. ±	Cross-section d2	Tol. ±
036	2- 3/8	2- 1/2	1/16	2.364	.018	.070	.003	60,05	0,46	1,78	0.08
037	2- 1/2	2- 5/8	1/16	2.489	.018	.070	.003	63,22	0,46	1,78	0.08
038	2- 5/8	2- 3/4	1/16	2.614	.020	.070	.003	66,40	0,51	1,78	0.08
039	2- 3/4	2- 7/8	1/16	2.739	.020	.070	.003	69,57	0,51	1,78	0.08
040	2- 7/8	3	1/16	2.864	.020	.070	.003	72,75	0,51	1,78	0.08
041	3	3- 1/8	1/16	2.989	.024	.070	.003	75,92	0,61	1,78	0.08
042	3- 1/4	3- 3/8	1/16	3.239	.024	.070	.003	82,27	0,61	1,78	0.08
043	3- 1/2	3- 5/8	1/16	3.489	.024	.070	.003	88,62	0,61	1,78	0.08
044	3- 3/4	3- 7/8	1/16	3.739	.027	.070	.003	94,97	0,69	1,78	0.08
045	4	4- 1/8	1/16	3.989	.027	.070	.003	101,32	0,69	1,78	0.08
046	4- 1/4	4- 3/8	1/16	4.239	.030	.070	.003	107,67	0,76	1,78	0.08
047	4- 1/2	4- 5/8	1/16	4.489	.030	.070	.003	114,02	0,76	1,78	0.08
048	4- 3/4	4- 7/8	1/16	4.739	.030	.070	.003	120,37	0,76	1,78	0.08
049	5	5- 1/8	1/16	4.989	.037	.070	.003	126,72	0,94	1,78	0.08
050	5- 1/4	5- 3/8	1/16	5.239	.037	.070	.003	133,07	0,94	1,78	0.08
102	1/16	1/4	3/32	.049	.005	.103	.003	1,24	0,13	2,62	0.08
103	3/32	9/32	3/32	.081	.005	.103	.003	2,06	0,13	2,62	0.08
104	1/8	5/16	3/32	.112	.005	.103	.003	2,84	0,13	2,62	0.08
105	5/32	11/32	3/32	.143	.005	.103	.003	3,63	0,13	2,62	0.08
106	3/16	3/8	3/32	.174	.005	.103	.003	4,42	0,13	2,62	0.08
107	7/32	13/32	3/32	.206	.005	.103	.003	5,23	0,13	2,62	0.08
108	1/4	7/16	3/32	.237	.005	.103	.003	6,02	0,13	2,62	0.08
109	5/16	1/2	3/32	.299	.005	.103	.003	7,59	0,13	2,62	0.08
110	3/8	9/16	3/32	.362	.005	.103	.003	9,19	0,13	2,62	0.08
111	7/16	5/8	3/32	.424	.005	.103	.003	10,77	0,13	2,62	0.08
112	1/2	11/16	3/32	.487	.005	.103	.003	12,37	0,13	2,62	0.08
113	9/16	3/4	3/32	.549	.007	.103	.003	13,94	0,18	2,62	0.08
114	5/8	13/16	3/32	.612	.009	.103	.003	15,54	0,23	2,62	0.08
115	11/16	7/8	3/32	.674	.009	.103	.003	17,12	0,23	2,62	0.08
116	3/4	15/16	3/32	.737	.009	.103	.003	18,72	0,23	2,62	0.08
117	13/16	1	3/32	.799	.010	.103	.003	20,30	0,25	2,62	0.08
118	7/8	1- 1/16	3/32	.862	.010	.103	.003	21,89	0,25	2,62	0.08
119	15/16	1- 1/8	3/32	.924	.010	.103	.003	23,47	0,25	2,62	0.08
120	1	1- 3/16	3/32	.987	.010	.103	.003	25,07	0,25	2,62	0.08
121	1- 1/16	1- 1/4	3/32	1.049	.010	.103	.003	26,64	0,25	2,62	0.08
122	1- 1/8	1- 5/16	3/32	1.112	.010	.103	.003	28,24	0,25	2,62	0.08
123	1- 3/16	1- 3/8	3/32	1.174	.012	.103	.003	29,82	0,30	2,62	0.08

Table 7-2: AS 568 B (Continued)

	Nominal size (inches)			Actual size (inches)				Actual size (mm)			
Dash No.	Inside diameter d1	Outside diameter	Cross-section d2	Inside diameter d1	Tol. ±	CS	Tol. ±	Inside diameter	Tol. ±	Cross-section d2	Tol. ±
024	1- 1/8	1- 1/4	1/16	1.114	.010	.070	.003	28,30	0,25	1,78	0.08
025	1- 3/16	1- 5/16	1/16	1.176	.011	.070	.003	29,87	0,28	1,78	0.08
026	1- 1/4	1- 3/8	1/16	1.239	.011	.070	.003	31,47	0,28	1,78	0.08
027	1- 5/16	1- 7/16	1/16	1.301	.011	.070	.003	33,05	0,28	1,78	0.08
028	1- 3/8	1- 1/2	1/16	1.364	.013	.070	.003	34,65	0,33	1,78	0.08
029	1- 1/2	1- 5/8	1/16	1.489	.013	.070	.003	37,82	0,33	1,78	0.08
030	1- 5/8	1- 3/4	1/16	1.614	.013	.070	.003	41,00	0,33	1,78	0.08
031	1- 3/4	1- 7/8	1/16	1.739	.015	.070	.003	44,17	0,38	1,78	0.08
032	1- 7/8	2	1/16	1.864	.015	.070	.003	47,35	0,38	1,78	0.08
033	2	2- 1/8	1/16	1.989	.018	.070	.003	50,52	0,46	1,78	0.08
034	2- 1/8	2- 1/4	1/16	2.114	.018	.070	.003	53,70	0,46	1,78	0.08
035	2- 1/4	2- 3/8	1/16	2.239	.018	.070	.003	56,87	0,46	1,78	0.08
036	2- 3/8	2- 1/2	1/16	2.364	.018	.070	.003	60,05	0,46	1,78	0.08
037	2- 1/2	2- 5/8	1/16	2.489	.018	.070	.003	63,22	0,46	1,78	0.08
038	2- 5/8	2- 3/4	1/16	2.614	.020	.070	.003	66,40	0,51	1,78	0.08
039	2- 3/4	2- 7/8	1/16	2.739	.020	.070	.003	69,57	0,51	1,78	0.08
040	2- 7/8	3	1/16	2.864	.020	.070	.003	72,75	0,51	1,78	0.08
041	3	3- 1/8	1/16	2.989	.024	.070	.003	75,92	0,61	1,78	0.08
042	3- 1/4	3- 3/8	1/16	3.239	.024	.070	.003	82,27	0,61	1,78	0.08
043	3- 1/2	3- 5/8	1/16	3.489	.024	.070	.003	88,62	0,61	1,78	0.08
044	3- 3/4	3- 7/8	1/16	3.739	.027	.070	.003	94,97	0,69	1,78	0.08
045	4	4- 1/8	1/16	3.989	.027	.070	.003	101,32	0,69	1,78	0.08
046	4- 1/4	4- 3/8	1/16	4.239	.030	.070	.003	107,67	0,76	1,78	0.08
047	4- 1/2	4- 5/8	1/16	4.489	.030	.070	.003	114,02	0,76	1,78	0.08
048	4- 3/4	4- 7/8	1/16	4.739	.030	.070	.003	120,37	0,76	1,78	0.08
049	5	5- 1/8	1/16	4.989	.037	.070	.003	126,72	0,94	1,78	0.08
050	5- 1/4	5- 3/8	1/16	5.239	.037	.070	.003	133,07	0,94	1,78	0.08
102	1/16	1/4	3/32	.049	.005	.103	.003	1,24	0,13	2,62	0.08
103	3/32	9/32	3/32	.081	.005	.103	.003	2,06	0,13	2,62	0.08
104	1/8	5/16	3/32	.112	.005	.103	.003	2,84	0,13	2,62	0.08
105	5/32	11/32	3/32	.143	.005	.103	.003	3,63	0,13	2,62	0.08
106	3/16	3/8	3/32	.174	.005	.103	.003	4,42	0,13	2,62	0.08
107	7/32	13/32	3/32	.206	.005	.103	.003	5,23	0,13	2,62	0.08
108	1/4	7/16	3/32	.237	.005	.103	.003	6,02	0,13	2,62	0.08
109	5/16	1/2	3/32	.299	.005	.103	.003	7,59	0,13	2,62	0.08
110	3/8	9/16	3/32	.362	.005	.103	.003	9,19	0,13	2,62	0.08
111	7/16	5/8	3/32	.424	.005	.103	.003	10,77	0,13	2,62	0.08

Table 7-2: AS 568 B (Continued)

