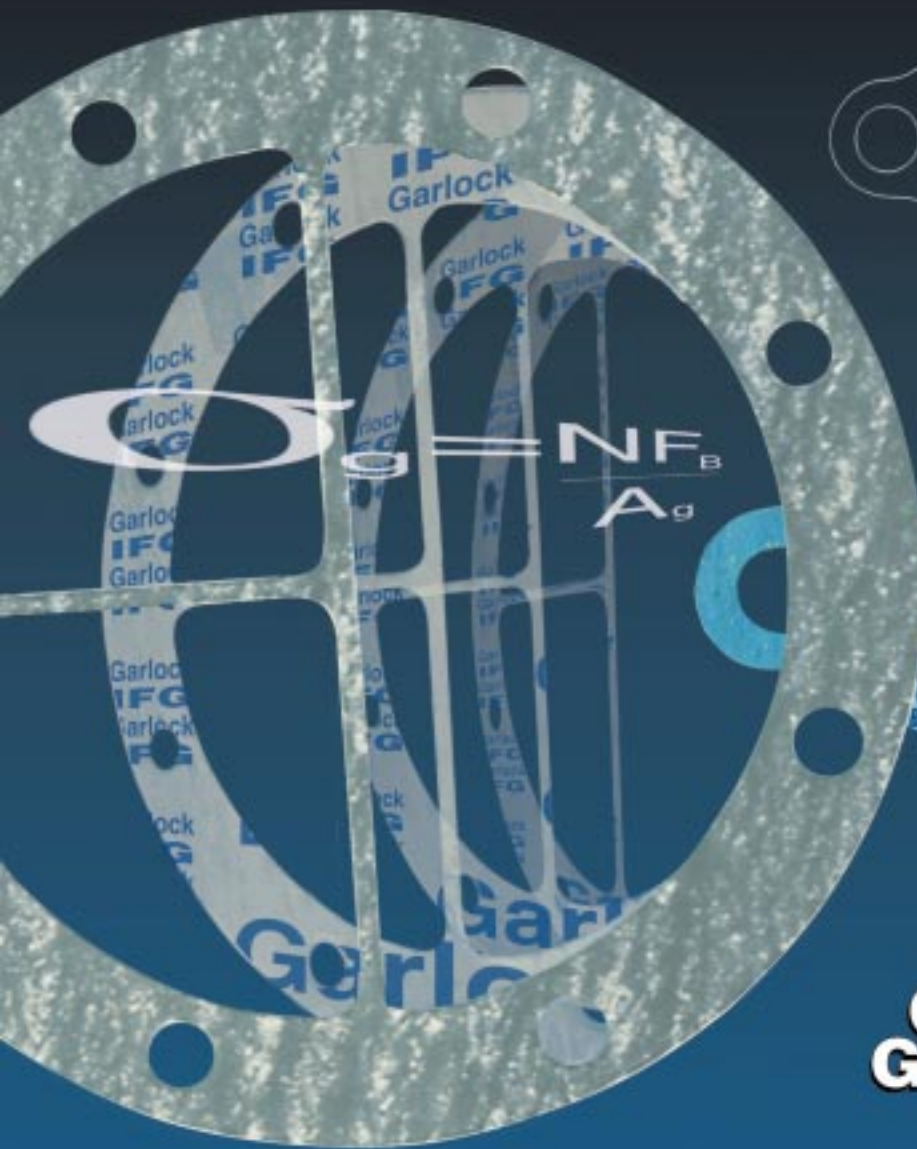


ENGINEERED GASKETING PRODUCTS



$$T_B = K F_B D$$



Garlock

SEALING TECHNOLOGIES®



Garlock Sealing Technologies

The demands of modern applications make the choice of the right sealing product an important consideration, both in the design of new equipment and in choosing the new products which will replace those no longer suitable.

This brochure provides some typical examples of appropriate applications, but is not intended to be a warranty of performance. All specific uses of sealing products require independent study and specific evaluation for suitability.

Garlock will provide the technical assistance of its applications engineers, who will give you specific recommendations. Please consult us. We are ready to help you make the right choice. Choosing the wrong sealing product can result in property damage and/or serious personal injury. Do not rely on the general criteria, which may not suit your application as well as one that Garlock Engineering can help you choose. Reliability and service to our customers is what the Garlock name means.

Let us help you choose the right product for your application.

Gasketing you can depend on

Garlock gasketing products are manufactured in completely modernized facilities. Tight quality controls are used to assure product conformance to specifications and uniformity that results in unvarying performance on the job. Garlock is certified to ISO-9002-94 standards and is audited annually by the Nuclear Procurement and Issues Committee (NUPIC).

Today's environmental concerns demand positive seals. Garlock gaskets provide that assurance, and perform with proven reliability. Whether your industry is chemical processing, hydrocarbon processing, power generation, pulp and paper, micro-electronics or transportation, Garlock gasketing products are the logical choice.

Garlock also manufactures a wide range of elastomeric and metallic gaskets. For products not listed in this catalog, contact Garlock Gasket Applications Engineering at 1-800-448-6688.

Made in the U.S.A.

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Factors Affecting Gasket Performance

A gasket has one basic function: to create a positive seal between two relatively stationary parts. The gasket must do a number of different jobs well to function properly: first, create an initial seal; second, maintain the seal over a desired length of time; third, be easily removed and replaced. Varying degrees of success are dependent on how well the gasket does the following:

1. Seals system fluid.
2. Chemically resists the system fluid to prevent serious impairment of its physical properties.
3. Deforms enough to flow into the imperfections on the gasket seating surfaces to provide intimate contact between the gasket and the seating surfaces.
4. Withstands system temperatures without serious impairment of its performance properties.
5. Is resilient and resists creep enough to maintain an adequate portion of the applied load.
6. Has sufficient strength to resist crushing under the applied load, and maintain its integrity when being handled and installed.
7. Does not contaminate the system fluid.
8. Does not promote corrosion of the gasket seating surfaces.
9. Is easily and cleanly removable at the time of replacement.

During the gasket product selection process that follows, we recommend that these nine (9) factors be used as a checklist from the viewpoint of the user's degree of need for each factor and the manufacturer's degree of compliance.

Questions? Call Gasket Applications Engineering at 1-800-448-6688

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Gasket Selection

Selecting gasketing materials for particular applications is not an easy task. The variables present in a flanged connection seem endless and yet all of them must be taken into consideration to assure a proper seal. In the past, the acronym "TAMP" (Temperature, Application, Media and Pressure) seemed to give sufficient information to make a gasketing recommendation. Today, items such as: the flange metallurgy, the amount of bolt thread embedment, the amount of flange rotation, the amount of bolt stretch, the additives to the media and the flange surface finish (in addition to other variables) determine how well a gasket will perform. In general, the definition of what a seal is has changed drastically over the years. Leakage measurements have gone from drips a minute to parts per million.

This catalog is designed to help guide you through the various gasketing products and narrow your choices. All industry standard tests are included in order to allow an end user a means of comparison between different materials. Many of the test procedures require that the tests be conducted on 1/32" material. As a rule of thumb, gasket performance decreases as material thickness increases. In addition, compressive loads must be increased with thicker materials. Proper bolting sequences are necessary to ensure those compressive loads are uniform. The temperature, pressure and P x T ratings are all based on optimum conditions. When approaching those extremes, it is suggested that you consult with the Garlock Applications Engineering Department or possibly upgrade to a material that has higher ratings.

As industry standards change and new products are introduced, this catalog will be updated. In the meantime, we urge you to take advantage of our experienced personnel for assistance. In-plant training, instructional video tapes, additional technical information and gasketing recommendations all are available to help in your selection process. Please feel free to call, fax, write, or e-mail us should you have any questions or concerns. Garlock is here to help.