	Nominal size (inches)			Actual size (inches)				Actual size (mm)			
Dash No.	Inside diameter d1	Outside diameter	Cross-section d2	Inside diameter d1	Tol. ±	CS	Tol. ±	Inside diameter	Tol. ±	Cross-section d2	Tol. ±
112	1/2	11/16	3/32	.487	.005	.103	.003	12,37	0,13	2,62	0.08
113	9/16	3/4	3/32	.549	.007	.103	.003	13,94	0,18	2,62	0.08
114	5/8	13/16	3/32	.612	.009	.103	.003	15,54	0,23	2,62	0.08
115	11/16	7/8	3/32	.674	.009	.103	.003	17,12	0,23	2,62	0.08
116	3/4	15/16	3/32	.737	.009	.103	.003	18,72	0,23	2,62	0.08
117	13/16	1	3/32	.799	.010	.103	.003	20,30	0,25	2,62	0.08
118	7/8	1- 1/16	3/32	.862	.010	.103	.003	21,89	0,25	2,62	0.08
119	15/16	1- 1/8	3/32	.924	.010	.103	.003	23,47	0,25	2,62	0.08
120	1	1- 3/16	3/32	.987	.010	.103	.003	25,07	0,25	2,62	0.08
121	1- 1/16	1- 1/4	3/32	1.049	.010	.103	.003	26,64	0,25	2,62	0.08
122	1- 1/8	1- 5/16	3/32	1.112	.010	.103	.003	28,24	0,25	2,62	0.08
123	1- 3/16	1- 3/8	3/32	1.174	.012	.103	.003	29,82	0,30	2,62	0.08
124	1- 1/4	1- 7/16	3/32	1.237	.012	.103	.003	31,42	0,30	2,62	0.08
125	1- 5/16	1- 1/2	3/32	1.299	.012	.103	.003	32,99	0,30	2,62	0.08
126	1- 3/8	1- 9/16	3/32	1.362	.012	.103	.003	34,59	0,30	2,62	0.08
127	1- 7/16	1- 5/8	3/32	1.424	.012	.103	.003	36,17	0,30	2,62	0.08
128	1- 1/2	1- 11/16	3/32	1.487	.012	.103	.003	37,77	0,30	2,62	0.08
129	1- 9/16	1- 3/4	3/32	1.549	.015	.103	.003	39,34	0,38	2,62	0.08
130	1- 5/8	1- 13/16	3/32	1.612	.015	.103	.003	40,94	0,38	2,62	0.08
131	1- 11/16	1- 7/8	3/32	1.674	.015	.103	.003	42,52	0,38	2,62	0.08
132	1- 3/4	1- 15/16	3/32	1.737	.015	.103	.003	44,12	0,38	2,62	0.08
133	1- 13/16	2	3/32	1.799	.015	.103	.003	45,69	0,38	2,62	0.08
134	1- 7/8	2- 1/16	3/32	1.862	.015	.103	.003	47,29	0,38	2,62	0.08
135	1- 15/16	2- 1/8	3/32	1.925	.017	.103	.003	48,90	0,43	2,62	0.08
136	2	2- 3/16	3/32	1.987	.017	.103	.003	50,47	0,43	2,62	0.08
137	2- 1/16	2- 1/4	3/32	2.050	.017	.103	.003	52,07	0,43	2,62	0.08
138	2- 1/8	2- 5/16	3/32	2.112	.017	.103	.003	53,64	0,43	2,62	0.08
139	2- 3/16	2- 3/8	3/32	2.175	.017	.103	.003	55,25	0,43	2,62	0.08
140	2- 1/4	2- 7/16	3/32	2.237	.017	.103	.003	56,82	0,43	2,62	0.08
141	2- 5/16	2- 1/2	3/32	2.300	.020	.103	.003	58,42	0,51	2,62	0.08
142	2- 3/8	2- 9/16	3/32	2.362	.020	.103	.003	59,99	0,51	2,62	0.08
143	2- 7/16	2- 5/8	3/32	2.425	.020	.103	.003	61,60	0,51	2,62	0.08
144	2- 1/2	2- 11/16	3/32	2.487	.020	.103	.003	63,17	0,51	2,62	0.08
145	2- 9/16	2- 3/4	3/32	2.550	.020	.103	.003	64,77	0,51	2,62	0.08
146	2- 5/8	2- 13/16	3/32	2.612	.020	.103	.003	66,34	0,51	2,62	0.08
147	2- 11/16	2- 7/8	3/32	2.675	.022	.103	.003	67,95	0,56	2,62	0.08
148	2- 3/4	2- 15/16	3/32	2.737	.022	.103	.003	69,52	0,56	2,62	0.08

Table 7-2: AS 568 B (Continued)

	Nominal size (inches)			Actual size (inches)				Actual size (mm)			
Dash No.	Inside diameter d1	Outside diameter	Cross-section d2	Inside diameter d1	Tol. ±	CS	Tol. ±	Inside diameter	Tol. ±	Cross-section d2	Tol. ±
149	2- 13/16	3	3/32	2.800	.022	.103	.003	71,12	0,56	2,62	0.08
150	2- 7/8	3- 1/16	3/32	2.862	.022	.103	.003	72,69	0,56	2,62	0.08
151	3	3- 3/16	3/32	2.987	.024	.103	.003	75,87	0,61	2,62	0.08
152	3- 1/4	3- 7/16	3/32	3.237	.024	.103	.003	82,22	0,61	2,62	0.08
153	3- 1/2	3- 11/16	3/32	3.487	.024	.103	.003	88,57	0,61	2,62	0.08
154	3- 3/4	3- 15/16	3/32	3.737	.028	.103	.003	94,92	0,71	2,62	0.08
155	4	4- 3/16	3/32	3.987	.028	.103	.003	101,27	0,71	2,62	0.08
156	4- 1/4	4- 7/16	3/32	4.237	.030	.103	.003	107,62	0,76	2,62	0.08
157	4- 1/2	4- 11/16	3/32	4.487	.030	.103	.003	113,97	0,76	2,62	0.08
158	4- 3/4	4- 15/16	3/32	4.737	.030	.103	.003	120,32	0,76	2,62	0.08
159	5	5- 3/16	3/32	4.987	.035	.103	.003	126,67	0,89	2,62	0.08
160	5- 1/4	5- 7/16	3/32	5.237	.035	.103	.003	133,02	0,89	2,62	0.08
161	5- 1/2	5- 11/16	3/32	5.487	.035	.103	.003	139,37	0,89	2,62	0.08
162	5- 3/4	5- 15/16	3/32	5.737	.035	.103	.003	145,72	0,89	2,62	0.08
163	6	6- 3/16	3/32	5.987	.035	.103	.003	152,07	0,89	2,62	0.08
164	6- 1/4	6- 7/16	3/32	6.237	.040	.103	.003	158,42	1,02	2,62	0.08
165	6- 1/2	6- 11/16	3/32	6.487	.040	.103	.003	164,77	1,02	2,62	0.08
166	6- 3/4	6- 15/16	3/32	6.737	.040	.103	.003	171,12	1,02	2,62	0.08
167	7	7- 3/16	3/32	6.987	.040	.103	.003	177,47	1,02	2,62	0.08
168	7- 1/4	7- 7/16	3/32	7.237	.045	.103	.003	183,82	1,14	2,62	0.08
169	7- 1/2	7- 11/16	3/32	7.487	.045	.103	.003	190,17	1,14	2,62	0.08
170	7- 3/4	7- 15/16	3/32	7.737	.045	.103	.003	196,52	1,14	2,62	0.08
171	8	8- 3/16	3/32	7.987	.045	.103	.003	202,87	1,14	2,62	0.08
172	8- 1/4	8- 7/16	3/32	8.237	.050	.103	.003	209,22	1,27	2,62	0.08
173	8- 1/2	8- 11/16	3/32	8.487	.050	.103	.003	215,57	1,27	2,62	0.08
174	8- 3/4	8- 15/16	3/32	8.737	.050	.103	.003	221,92	1,27	2,62	0.08
175	9	9- 3/16	3/32	8.987	.050	.103	.003	228,27	1,27	2,62	0.08
176	9- 1/4	9- 7/16	3/32	9.237	.055	.103	.003	234,62	1,40	2,62	0.08
177	9- 1/2	9- 11/16	3/32	9.487	.055	.103	.003	240,97	1,40	2,62	0.08
178	9- 3/4	9- 15/16	3/32	9.737	.055	.103	.003	247,32	1,40	2,62	0.08
201	3/16	7/16	1/8	.171	.055	.139	.004	4,34	0,13	3,53	0.10
202	1/4	1/2	1/8	.234	.005	.139	.004	5,94	0,13	3,53	0.10
203	5/16	9/16	1/8	.296	.005	.139	.004	7,52	0,13	3,53	0.10
204	3/8	5/8	1/8	.359	.005	.139	.004	9,12	0,13	3,53	0.10
205	7/16	11/16	1/8	.421	.005	.139	.004	10,69	0,13	3,53	0.10
206	1/2	3/4	1/8	.484	.005	.139	.004	12,29	0,13	3,53	0.10
207	9/16	13/16	1/8	.546	.007	.139	.004	13,87	0,18	3,53	0.10

Table 7-2: AS 568 B (Continued)

	Nominal size (inches)			Actual size (inches)				Actual size (mm)			
Dash No.	Inside diameter d1	Outside diameter	Cross-section d2	Inside diameter d1	Tol. ±	CS	Tol. ±	Inside diameter	Tol. ±	Cross-section d2	Tol. ±
208	5/8	7/8	1/8	.609	.009	.139	.004	15,47	0,23	3,53	0.10
209	11/16	15/16	1/8	.671	.010	.139	.004	17,04	0,23	3,53	0.10
210	3/4	1	1/8	.734	.010	.139	.004	18,64	0,25	3,53	0.10
211	13/16	1- 1/16	1/8	.796	.010	.139	.004	20,22	0,25	3,53	0.10
212	7/8	1- 1/8	1/8	.859	.010	.139	.004	21,82	0,25	3,53	0.10
213	15/16	1- 3/16	1/8	.921	.010	.139	.004	23,39	0,25	3,53	0.10
214	1	1- 1/4	1/8	.984	.010	.139	.004	24,99	0,25	3,53	0.10
215	1- 1/16	1- 5/16	1/8	1.046	.010	.139	.004	26,57	0,25	3,53	0.10
216	1- 1/8	1- 3/8	1/8	1.109	.012	.139	.004	28,17	0,30	3,53	0.10
217	1- 3/16	1- 7/16	1/8	1.171	.012	.139	.004	29,74	0,30	3,53	0.10
218	1- 1/4	1- 1/2	1/8	1.234	.012	.139	.004	31,34	0,30	3,53	0.10
219	1- 5/16	1- 9/16	1/8	1.296	.012	.139	.004	32,92	0,30	3,53	0.10
220	1- 3/8	1- 5/8	1/8	1.359	.012	.139	.004	34,52	0,30	3,53	0.10
221	1- 7/16	1- 11/16	1/8	1.421	.012	.139	.004	36,09	0,30	3,53	0.10
222	1- 1/2	1- 3/4	1/8	1.484	.015	.139	.004	37,69	0,38	3,53	0.10
223	1- 5/8	1- 7/8	1/8	1.609	.015	.139	.004	40,87	0,38	3,53	0.10
224	1- 3/4	2	1/8	1.734	.015	.139	.004	44,04	0,38	3,53	0.10
225	1- 7/8	2- 1/8	1/8	1.859	.015	.139	.004	47,22	0,46	3,53	0.10
226	2	2- 1/4	1/8	1.984	.018	.139	.004	50,39	0,46	3,53	0.10
227	2- 1/16	2- 3/8	1/8	2.109	.018	.139	.004	53,57	0,46	3,53	0.10
228	2- 1/4	2- 1/2	1/8	2.234	.020	.139	.004	56,74	0,51	3,53	0.10
229	2- 3/8	2- 5/8	1/8	2.359	.020	.139	.004	59,92	0,51	3,53	0.10
230	2- 1/2	2- 3/4	1/8	2.484	.020	.139	.004	63,09	0,51	3,53	0.10
231	2- 5/8	2- 7/8	1/8	2.609	.020	.139	.004	66,27	0,51	3,53	0.10
232	2- 3/4	3	1/8	2.734	.024	.139	.004	69,44	0,61	3,53	0.10
233	2- 7/8	3- 1/8	1/8	2.859	.024	.139	.004	72,62	0,61	3,53	0.10
234	3	3- 1/4	1/8	2.984	.024	.139	.004	75,79	0,61	3,53	0.10
235	3- 1/8	3- 3/8	1/8	3.109	.024	.139	.004	78,97	0,61	3,53	0.10
236	3- 1/4	3- 1/2	1/8	3.234	.024	.139	.004	82,14	0,61	3,53	0.10
237	3- 3/8	3- 5/8	1/8	3.359	.024	.139	.004	85,32	0,61	3,53	0.10
238	3- 1/2	3- 3/4	1/8	3.484	.024	.139	.004	88,49	0,61	3,53	0.10
239	3- 5/8	3- 7/8	1/8	3.609	.024	.139	.004	91,67	0,71	3,53	0.10
240	3- 3/4	4	1/8	3.734	.028	.139	.004	94,84	0,71	3,53	0.10
241	3- 7/8	4- 1/8	1/8	3.859	.028	.139	.004	98,02	0,71	3,53	0.10
242	4	4- 1/4	1/8	3.984	.028	.139	.004	101,19	0,71	3,53	0.10
243	4- 1/8	4- 3/8	1/8	4.109	.028	.139	.004	104,37	0,71	3,53	0.10
244	4- 1/4	4- 1/2	1/8	4.234	.030	.139	.004	107,54	0,76	3,53	0.10

Table 7-2: AS 568 B (Continued)

	Nominal size (inches)			Actual size (inches)				Actual size (mm)			
Dash No.	Inside diameter d1	Outside diameter	Cross-section d2	Inside diameter d1	Tol. ±	CS	Tol. ±	Inside diameter	Tol. ±	Cross-section d2	Tol. ±
245	4- 3/8	4- 5/8	1/8	4.359	.030	.139	.004	110,72	0,76	3,53	0.10
246	4- 1/2	4- 3/4	1/8	4.484	.030	.139	.004	113,89	0,76	3,53	0.10
247	4- 5/8	4- 7/8	1/8	4.609	.030	.139	.004	117,07	0,76	3,53	0.10
248	4- 3/4	5	1/8	4.734	.030	.139	.004	120,24	0,76	3,53	0.10
249	4- 7/8	5- 1/8	1/8	4.859	.035	.139	.004	123,42	0,89	3,53	0.10
250	5	5- 1/4	1/8	4.984	.035	.139	.004	126,59	0,89	3,53	0.10
251	5- 1/8	5- 3/8	1/8	5.109	.035	.139	.004	129,77	0,89	3,53	0.10
252	5- 1/4	5- 1/2	1/8	5.234	.035	.139	.004	132,94	0,89	3,53	0.10
253	5- 3/8	5- 5/8	1/8	5.359	.035	.139	.004	136,12	0,89	3,53	0.10
254	5- 1/2	5- 3/4	1/8	5.484	.035	.139	.004	139,29	0,89	3,53	0.10
255	5- 5/8	5- 7/8	1/8	5.609	.035	.139	.004	142,47	0,89	3,53	0.10
256	5- 3/4	6	1/8	5.734	.035	.139	.004	145,64	0,89	3,53	0.10
257	5- 7/8	6- 1/8	1/8	5.859	.035	.139	.004	148,82	0,89	3,53	0.10
258	6	6- 1/4	1/8	5.984	.035	.139	.004	151,99	0,89	3,53	0.10
259	6- 1/4	6- 1/2	1/8	6.234	.040	.139	.004	158,34	1,02	3,53	0.10
260	6- 1/2	6- 3/4	1/8	6.484	.040	.139	.004	164,69	1,02	3,53	0.10
261	6- 3/4	7	1/8	6.734	.040	.139	.004	171,04	1,02	3,53	0.10
262	7	7- 1/4	1/8	6.984	.040	.139	.004	177,39	1,02	3,53	0.10
263	7- 1/4	7- 1/2	1/8	7.234	.045	.139	.004	183,74	1,14	3,53	0.10
264	7- 1/2	7- 3/4	1/8	7.484	.045	.139	.004	190.09	1,14	3,53	0.10
265	7- 3/4	8	1/8	7.734	.045	.139	.004	196,44	1,14	3,53	0.10
266	8	8- 1/4	1/8	7.984	.045	.139	.004	202,79	1,14	3,53	0.10
267	8- 1/4	8- 1/2	1/8	8.234	.050	.139	.004	209,14	1,27	3,53	0.10
268	8- 1/2	8- 3/4	1/8	8.484	.050	.139	.004	215,49	1,27	3,53	0.10
269	8- 3/4	9	1/8	8.734	.050	.139	.004	221,84	1,27	3,53	0.10
270	9	9- 1/4	1/8	8.984	.050	.139	.004	228,19	1,27	3,53	0.10
271	9- 1/4	9- 1/2	1/8	9.234	.055	.139	.004	234,54	1,40	3,53	0.10
272	9- 1/2	9- 3/4	1/8	9.484	.055	.139	.004	240,89	1,40	3,53	0.10
273	9- 3/4	10	1/8	9.734	.055	.139	.004	247,24	1,40	3,53	0.10
274	10	10- 1/4	1/8	9.984	.055	.139	.004	253,59	1,40	3,53	0.10
275	10- 1/2	10- 3/4	1/8	10.484	.055	.139	.004	266,29	1,40	3,53	0.10
276	11	11- 1/4	1/8	10.984	.065	.139	.004	278,99	1,65	3,53	0.10
277	11- 1/2	11- 3/4	1/8	11.484	.065	.139	.004	291,69	1,65	3,53	0.10
278	12	12- 1/4	1/8	11.984	.065	.139	.004	304,39	1,65	3,53	0.10
279	13	13- 1/4	1/8	12.984	.065	.139	.004	329,79	1,65	3,53	0.10
280	14	14- 1/4	1/8	13.984	.065	.139	.004	355,19	1,65	3,53	0.10
281	15	15- 1/4	1/8	14.984	.065	.139	.004	380,59	1,65	3,53	0.10

Table 7-2: AS 568 B (Continued)

	Nominal size (inches)			Actual size (inches)				Actual size (mm)			
Dash No.	Inside diameter d1	Outside diameter	Cross-section d2	Inside diameter d1	Tol. ±	CS	Tol. ±	Inside diameter	Tol. ±	Cross-section d2	Tol. ±
282	16	16- 1/4	1/8	15.955	.075	.139	.004	405,26	1,91	3,53	0.10
283	17	17- 1/4	1/8	16.955	.080	.139	.004	430,66	2,03	3,53	0.10
284	18	18- 1/4	1/8	17.955	.085	.139	.004	456,06	2,16	3,53	0.10
309	7/16	13/16	3/16	.412	.005	.210	.005	10,46	0,13	5,33	0.13
310	1/2	7/8	3/16	.475	.005	.210	.005	12,07	0,13	5,33	0.13
311	9/16	15/16	3/16	.537	.007	.210	.005	13,64	0,18	5,33	0.13
312	5/8	1	3/16	.600	.009	.210	.005	15,24	0,23	5,33	0.13
313	11/16	1- 1/16	3/16	.662	.009	.210	.005	16,81	0,23	5,33	0.13
314	3/4	1- 1/8	3/16	.725	.010	.210	.005	18,42	0,25	5,33	0.13
315	13/16	1- 3/16	3/16	.787	.010	.210	.005	19,99	0,25	5,33	0.13
316	7/8	1- 1/4	3/16	.850	.010	.210	.005	21,59	0,25	5,33	0.13
317	15/16	1- 5/16	3/16	.912	.010	.210	.005	23,16	0,25	5,33	0.13
318	1	1- 3/8	3/16	.975	.010	.210	.005	24,77	0,25	5,33	0.13
319	1- 1/16	1- 7/16	3/16	1.037	.010	.210	.005	26,34	0,25	5,33	0.13
320	1- 1/8	1- 1/2	3/16	1.100	.012	.210	.005	27,94	0,30	5,33	0.13
321	1- 3/16	1- 9/16	3/16	1.162	.012	.210	.005	29,51	0,30	5,33	0.13
322	1- 1/4	1- 5/8	3/16	1.225	.012	.210	.005	31,12	0,30	5,33	0.13
323	1- 5/16	1- 11/16	3/16	1.287	.012	.210	.005	32,69	0,30	5,33	0.13
324	1- 3/8	1- 3/4	3/16	1.350	.012	.210	.005	34,29	0,30	5,33	0.13
325	1- 1/2	1- 7/8	3/16	1.475	.015	.210	.005	37,47	0,38	5,33	0.13
326	1- 5/8	2	3/16	1.600	.015	.210	.005	40,64	0,38	5,33	0.13
327	1- 3/4	2- 1/8	3/16	1.725	.015	.210	.005	43,82	0,38	5,33	0.13
328	1- 7/8	2- 1/4	3/16	1.850	.015	.210	.005	46,99	0,38	5,33	0.13
329	2	2- 3/8	3/16	1.975	.018	.210	.005	50,17	0,46	5,33	0.13
330	2- 1/8	2- 1/2	3/16	2.100	.018	.210	.005	53,34	0,46	5,33	0.13
331	2- 1/4	2- 5/8	3/16	2.225	.018	.210	.005	56,52	0,46	5,33	0.13
332	2- 3/8	2- 3/4	3/16	2.350	.018	.210	.005	59,69	0,46	5,33	0.13
333	2- 1/2	2- 7/8	3/16	2.475	.020	.210	.005	62,87	0,51	5,33	0.13
334	2- 5/8	3	3/16	2.600	.020	.210	.005	66.04	0.51	5,33	0.13
335	2- 3/4	3- 1/8	3/16	2.725	.020	.210	.005	69,22	0,51	5,33	0.13
336	2- 7/8	3- 1/4	3/16	2.850	.020	.210	.005	72,39	0,51	5,33	0.13
337	3	3- 3/8	3/16	2.975	.024	.210	.005	75,37	0,61	5,33	0.13
338	3- 1/8	3- 1/2	3/16	3.100	.024	.210	.005	78,74	0,61	5,33	0.13
339	3- 1/4	3- 5/8	3/16	3.225	.024	.210	.005	81,92	0,61	5,33	0.13
340	3- 3/8	3- 3/4	3/16	3.350	.024	.210	.005	85,09	0,61	5,33	0.13
341	3- 1/2	3- 7/8	3/16	3.475	.024	.210	.005	88,27	0,61	5,33	0.13
342	3- 5/8	4	3/16	3.600	.028	.210	.005	91,44	0,71	5,33	0.13