Temperature

In most selection processes, the temperature of the fluid at the gasketed joint should be considered first. This will reduce the number of product candidates quickly, especially as temperatures go from 200°F (95°C) to 1000°F (540°C). When system operating temperatures approach a particular gasket material's maximum continuous operating temperature limit, an upgrade to a superior material is suggested. In some situations cryogenic temperatures must also be considered.

Application

The most important information under Application is the type of flange and bolts used. The number, size and grade of bolts used in the application determines the load available. The surface area being compressed is calculated from the gasket contact dimensions. The load from the bolts and the contact area of the gasket result in the compressive load available to seal the gasket. We have calculated and tabulated this information on standard ANSI raised face flanges (see page 40). Compressive stress available on non-standard flanges must be calculated on an individual basis. Without this information, we cannot choose between various types of materials such as elastomeric (rubber) gaskets, compressed sheet, GRAPH-LOCK® and GYLON® styles.

Media

There are thousands of different fluids. We cannot, in this manual, make recommendations for all fluids. Fortunately, however, there are a relatively limited number of fluids that make up the vast majority of the media encountered in industry. A general overview of fluid compatibility is provided for the most popular styles shown in this manual (see Chemical Resistance chart, pages 5-17). System cleanout and flushes should also be considered. Additional information on products versus fluids is available upon request.

Pressure

Next to be considered is the internal pressure of the fluid at the gasketed joint. We list the maximum pressure limits for each style. If severe and frequent pressure changes are involved, we should be given the details, since an alternative product may be needed.

Pressure (psi or bar) x Temperature (°F or °C)

We strongly recommend that pressure and temperature be considered simultaneously by using the following procedure:

1. First select the Garlock style(s) being considered for your application/service,
2. List the maximum pressure, temperature and P x T value for the style(s),
3. Make sure the actual service conditions do not exceed the style limitations in any of the three criteria. If they don't, the style(s) can be used, provided all other requirements are met. If they do exceed any one limit, another style or styles should be considered. Rarely can a style be recommended when the service conditions of pressure and temperature are both at the maximum limits for that style.

Example: BLUE-GARD® Compressed Asbestos-free Gasketing Style 3000

- | | |
|-------------------------------|---------------------|
| 1. Pressure Limit: | 1,000 psig (70 bar) |
| 2. Maximum Temperature Limit: | 700°F (370°C); |
| Continuous Operating Temp.: | 400°F (205°C) |
| 3. P x T Limit: | 350,000* (12,000) |

At 1,000 psig (70 bar), maximum temperature is 350°F (180°C).

Important

All pressure and P x T limits in this manual are based on laboratory tests utilizing ideal gasketing conditions. Field conditions will undoubtedly affect the gasket performance.

We hasten to point out that this method for gasket selection is merely a general guide and should not be the sole means for selecting or rejecting a product.

* P x T based on 1/16" sheet thickness unless otherwise stated.



Quick Reference Selection Guide

To be considered acceptable for a specific application, a product must meet the criteria in all four of the categories shown below. Acceptable values are marked with a "■". Also refer to chemical compatibility charts to verify chemical compatibility or call Garlock Engineering for assistance.

This chart does not take special operation conditions into consideration. i.e., pressure surges, temperature cycling and flange design.