Table 7-2: AS 568 B (Continued)

	Nominal size (inches)			Actual size (inches)				Actual size (mm)			
Dash No.	Inside diameter d1	Outside diameter	Cross-section d2	Inside diameter d1	Tol. ±	CS	Tol. ±	Inside diameter	Tol. ±	Cross-section d2	Tol. ±
343	3- 3/4	4- 1/8	3/16	3.725	.028	.210	.005	94,62	0,71	5,33	0.13
344	3- 7/8	4- 1/4	3/16	3.850	.028	.210	.005	97,79	0,71	5,33	0.13
345	4	4- 3/8	3/16	3.975	.028	.210	.005	100,97	0,71	5,33	0.13
346	4- 1/8	4- 1/2	3/16	4.100	.028	.210	.005	104,14	0,71	5,33	0.13
347	4- 1/4	4- 5/8	3/16	4.225	.030	.210	.005	107,32	0,76	5,33	0.13
348	4- 3/8	4- 3/4	3/16	4.350	.030	.210	.005	110,49	0,76	5,33	0.13
349	4- 1/2	4- 7/8	3/16	4.475	.030	.210	.005	113,67	0,76	5,33	0.13
350	4- 5/8	5	3/16	4.600	.030	.210	.005	116,84	0,76	5,33	0.13
351	4- 3/4	5- 1/8	3/16	4.725	.030	.210	.005	120,02	0,76	5,33	0.13
352	4- 7/8	5- 1/4	3/16	4.850	.030	.210	.005	123,19	0,76	5,33	0.13
353	5	5- 3/8	3/16	4.975	.037	.210	.005	126,37	0,94	5,33	0.13
354	5- 1/8	5- 1/2	3/16	5.100	.037	.210	.005	129,54	0,94	5,33	0.13
355	5- 1/4	5- 3/8	3/16	5.225	.037	.210	.005	132,72	0,94	5,33	0.13
356	5- 3/8	5- 3/4	3/16	5.350	.037	.210	.005	135,89	0,94	5,33	0.13
357	5- 1/2	5- 7/8	3/16	5.475	.037	.210	.005	139,07	0,94	5,33	0.13
358	5- 5/8	6	3/16	5.600	.037	.210	.005	142,24	0,94	5,33	0.13
359	5- 3/4	6- 1/8	3/16	5.725	.037	.210	.005	145,42	0,94	5,33	0.13
360	5- 7/8	6- 1/4	3/16	5.850	.037	.210	.005	148,59	0,94	5,33	0.13
361	6	6- 3/8	3/16	5.975	.037	.210	.005	151,77	0,94	5,33	0.13
362	6- 1/4	6- 5/8	3/16	6.225	.040	.210	.005	158,12	1,02	5,33	0.13
363	6- 1/2	6- 7/8	3/16	6.475	.040	.210	.005	164,47	1,02	5,33	0.13
364	6- 3/4	7- 1/8	3/16	6.725	.040	.210	.005	170,82	1,02	5,33	0.13
365	7	7- 3/8	3/16	6.975	.040	.210	.005	177,17	1,02	5,33	0.13
366	7- 1/4	7- 5/8	3/16	7.225	.045	.210	.005	183,52	1,14	5,33	0.13
367	7- 1/2	7- 7/8	3/16	7.475	.045	.210	.005	189,87	1,14	5,33	0.13
368	7- 3/4	8- 1/8	3/16	7.725	.045	.210	.005	196,22	1,14	5,33	0.13
369	8	8- 3/8	3/16	7.925	.045	.210	.005	202,57	1,14	5,33	0.13
370	8- 1/4	8- 5/8	3/16	8.225	.050	.210	.005	208,92	1,27	5,33	0.13
371	8- 1/2	8- 7/8	3/16	8.475	.050	.210	.005	215,27	1,27	5,33	0.13
372	8- 3/4	9- 1/8	3/16	8.725	.050	.210	.005	221,62	1,27	5,33	0.13
373	9	9- 3/8	3/16	8.975	.050	.210	.005	227,97	1,27	5,33	0.13
374	9- 1/4	9- 5/8	3/16	9.225	.055	.210	.005	234,32	1,40	5,33	0.13
375	9- 1/2	9- 7/8	3/16	9.475	.055	.210	.005	240,67	1,40	5,33	0.13
376	9- 3/4	10- 1/8	3/16	9.725	.055	.210	.005	247,02	1,40	5,33	0.13
377	10	10- 3/8	3/16	9.975	.055	.210	.005	253,37	1,40	5,33	0.13
378	10- 1/2	10- 7/8	3/16	10.475	.060	.210	.005	266,07	1,52	5,33	0.13
379	11	11- 3/8	3/16	10.975	.060	.210	.005	278,77	1,52	5,33	0.13

Table 7-2: AS 568 B (Continued)

	Nominal size (inches)			Actual size (inches)				Actual size (mm)			
Dash No.	Inside diameter d1	Outside diameter	Cross-section d2	Inside diameter d1	Tol. ±	CS	Tol. ±	Inside diameter	Tol. ±	Cross-section d2	Tol. ±
380	11- 1/2	11- 7/8	3/16	11.475	.065	.210	.005	291,47	1,65	5,33	0.13
381	12	12- 3/8	3/16	11.975	.065	.210	.005	304,17	1,65	5,33	0.13
382	13	13- 3/8	3/16	12.975	.065	.210	.005	329,57	1,65	5,33	0.13
383	14	14- 3/8	3/16	13.975	.070	.210	.005	354,97	1,78	5,33	0.13
384	15	15- 3/8	3/16	14.975	.070	.210	.005	380,37	1,78	5,33	0.13
385	16	16- 3/8	3/16	15.955	.075	.210	.005	405,26	1,91	5,33	0.13
386	17	17- 3/8	3/16	16.955	.080	.210	.005	430,66	2,03	5,33	0.13
387	18	18- 3/8	3/16	17.955	.085	.210	.005	456,06	2,16	5,33	0.13
388	19	19- 3/8	3/16	18.955	.090	.210	.005	481,41	2,29	5,33	0.13
389	20	20- 3/8	3/16	19.955	.095	.210	.005	506,81	2,41	5,33	0.13
390	21	21- 3/8	3/16	20.955	.095	.210	.005	532,21	2,41	5,33	0.13
391	22	22- 3/8	3/16	21.955	.100	.210	.005	557,61	2,54	5,33	0.13
392	23	23- 3/8	3/16	22.940	.105	.210	.005	582,68	2,67	5,33	0.13
393	24	24- 3/8	3/16	23.940	.110	.210	.005	608,08	2,79	5,33	0.13
394	25	25- 3/8	3/16	24.940	.115	.210	.005	633,48	2,92	5,33	0.13
395	26	26- 3/8	3/16	25.940	.120	.210	.005	658,88	3,05	5,33	0.13
425	4- 1/2	5	1/4	4.475	.033	.275	.006	113,67	0,84	6,99	0.15
426	4- 5/8	5- 1/8	1/4	4.600	.033	.275	.006	116,84	0,84	6,99	0.15
427	4- 3/4	5- 1/4	1/4	4.725	.033	.275	.006	120,02	0,84	6,99	0.15
428	4- 7/8	5- 3/8	1/4	4.850	.033	.275	.006	123,19	0,84	6,99	0.15
429	5	5- 1/2	1/4	4.975	.037	.275	.006	126,37	0,94	6,99	0.15
430	5- 1/8	5- 5/8	1/4	5.100	.037	.275	.006	129,54	0,94	6,99	0.15
431	5- 1/4	5- 3/4	1/4	5.225	.037	.275	.006	132,72	0,94	6,99	0.15
432	5- 3/8	5- 7/8	1/4	5.350	.037	.275	.006	135,89	0,94	6,99	0.15
433	5- 1/2	6	1/4	5.475	.037	.275	.006	139,07	0,94	6,99	0.15
434	5- 5/8	6- 1/8	1/4	5.600	.037	.275	.006	142,24	0,94	6,99	0.15
435	5- 3/4	6- 1/4	1/4	5.725	.037	.275	.006	145,42	0,94	6,99	0.15
436	5- 7/8	6- 3/8	1/4	5.850	.037	.275	.006	148,59	0,94	6,99	0.15
437	6	6- 1/2	1/4	5.975	.037	.275	.006	151,77	0,94	6,99	0.15
438	6- 1/4	6- 3/4	1/4	6.225	.040	.275	.006	158,12	1,02	6,99	0.15
439	6- 1/2	7	1/4	6.475	.040	.275	.006	164,47	1,02	6,99	0.15
440	6- 3/4	7- 1/4	1/4	6.725	.040	.275	.006	170,82	1,02	6,99	0.15
441	7	7- 1/2	1/4	6.975	.040	.275	.006	177,17	1,02	6,99	0.15
442	7- 1/4	7- 3/4	1/4	7.225	.045	.275	.006	183,52	1,14	6,99	0.15
443	7- 1/2	8	1/4	7.475	.045	.275	.006	189,87	1,14	6,99	0.15
444	7- 3/4	8- 1/4	1/4	7.725	.045	.275	.006	196,22	1,14	6,99	0.15
445	8	8- 1/2	1/4	7.975	.045	.275	.006	202,57	1,14	6,99	0.15

Table 7-2: AS 568 B (Continued)

	Nominal size (inches)			Actual size (inches)				Actual size (mm)			
Dash No.	Inside diameter d1	Outside diameter	Cross-section d2	Inside diameter d1	Tol. ±	CS	Tol. ±	Inside diameter	Tol. ±	Cross-section d2	Tol. ±
446	8- 1/2	9	1/4	8.475	.055	.275	.006	215,27	1,40	6,99	0.15
447	9	9- 1/2	1/4	8.975	.055	.275	.006	227,97	1,40	6,99	0.15
448	9- 1/2	10	1/4	9.475	.055	.275	.006	240,67	1,40	6,99	0.15
449	10	10- 1/2	1/4	9.975	.055	.275	.006	253,37	1,40	6,99	0.15
450	10- 1/2	11	1/4	10.475	.060	.275	.006	266,07	1,52	6,99	0.15
451	11	11- 1/2	1/4	10.975	.060	.275	.006	278,77	1,52	6,99	0.15
452	11- 1/2	12	1/4	11.475	.060	.275	.006	291,47	1,52	6,99	0.15
453	12	12- 1/2	1/4	11.975	.060	.275	.006	304,17	1,52	6,99	0.15
454	12- 1/2	13	1/4	12.475	.060	.275	.006	316,87	1,52	6,99	0.15
455	13	13- 1/2	1/4	12.975	.060	.275	.006	329,57	1,52	6,99	0.15
456	13- 1/2	14	1/4	13.475	.070	.275	.006	342,27	1,78	6,99	0.15
457	14	14- 1/2	1/4	13.975	.070	.275	.006	354,97	1,78	6,99	0.15
458	14- 1/2	15	1/4	14.475	.070	.275	.006	367,67	1,78	6,99	0.15
459	15	15- 1/2	1/4	14.975	.070	.275	.006	380,37	1,78	6,99	0.15
460	15- 1/2	16	1/4	15.475	.070	.275	.006	393,07	1,78	6,99	0.15
461	16	16- 1/2	1/4	15.955	.075	.275	.006	405,26	1,91	6,99	0.15
462	16- 1/2	17	1/4	16.455	.075	.275	.006	417,96	1,91	6,99	0.15
463	17	17- 1/2	1/4	16.955	.080	.275	.006	430,66	2,03	6,99	0.15
464	17- 1/2	18	1/4	17.455	.085	.275	.006	443,36	2,16	6,99	0.15
465	18	18- 1/2	1/4	17.955	.085	.275	.006	456,06	2,16	6,99	0.15
466	18- 1/2	19	1/4	18.455	.085	.275	.006	468,76	2,16	6,99	0.15
467	19	19- 1/2	1/4	18.955	.090	.275	.006	481,46	2,29	6,99	0.15
468	19- 1/2	20	1/4	19.455	.090	.275	.006	494,16	2,29	6,99	0.15
469	20	20- 1/2	1/4	19.955	.095	.275	.006	506,86	2,41	6,99	0.15
470	21	21- 1/2	1/4	20.955	.095	.275	.006	532,26	2,41	6,99	0.15
471	22	22- 1/2	1/4	21.955	.100	.275	.006	557,66	2,54	6,99	0.15
472	23	23- 1/2	1/4	22.940	.105	.275	.006	582,68	2,67	6,99	0.15
473	24	24- 1/2	1/4	23.940	.110	.275	.006	608,08	2,79	6,99	0.15
474	25	25- 1/2	1/4	24.940	.115	.275	.006	633,48	2,92	6,99	0.15
475	26	26- 1/2	1/4	25.940	.120	.275	.006	658,88	3,05	6,99	0.15

Table 7-2: AS 568 B (Continued)

	Nominal size (inches)			Actual size (inches)				Actual size (mm)			
Dash No.	Inside diameter d1	Outside diameter	Cross-section d2	Inside diameter d1	Tol. ±	CS	Tol. ±	Inside diameter	Tol. ±	Cross-section d2	Tol. ±
901				.185	.005	.056	.003	4,70	0,13	1,42	0.08
902				.239	.005	.064	.003	6,07	0,13	1,63	0.08
903				.301	.005	.064	.003	7,65	0,13	1,63	0.08
904				.351	.005	.072	.003	8,92	0,13	1,83	0.08
905				.414	.005	.072	.003	10,52	0,13	1,83	0.08
906				.468	.005	.078	.003	11,89	0,13	1,98	0.08
907				.530	.007	.082	.003	13,46	0,18	2,08	0.08
908				.644	.009	.087	.003	16,36	0,23	2,21	0.08
909				.706	.009	.097	.003	17,93	0,23	2,46	0.08
910				.755	.009	.097	.003	19,18	0,23	2,46	0.08
911				.863	.009	.116	.004	21,92	0,23	2,95	0.10
912				.924	.009	.116	.004	23,47	0,23	2,95	0.10
913				.986	.010	.116	.004	25,04	0,26	2,95	0.10
914				1.047	.010	.116	.004	26,59	0,26	2,95	0.10
916				1.171	.010	.116	.004	29,74	0,26	2,95	0.10
918				1.355	.012	.116	.004	34,42	0,30	2,95	0.10
920				1.475	.014	.118	.004	37,47	0,36	3,00	0.10
924				1.720	.014	.118	.004	43,69	0,36	3,00	0.10
928				2.090	.018	.118	.004	53,09	0,46	3,00	0.10
932				2.337	.018	.118	.004	59,36	0,46	3,00	0.10

Table 7-2: AS 568 B (Continued)

O-Ring Standard Size (JIS B 2401)

JIS B 2401	MILLIMETERS		INCHES					
SIZE	ID	±	CS	±	ID	±	CS	±
G25	24.4	0.25	3.1	0.1	0.961	0.01	0.122	0.004
G30	29.4	0.29	3.1	0.1	1.157	0.01	0.122	0.004
G35	34.4	0.33	3.1	0.1	1.354	0.01	0.122	0.004
G40	39.4	0.37	3.1	0.1	1.551	0.02	0.122	0.004
G45	44.4	0.41	3.1	0.1	1.748	0.02	0.122	0.004
G50	49.4	0.45	3.1	0.1	1.945	0.02	0.122	0.004
G55	54.4	0.49	3.1	0.1	2.142	0.02	0.122	0.004
G60	59.4	0.53	3.1	0.1	2.339	0.02	0.122	0.004
G65	64.4	0.57	3.1	0.1	2.535	0.02	0.122	0.004
G70	69.4	0.61	3.1	0.1	2.732	0.02	0.122	0.004
G75	74.4	0.65	3.1	0.1	2.929	0.03	0.122	0.004
G80	79.4	0.69	3.1	0.1	3.126	0.03	0.122	0.004
G85	84.4	0.73	3.1	0.1	3.323	0.03	0.122	0.004
G90	89.4	0.77	3.1	0.1	3.52	0.03	0.122	0.004
G95	94.4	0.81	3.1	0.1	3.717	0.03	0.122	0.004
G100	99.4	0.85	3.1	0.1	3.913	0.03	0.122	0.004
G105	104.4	0.87	3.1	0.1	4.11	0.03	0.122	0.004
G110	109.4	0.91	3.1	0.1	4.307	0.04	0.122	0.004
G115	114.4	0.94	3.1	0.1	4.504	0.04	0.122	0.004
G120	119.4	0.98	3.1	0.1	4.701	0.04	0.122	0.004
G125	124.4	1.01	3.1	0.1	4.898	0.04	0.122	0.004
G130	129.4	1.05	3.1	0.1	5.094	0.04	0.122	0.004
G135	134.4	1.08	3.1	0.1	5.291	0.04	0.122	0.004
G140	139.4	1.12	3.1	0.1	5.488	0.04	0.122	0.004
G145	144.4	1.16	3.1	0.1	5.685	0.05	0.122	0.004
G150	149.3	1.19	5.7	0.13	5.878	0.05	0.224	0.005
G155	154.3	1.23	5.7	0.13	6.075	0.05	0.224	0.005
G160	159.3	1.26	5.7	0.13	6.272	0.05	0.224	0.005
G165	164.3	1.3	5.7	0.13	6.468	0.05	0.224	0.005
G170	169.3	1.33	5.7	0.13	6.665	0.05	0.224	0.005
G175	174.3	1.37	5.7	0.13	6.862	0.05	0.224	0.005
G180	179.3	1.4	5.7	0.13	7.059	0.06	0.224	0.005

G185	184.3	1.44	5.7	0.13	7.256	0.06	0.224	0.005
G190	189.3	1.47	5.7	0.13	7.453	0.06	0.224	0.005
G195	194.3	1.51	5.7	0.13	7.65	0.06	0.224	0.005
G200	199.3	1.55	5.7	0.13	7.846	0.06	0.224	0.005
G205	204.3	1.58	5.7	0.13	8.043	0.06	0.224	0.005
G210	209.3	1.61	5.7	0.13	8.24	0.06	0.224	0.005
G215	214.3	1.65	5.7	0.13	8.437	0.07	0.224	0.005
G220	219.3	1.68	5.7	0.13	8.634	0.07	0.224	0.005
G225	224.3	1.71	5.7	0.13	8.831	0.07	0.224	0.005
G230	229.3	1.73	5.7	0.13	9.028	0.07	0.224	0.005
G235	234.3	1.78	5.7	0.13	9.224	0.07	0.224	0.005
G240	239.3	1.81	5.7	0.13	9.421	0.07	0.224	0.005
G245	244.3	1.85	5.7	0.13	9.618	0.07	0.224	0.005
G250	249.3	1.88	5.7	0.13	9.815	0.07	0.224	0.005
G255	254.3	1.91	5.7	0.13	10.012	0.08	0.224	0.005
G260	259.3	1.94	5.7	0.13	10.209	0.08	0.224	0.005
G265	264.3	1.98	5.7	0.13	10.405	0.08	0.224	0.005
G270	269.3	2.01	5.7	0.13	10.602	0.08	0.224	0.005
G275	274.3	2.04	5.7	0.13	10.799	0.08	0.224	0.005
G280	279.3	2.07	5.7	0.13	10.996	0.08	0.224	0.005
G285	284.3	2.11	5.7	0.13	11.193	0.08	0.224	0.005
G290	289.3	2.14	5.7	0.13	11.39	0.08	0.224	0.005
G295	294.3	2.17	5.7	0.13	11.587	0.09	0.224	0.005
G300	299.3	2.2	5.7	0.13	11.783	0.09	0.224	0.005
G305	304.3	2.24	5.7	0.13	11.98	0.09	0.224	0.005
G310	309.3	2.27	5.7	0.13	12.177	0.09	0.224	0.005
G315	314.3	2.3	5.7	0.13	12.374	0.09	0.224	0.005
G320	319.3	2.33	5.7	0.13	12.571	0.09	0.224	0.005
G325	324.3	2.36	5.7	0.13	12.768	0.09	0.224	0.005
G330	329.3	2.39	5.7	0.13	12.965	0.09	0.224	0.005
G335	334.3	2.42	5.7	0.13	13.161	0.1	0.224	0.005
G340	339.3	2.45	5.7	0.13	13.358	0.1	0.224	0.005
G345	344.3	2.48	5.7	0.13	13.555	0.1	0.224	0.005
G350	349.3	2.51	5.7	0.13	13.752	0.1	0.224	0.005
G355	354.3	2.54	5.7	0.13	13.949	0.1	0.224	0.005
G360	359.3	2.57	5.7	0.13	14.146	0.1	0.224	0.005
G365	364.3	2.6	5.7	0.13	14.342	0.1	0.224	0.005
G370	369.3	2.63	5.7	0.13	14.539	0.1	0.224	0.005
G375	374.3	2.67	5.7	0.13	14.736	0.11	0.224	0.005

G380	379.3	2.7	5.7	0.13	14.933	0.11	0.224	0.005
G385	384.3	2.73	5.7	0.13	15.13	0.11	0.224	0.005
G390	389.3	2.77	5.7	0.13	15.327	0.11	0.224	0.005
G395	394.3	2.79	5.7	0.13	15.524	0.11	0.224	0.005
G400	399.3	2.82	5.7	0.13	15.72	0.11	0.224	0.005
G405	404.3	3	5.7	0.13	15.917	0.12	0.224	0.005
G410	409.3	3	5.7	0.13	16.114	0.12	0.224	0.005
G415	414.3	3	5.7	0.13	16.311	0.12	0.224	0.005
G420	419.3	3	5.7	0.13	16.508	0.12	0.224	0.005
G425	424.3	3	5.7	0.13	16.705	0.12	0.224	0.005
G430	429.3	3	5.7	0.13	16.902	0.12	0.224	0.005
G435	434.3	3	5.7	0.13	17.098	0.12	0.224	0.005
G440	439.3	3	5.7	0.13	17.295	0.12	0.224	0.005
G445	444.3	3	5.7	0.13	17.492	0.12	0.224	0.005
G450	449.3	3	5.7	0.13	17.689	0.12	0.224	0.005
G455	454.3	3.3	5.7	0.13	17.886	0.13	0.224	0.005
G460	459.3	3.3	5.7	0.13	18.083	0.13	0.224	0.005
G465	464.3	3.3	5.7	0.13	18.279	0.13	0.224	0.005
G470	469.3	3.3	5.7	0.13	18.476	0.13	0.224	0.005
G475	474.3	3.3	5.7	0.13	18.673	0.13	0.224	0.005
G480	479.3	3.3	5.7	0.13	18.87	0.13	0.224	0.005
G485	484.3	3.3	5.7	0.13	19.067	0.13	0.224	0.005
G490	489.3	3.3	5.7	0.13	19.264	0.13	0.224	0.005
G495	494.3	3.3	5.7	0.13	19.461	0.13	0.224	0.005
G500	499.3	3.3	5.7	0.13	19.657	0.13	0.224	0.005
G510	509.3	3.47	5.7	0.13	20.051	0.14	0.224	0.005
G520	519.3	3.53	5.7	0.13	20.445	0.14	0.224	0.005
G530	529.3	3.59	5.7	0.13	20.839	0.14	0.224	0.005
G540	539.3	3.65	5.7	0.13	21.232	0.14	0.224	0.005
G550	549.3	3.72	5.7	0.13	21.626	0.15	0.224	0.005
G560	559.3	3.78	5.7	0.13	22.02	0.15	0.224	0.005
G570	569.3	3.84	5.7	0.13	22.413	0.15	0.224	0.005
G580	579.3	3.9	5.7	0.13	22.807	0.15	0.224	0.005
G590	589.3	3.97	5.7	0.13	23.201	0.16	0.224	0.005
G600	599.3	4.03	5.7	0.13	23.594	0.16	0.224	0.005
G605	604.3	4.06	5.7	0.13	23.791	0.16	0.224	0.005
G860	859.3	5.63	5.7	0.13	33.831	0.22	0.224	0.005
G910	909.3	5.93	5.7	0.13	35.799	0.23	0.224	0.005

P3	2.8	0.14	1.9	0.07	0.11	0.01	0.075	0.003
P4	3.8	0.14	1.9	0.07	0.15	0.01	0.075	0.003
P5	4.8	0.15	1.9	0.07	0.189	0.01	0.075	0.003
P6	5.8	0.15	1.9	0.07	0.228	0.01	0.075	0.003
P7	6.8	0.16	1.9	0.07	0.268	0.01	0.075	0.003
P8	7.8	0.16	1.9	0.07	0.307	0.01	0.075	0.003
P9	8.8	0.17	1.9	0.07	0.346	0.01	0.075	0.003
P10	9.8	0.17	1.9	0.07	0.386	0.01	0.075	0.003
P10A	9.8	0.17	2.4	0.07	0.386	0.01	0.094	0.003
P11	10.8	0.18	2.4	0.07	0.425	0.01	0.094	0.003
P11.2	11	0.18	2.4	0.07	0.433	0.01	0.094	0.003
P12	11.8	0.19	2.4	0.07	0.465	0.01	0.094	0.003
P12.5	12.3	0.19	2.4	0.07	0.484	0.01	0.094	0.003
P14	13.8	0.19	2.4	0.07	0.543	0.01	0.094	0.003
P15	14.8	0.2	2.4	0.07	0.583	0.01	0.094	0.003
P16	15.8	0.2	2.4	0.07	0.622	0.01	0.094	0.003
P18	17.8	0.21	2.4	0.07	0.701	0.01	0.094	0.003
P20	19.8	0.22	2.4	0.07	0.78	0.01	0.094	0.003
P21	20.8	0.23	2.4	0.07	0.819	0.01	0.094	0.003
P22	21.8	0.24	2.4	0.07	0.858	0.01	0.094	0.003
P22A	21.7	0.24	3.5	0.1	0.854	0.01	0.138	0.004
P22.4	22.1	0.24	3.5	0.1	0.87	0.01	0.138	0.004
P24	23.7	0.24	3.5	0.1	0.933	0.01	0.138	0.004
P25	24.7	0.25	3.5	0.1	0.972	0.01	0.138	0.004
P25.5	25.2	0.25	3.5	0.1	0.992	0.01	0.138	0.004
P26	25.7	0.26	3.5	0.1	1.012	0.01	0.138	0.004
P28	27.7	0.28	3.5	0.1	1.091	0.01	0.138	0.004
P29	28.7	0.29	3.5	0.1	1.13	0.01	0.138	0.004
P29.5	29.2	0.29	3.5	0.1	1.15	0.01	0.138	0.004
P30	29.7	0.29	3.5	0.1	1.169	0.01	0.138	0.004
P31	30.7	0.3	3.5	0.1	1.209	0.01	0.138	0.004
P31.5	31.2	0.31	3.5	0.1	1.228	0.01	0.138	0.004
P32	31.7	0.31	3.5	0.1	1.248	0.01	0.138	0.004
P34	33.7	0.33	3.5	0.1	1.327	0.01	0.138	0.004
P35	34.7	0.34	3.5	0.1	1.366	0.01	0.138	0.004
P35.5	35.2	0.34	3.5	0.1	1.386	0.01	0.138	0.004
P36	35.7	0.34	3.5	0.1	1.406	0.01	0.138	0.004
P38	37.7	0.37	3.5	0.1	1.484	0.02	0.138	0.004
P39	38.7	0.37	3.5	0.1	1.524	0.02	0.138	0.004

P40	39.7	0.37	3.5	0.1	1.563	0.02	0.138	0.004
P41	40.7	0.38	3.5	0.1	1.602	0.02	0.138	0.004
P42	41.7	0.39	3.5	0.1	1.642	0.02	0.138	0.004
P44	43.7	0.41	3.5	0.1	1.72	0.02	0.138	0.004
P45	44.7	0.41	3.5	0.1	1.76	0.02	0.138	0.004
P46	45.7	0.42	3.5	0.1	1.799	0.02	0.138	0.004
P48	47.7	0.44	3.5	0.1	1.878	0.02	0.138	0.004
P49	48.7	0.45	3.5	0.1	1.917	0.02	0.138	0.004
P50	49.7	0.45	3.5	0.1	1.957	0.02	0.138	0.004
P48A	47.6	0.44	5.7	0.13	1.874	0.02	0.224	0.005
P50A	49.6	0.45	5.7	0.13	1.953	0.02	0.224	0.005
P52	51.6	0.47	5.7	0.13	2.031	0.02	0.224	0.005
P53	52.6	0.48	5.7	0.13	2.071	0.02	0.224	0.005
P55	54.6	0.49	5.7	0.13	2.15	0.02	0.224	0.005
P56	55.6	0.5	5.7	0.13	2.189	0.02	0.224	0.005
P58	57.6	0.52	5.7	0.13	2.268	0.02	0.224	0.005
P60	59.6	0.53	5.7	0.13	2.346	0.02	0.224	0.005
P62	61.6	0.55	5.7	0.13	2.425	0.02	0.224	0.005
P63	62.6	0.56	5.7	0.13	2.465	0.02	0.224	0.005
P65	64.6	0.57	5.7	0.13	2.543	0.02	0.224	0.005
P67	66.6	0.59	5.7	0.13	2.622	0.02	0.224	0.005
P70	69.6	0.61	5.7	0.13	2.74	0.02	0.224	0.005
P71	70.6	0.62	5.7	0.13	2.78	0.02	0.224	0.005
P75	74.6	0.65	5.7	0.13	2.937	0.03	0.224	0.005
P80	79.6	0.69	5.7	0.13	3.134	0.03	0.224	0.005
P85	84.6	0.73	5.7	0.13	3.331	0.03	0.224	0.005
P90	89.6	0.77	5.7	0.13	3.528	0.03	0.224	0.005
P95	94.6	0.81	5.7	0.13	3.724	0.03	0.224	0.005
P100	99.6	0.84	5.7	0.13	3.921	0.03	0.224	0.005
P102	101.6	0.85	5.7	0.13	4	0.03	0.224	0.005
P105	104.6	0.87	5.7	0.13	4.118	0.03	0.224	0.005
P110	109.6	0.91	5.7	0.13	4.315	0.04	0.224	0.005
P112	111.6	0.92	5.7	0.13	4.394	0.04	0.224	0.005
P115	114.6	0.94	5.7	0.13	4.512	0.04	0.224	0.005
P120	119.6	0.98	5.7	0.13	4.709	0.04	0.224	0.005
P125	124.6	1.01	5.7	0.13	4.906	0.04	0.224	0.005
P130	129.6	1.05	5.7	0.13	5.102	0.04	0.224	0.005
P132	131.6	1.06	5.7	0.13	5.181	0.04	0.224	0.005
P135	134.6	1.09	5.7	0.13	5.299	0.04	0.224	0.005

P140	139.6	1.12	5.7	0.13	5.496	0.04	0.224	0.005
P145	144.6	1.16	5.7	0.13	5.693	0.05	0.224	0.005
P150	149.6	1.19	5.7	0.13	5.89	0.05	0.224	0.005
P150A	149.5	1.19	8.4	0.15	5.886	0.05	0.331	0.006
P155	154.5	1.23	8.4	0.15	6.083	0.05	0.331	0.006
P160	159.5	1.26	8.4	0.15	6.28	0.05	0.331	0.006
P165	164.5	1.3	8.4	0.15	6.476	0.05	0.331	0.006
P170	169.5	1.33	8.4	0.15	6.673	0.05	0.331	0.006
P175	174.5	1.37	8.4	0.15	6.87	0.05	0.331	0.006
P180	179.5	1.4	8.4	0.15	7.067	0.06	0.331	0.006
P185	184.5	1.44	8.4	0.15	7.264	0.06	0.331	0.006
P190	189.5	1.48	8.4	0.15	7.461	0.06	0.331	0.006
P195	194.5	1.51	8.4	0.15	7.657	0.06	0.331	0.006
P200	199.5	1.55	8.4	0.15	7.854	0.06	0.331	0.006
P205	204.5	1.58	8.4	0.15	8.051	0.06	0.331	0.006
P209	208.5	1.61	8.4	0.15	8.209	0.06	0.331	0.006
P210	209.5	1.62	8.4	0.15	8.248	0.06	0.331	0.006
P215	214.5	1.65	8.4	0.15	8.445	0.07	0.331	0.006
P220	219.5	1.68	8.4	0.15	8.642	0.07	0.331	0.006
P225	224.5	1.71	8.4	0.15	8.839	0.07	0.331	0.006
P230	229.5	1.75	8.4	0.15	9.035	0.07	0.331	0.006
P235	234.5	1.78	8.4	0.15	9.232	0.07	0.331	0.006
P240	239.5	1.81	8.4	0.15	9.429	0.07	0.331	0.006
P245	244.5	1.84	8.4	0.15	9.626	0.07	0.331	0.006
P250	249.5	1.88	8.4	0.15	9.823	0.07	0.331	0.006
P255	254.5	1.91	8.4	0.15	10.02	0.08	0.331	0.006
P260	259.5	1.94	8.4	0.15	10.217	0.08	0.331	0.006
P265	264.5	1.97	8.4	0.15	10.413	0.08	0.331	0.006
P270	269.5	2.01	8.4	0.15	10.61	0.08	0.331	0.006
P275	274.5	2.04	8.4	0.15	10.807	0.08	0.331	0.006
P280	279.5	2.07	8.4	0.15	11.004	0.08	0.331	0.006
P285	284.5	2.1	8.4	0.15	11.201	0.08	0.331	0.006
P290	289.5	2.14	8.4	0.15	11.398	0.08	0.331	0.006
P295	294.5	2.17	8.4	0.15	11.594	0.09	0.331	0.006
P300	299.5	2.2	8.4	0.15	11.791	0.09	0.331	0.006
P305	304.5	2.24	8.4	0.15	11.988	0.09	0.331	0.006
P310	309.5	2.27	8.4	0.15	12.185	0.09	0.331	0.006
P315	314.5	2.3	8.4	0.15	12.382	0.09	0.331	0.006
P320	319.5	2.33	8.4	0.15	12.579	0.09	0.331	0.006

P325	324.5	2.36	8.4	0.15	12.776	0.09	0.331	0.006
P330	329.5	2.39	8.4	0.15	12.972	0.09	0.331	0.006
P335	334.5	2.42	8.4	0.15	13.169	0.1	0.331	0.006
P340	339.5	2.45	8.4	0.15	13.366	0.1	0.331	0.006
P345	344.5	2.48	8.4	0.15	13.563	0.1	0.331	0.006
P350	349.5	2.51	8.4	0.15	13.76	0.1	0.331	0.006
P355	354.5	2.54	8.4	0.15	13.957	0.1	0.331	0.006
P360	359.5	2.57	8.4	0.15	14.154	0.1	0.331	0.006
P365	364.5	2.6	8.4	0.15	14.35	0.1	0.331	0.006
P370	369.5	2.63	8.4	0.15	14.547	0.1	0.331	0.006
P375	374.5	2.67	8.4	0.15	14.744	0.11	0.331	0.006
P380	379.5	2.7	8.4	0.15	14.941	0.11	0.331	0.006
P385	384.5	2.73	8.4	0.15	15.138	0.11	0.331	0.006
P390	389.5	2.77	8.4	0.15	15.335	0.11	0.331	0.006
P395	394.5	2.79	8.4	0.15	15.531	0.11	0.331	0.006
P400	399.5	2.82	8.4	0.15	15.728	0.11	0.331	0.006
P405	404.5	3	8.4	0.15	15.925	0.12	0.331	0.006
P410	409.5	3	8.4	0.15	16.122	0.12	0.331	0.006
P415	414.5	3	8.4	0.15	16.319	0.12	0.331	0.006
P420	419.5	3	8.4	0.15	16.516	0.12	0.331	0.006
P425	424.5	3	8.4	0.15	16.713	0.12	0.331	0.006
P430	429.5	3	8.4	0.15	16.909	0.12	0.331	0.006
P435	434.5	3	8.4	0.15	17.106	0.12	0.331	0.006
P440	439.5	3	8.4	0.15	17.303	0.12	0.331	0.006
P445	444.5	3	8.4	0.15	17.5	0.12	0.331	0.006
P450	449.5	3	8.4	0.15	17.697	0.12	0.331	0.006
P455	454.5	3.3	8.4	0.15	17.894	0.13	0.331	0.006
P460	459.5	3.3	8.4	0.15	18.091	0.13	0.331	0.006
P465	464.5	3.3	8.4	0.15	18.287	0.13	0.331	0.006
P470	469.5	3.3	8.4	0.15	18.484	0.13	0.331	0.006
P475	474.5	3.3	8.4	0.15	18.681	0.13	0.331	0.006
P480	479.5	3.3	8.4	0.15	18.878	0.13	0.331	0.006
P485	484.5	3.3	8.4	0.15	19.075	0.13	0.331	0.006
P490	489.5	3.3	8.4	0.15	19.272	0.13	0.331	0.006
P495	494.5	3.3	8.4	0.15	19.468	0.13	0.331	0.006
P500	499.5	3.3	8.4	0.15	19.665	0.13	0.331	0.006
P590	589.5	3.97	8.4	0.15	23.209	0.16	0.331	0.006
P600	599.5	4.03	8.4	0.15	23.602	0.16	0.331	0.006
P610	609.5	4.09	8.4	0.15	23.996	0.16	0.331	0.006

P620	619.5	4.15	8.4	0.15	24.39	0.16	0.331	0.006
P625	624.5	4.18	8.4	0.15	24.587	0.17	0.331	0.006
P635	634.5	4.25	8.4	0.15	24.98	0.17	0.331	0.006
P650	649.5	4.34	8.4	0.15	25.571	0.17	0.331	0.006
P680	679.5	4.52	8.4	0.15	26.752	0.18	0.331	0.006
P690	689.5	4.59	8.4	0.15	27.146	0.18	0.331	0.006
P700	699.5	4.65	8.4	0.15	27.539	0.18	0.331	0.006
P710	709.5	4.71	8.4	0.15	27.933	0.19	0.331	0.006
P285	284.5	2.1	8.4	0.15	11.201	0.08	0.331	0.006
P290	289.5	2.14	8.4	0.15	11.398	0.08	0.331	0.006
P295	294.5	2.17	8.4	0.15	11.594	0.09	0.331	0.006
P300	299.5	2.2	8.4	0.15	11.791	0.09	0.331	0.006
P305	304.5	2.24	8.4	0.15	11.988	0.09	0.331	0.006
P310	309.5	2.27	8.4	0.15	12.185	0.09	0.331	0.006
P315	314.5	2.3	8.4	0.15	12.382	0.09	0.331	0.006
P320	319.5	2.33	8.4	0.15	12.579	0.09	0.331	0.006
P325	324.5	2.36	8.4	0.15	12.776	0.09	0.331	0.006
P330	329.5	2.39	8.4	0.15	12.972	0.09	0.331	0.006
P335	334.5	2.42	8.4	0.15	13.169	0.1	0.331	0.006
P340	339.5	2.45	8.4	0.15	13.366	0.1	0.331	0.006
P345	344.5	2.48	8.4	0.15	13.563	0.1	0.331	0.006
P350	349.5	2.51	8.4	0.15	13.76	0.1	0.331	0.006
P355	354.5	2.54	8.4	0.15	13.957	0.1	0.331	0.006
P360	359.5	2.57	8.4	0.15	14.154	0.1	0.331	0.006
P365	364.5	2.6	8.4	0.15	14.35	0.1	0.331	0.006
P370	369.5	2.63	8.4	0.15	14.547	0.1	0.331	0.006
P375	374.5	2.67	8.4	0.15	14.744	0.11	0.331	0.006
P380	379.5	2.7	8.4	0.15	14.941	0.11	0.331	0.006
P385	384.5	2.73	8.4	0.15	15.138	0.11	0.331	0.006
P390	389.5	2.77	8.4	0.15	15.335	0.11	0.331	0.006
P395	394.5	2.79	8.4	0.15	15.531	0.11	0.331	0.006
P400	399.5	2.82	8.4	0.15	15.728	0.11	0.331	0.006
P405	404.5	3	8.4	0.15	15.925	0.12	0.331	0.006
P410	409.5	3	8.4	0.15	16.122	0.12	0.331	0.006
P415	414.5	3	8.4	0.15	16.319	0.12	0.331	0.006
P420	419.5	3	8.4	0.15	16.516	0.12	0.331	0.006
P425	424.5	3	8.4	0.15	16.713	0.12	0.331	0.006
P430	429.5	3	8.4	0.15	16.909	0.12	0.331	0.006
P435	434.5	3	8.4	0.15	17.106	0.12	0.331	0.006

P440	439.5	3	8.4	0.15	17.303	0.12	0.331	0.006
P445	444.5	3	8.4	0.15	17.5	0.12	0.331	0.006
P450	449.5	3	8.4	0.15	17.697	0.12	0.331	0.006
P455	454.5	3.3	8.4	0.15	17.894	0.13	0.331	0.006
P460	459.5	3.3	8.4	0.15	18.091	0.13	0.331	0.006
P465	464.5	3.3	8.4	0.15	18.287	0.13	0.331	0.006
P470	469.5	3.3	8.4	0.15	18.484	0.13	0.331	0.006
P475	474.5	3.3	8.4	0.15	18.681	0.13	0.331	0.006
P480	479.5	3.3	8.4	0.15	18.878	0.13	0.331	0.006
P485	484.5	3.3	8.4	0.15	19.075	0.13	0.331	0.006
P490	489.5	3.3	8.4	0.15	19.272	0.13	0.331	0.006
P495	494.5	3.3	8.4	0.15	19.468	0.13	0.331	0.006
P500	499.5	3.3	8.4	0.15	19.665	0.13	0.331	0.006
P590	589.5	3.97	8.4	0.15	23.209	0.16	0.331	0.006
P600	599.5	4.03	8.4	0.15	23.602	0.16	0.331	0.006
P610	609.5	4.09	8.4	0.15	23.996	0.16	0.331	0.006
P620	619.5	4.15	8.4	0.15	24.39	0.16	0.331	0.006
P625	624.5	4.18	8.4	0.15	24.587	0.17	0.331	0.006
P635	634.5	4.25	8.4	0.15	24.98	0.17	0.331	0.006
P650	649.5	4.34	8.4	0.15	25.571	0.17	0.331	0.006
P680	679.5	4.52	8.4	0.15	26.752	0.18	0.331	0.006
P690	689.5	4.59	8.4	0.15	27.146	0.18	0.331	0.006
P700	699.5	4.65	8.4	0.15	27.539	0.18	0.331	0.006
P710	709.5	4.71	8.4	0.15	27.933	0.19	0.331	0.006
S3	2.5	0.13	1.5	0.08	0.098	0.01	0.059	0.003
S4	3.5	0.14	1.5	0.08	0.138	0.01	0.059	0.003
S5	4.5	0.14	1.5	0.08	0.177	0.01	0.059	0.003
S6	5.5	0.15	1.5	0.08	0.217	0.01	0.059	0.003
S7	6.5	0.15	1.5	0.08	0.256	0.01	0.059	0.003
S8	7.5	0.16	1.5	0.08	0.295	0.01	0.059	0.003
S9	8.5	0.16	1.5	0.08	0.335	0.01	0.059	0.003
S10	9.5	0.17	1.5	0.08	0.374	0.01	0.059	0.003
S11.2	10.7	0.18	1.5	0.08	0.421	0.01	0.059	0.003
S12	11.5	0.18	1.5	0.08	0.453	0.01	0.059	0.003
S12.5	12	0.19	1.5	0.08	0.472	0.01	0.059	0.003
S14	13.5	0.19	1.5	0.08	0.531	0.01	0.059	0.003
S15	14.5	0.19	1.5	0.08	0.571	0.01	0.059	0.003
S16	15.5	0.2	1.5	0.08	0.61	0.01	0.059	0.003

S18	17.5	0.21	1.5	0.08	0.689	0.01	0.059	0.003
S20	19.5	0.22	1.5	0.08	0.768	0.01	0.059	0.003
S22	21.5	0.23	1.5	0.08	0.846	0.01	0.059	0.003
S22.4	21.9	0.23	2	0.08	0.862	0.01	0.079	0.003
S24	23.5	0.24	2	0.08	0.925	0.01	0.079	0.003
S25	24.5	0.24	2	0.08	0.965	0.01	0.079	0.003
S26	25.5	0.25	2	0.08	1.004	0.01	0.079	0.003
S28	27.5	0.26	2	0.08	1.083	0.01	0.079	0.003
S29	28.5	0.28	2	0.08	1.122	0.01	0.079	0.003
S30	29.5	0.28	2	0.08	1.161	0.01	0.079	0.003
S31.5	31	0.29	2	0.08	1.22	0.01	0.079	0.003
S32	31.5	0.31	2	0.08	1.24	0.01	0.079	0.003
S34	33.5	0.32	2	0.08	1.319	0.01	0.079	0.003
S35	34.5	0.33	2	0.08	1.358	0.01	0.079	0.003
S35.5	35	0.33	2	0.08	1.378	0.01	0.079	0.003
S36	35.5	0.34	2	0.08	1.398	0.01	0.079	0.003
S38	37.5	0.36	2	0.08	1.476	0.01	0.079	0.003
S39	38.5	0.36	2	0.08	1.516	0.01	0.079	0.003
S40	39.5	0.38	2	0.08	1.555	0.02	0.079	0.003
S42	41.5	0.39	2	0.08	1.634	0.02	0.079	0.003
S44	43.5	0.4	2	0.08	1.713	0.02	0.079	0.003
S45	44.5	0.41	2	0.08	1.752	0.02	0.079	0.003
S46	45.5	0.42	2	0.08	1.791	0.02	0.079	0.003
S48	47.5	0.44	2	0.08	1.87	0.02	0.079	0.003
S50	49.5	0.45	2	0.08	1.949	0.02	0.079	0.003
S53	52.5	0.47	2	0.08	2.067	0.02	0.079	0.003
S55	54.5	0.5	2	0.08	2.146	0.02	0.079	0.003
S56	55.5	0.5	2	0.08	2.185	0.02	0.079	0.003
S60	59.5	0.52	2	0.08	2.343	0.02	0.079	0.003
S63	62.5	0.55	2	0.08	2.461	0.02	0.079	0.003
S65	64.5	0.56	2	0.08	2.539	0.02	0.079	0.003
S67	66.5	0.58	2	0.08	2.618	0.02	0.079	0.003
S70	69.5	0.61	2	0.08	2.736	0.02	0.079	0.003
S71	70.5	0.61	2	0.08	2.776	0.02	0.079	0.003
S75	74.5	0.64	2	0.08	2.933	0.03	0.079	0.003
S80	79.5	0.67	2	0.08	3.13	0.03	0.079	0.003
S85	84.5	0.71	2	0.08	3.327	0.03	0.079	0.003
S90	89.5	0.75	2	0.08	3.524	0.03	0.079	0.003
S95	94.5	0.79	2	0.08	3.72	0.03	0.079	0.003

S100	99.5	0.83	2	0.08	3.917	0.03	0.079	0.003
S105	104.5	0.87	2	0.08	4.114	0.03	0.079	0.003
S110	109.5	0.91	2	0.08	4.311	0.04	0.079	0.003
S112	111.5	0.91	2	0.08	4.39	0.04	0.079	0.003
S115	114.5	0.93	2	0.08	4.508	0.04	0.079	0.003
S120	119.5	0.97	2	0.08	4.705	0.04	0.079	0.003
S125	124.5	1	2	0.08	4.902	0.04	0.079	0.003
S130	129.5	1.05	2	0.08	5.098	0.04	0.079	0.003
S132	131.5	1.05	2	0.08	5.177	0.04	0.079	0.003
S135	134.5	1.08	2	0.08	5.295	0.04	0.079	0.003
S140	139.5	1.1	2	0.08	5.492	0.04	0.079	0.003
S145	144.5	1.13	2	0.08	5.689	0.04	0.079	0.003
S150	149.5	1.17	2	0.08	5.886	0.05	0.079	0.003
V10	9.5	0.17	4	0.1	0.374	0.01	0.157	0.004
V15	14.5	0.2	4	0.1	0.571	0.01	0.157	0.004
V24	23.5	0.24	4	0.1	0.925	0.01	0.157	0.004
V34	33.5	0.33	4	0.1	1.319	0.01	0.157	0.004
V40	39.5	0.37	4	0.1	1.555	0.02	0.157	0.004
V55	54.5	0.49	4	0.1	2.146	0.02	0.157	0.004
V58	57.5	0.52	4	0.1	2.264	0.02	0.157	0.004
V70	69	0.61	4	0.1	2.717	0.02	0.157	0.004
V85	84	0.72	4	0.1	3.307	0.03	0.157	0.004
V100	99	0.83	4	0.1	3.898	0.03	0.157	0.004
V120	119	0.97	4	0.1	4.685	0.04	0.157	0.004
V140	138.5	1.08	4	0.1	5.453	0.04	0.157	0.004
V150	148.5	1.18	4	0.1	5.846	0.05	0.157	0.004
V175	173	1.36	4	0.1	6.811	0.05	0.157	0.004
V225	222.5	1.7	6	0.15	8.76	0.07	0.236	0.006
V275	272	2.02	6	0.15	10.709	0.08	0.236	0.006
V315	312	2.22	6	0.15	12.283	0.09	0.236	0.006
V325	321.5	2.34	6	0.15	12.657	0.09	0.236	0.006
V380	376	2.68	6	0.15	14.803	0.11	0.236	0.006
V430	425.5	2.99	6	0.15	16.752	0.12	0.236	0.006
V475	470.5	3.22	6	0.15	18.524	0.13	0.236	0.006
V480	475	3.3	10	0.3	18.701	0.13	0.394	0.012
V490	485	3.31	10	0.3	19.094	0.13	0.394	0.012
V510	504.5	3.44	10	0.3	19.862	0.14	0.394	0.012
V530	524.5	3.6	10	0.3	20.65	0.14	0.394	0.012

V585	579	3.92	10	0.3	22.795	0.15	0.394	0.012
V640	633.5	4.24	10	0.3	24.941	0.17	0.394	0.012
V690	683	4.54	10	0.3	26.89	0.18	0.394	0.012
V740	732.5	4.83	10	0.3	28.839	0.19	0.394	0.012
V790	782	5.12	10	0.3	30.787	0.2	0.394	0.012
V950	940.5	6.06	10	0.3	37.027	0.24	0.394	0.012
V1055	1044	6.67	10	0.3	41.102	0.26	0.394	0.012