		IFG® 5500 General Service	Style G-9900 High Temperature	Style 3125SS/TC High Temperature	Style ST-706 Saturated, Superheated Steam	Style 3500 GYLON® Aggressive Chemicals	Style 3510 GYLON® Aggressive Chemicals	Style 3545 GYLON® Aggressive Chemicals
1. Flange Materials	Metallic	■	■	■	■	■	■	■
	Non-Metallic							■
2. Continuous Operating Temperature (COT)	Ambient to 200°F (20°C to 95°C)	■	■	■	■	■	■	■
	200°F to 300°F (95°C to 150°C)	■	■	■	■	■	■	■
	300°F to 400°F (150°C to 205°C)	■	■	■	■	■	■	■
	400°F to 500°F (205°C to 260°C)	■	■	■	■	■	■	■
	500°F to 650°F (260°C to 345°C)		■	■	■			
	650°F to 750°F (345°C to 400°C)			■	■			
	750°F to 1200°F (400°C to 650°C)			*				
3. Application Pressure	Vacuum to 250 psig (Vacuum to 17 bar)	■	■	■	■	■	■	■
	Vacuum to 1000 psig (Vacuum to 69 bar)	■	■	■	■	■	■	■
	Vacuum to 1500 psig (Vacuum to 103 bar)		■	■	■			
	Vacuum to 2000 psig (Vacuum to 138 bar)		■	■				
4. PxT Values	0 to 50,000 psig x °F (0 to 1,500 bar x °C)	■	■	■	■	■	■	■
	0 to 350,000 psig x °F (0 to 12,000 bar x °C)	■ ¹	■	■	■ ^{2*}	■	■	■
	0 to 700,000 psig x °F (0 to 25,000 bar x °C)		■ ³	■ ³				

* Consult Garlock Applications Engineering at 1-800-448-6688

P x T max. = psig x °F (bar x °C)

¹ 1/8" thick IFG® is rated at 250,000 P x T

² 1/8" thick ST-706 is rated at 500,000 P x T

³ 1/8" thick G-9900 and 3125SS/TC are rated at 350,000 P x T

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Chemical Resistance of Garlock Compressed Sheet and GYLON®

A general guide for selection of gasketing material

Key: A = Suitable
 B = Depends on operating conditions
 C = Unsuitable
 – = No data or insufficient evidence

Footnotes explained on page 17.

Medium	Garlock Style Number													
	GYLON®							IFG 5500 G-9900 9850	9800	ST-706	3000 3001 CP-3900	3200 3400 CP-3920	3300 3800	IFG 5507 3700
	3500	3565 3504	3510	3560	3561	3535 3545	3530							
Abietic Acid	A	A	A	A	A	A	A	A	–	A	A	–	–	–
Acetaldehyde	A	A	A	A	A	A	A	C	C	C	C	C	C	B
Acetamide	A	A	A	A	A	A	A	A	C	A	A	C	A	B
Acetic Acid (Crude, Glacial, Pure)	A	A	A	A	A	A	A	B	B	B	B	B	B	B
Acetic Anhydride	A	A	A	A	A	A	A	A	A	A	A	A	B	A
Acetone	A	A	A	A	A	A	A	C	B	C	C	B	B	A
Acetonitrile	A	A	A	A	A	A	A	C	–	C	C	–	B	B
Acetophenone	A	A	A	A	A	A	A	C	C	C	C	C	C	B
2-Acetylaminofluorene	A	A	A	A	A	A	A	C	C	C	C	C	C	C
Acetylene	A	A	A	A	A	A	A	A	B	A	A ¹²	B	A	B
Acrolein	A ¹	A ¹	A ¹	A ¹	A ¹	A ¹	A ¹	B	C	B	B	C	B	B
Acrylamide	A ¹	A ¹	A ¹	A ¹	A ¹	A ¹	A ¹	C	C	C	C	C	C	C
Acrylic Acid	A ¹	A ¹	A ¹	A ¹	A ¹	A ¹	A ¹	C	C	C	C	C	C	B
Acrylic Anhydride	A	A	A	A	A	A	A	–	–	–	–	–	–	–
Acrylonitrile	A ¹	A ¹	A ¹	A ¹	A ¹	A ¹	A ¹	C	C	C	C	C	C	C
Air	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Allyl Acetate	A	A	A	A	A	A	A	C	C	C	C	C	C	B
Allyl Chloride	A	A	A	B	B	A	A	C	C	C	C	C	C	B
Allyl Methacrylate	A	A	A	A	A	A	A	C	C	C	C	C	C	C
Aluminum Chloride	A	A	A	B	B	A	A	A	A	A	A	A	A	A
Aluminum Fluoride	C	–	A	C	C	A	A	A	A	A	A	A	A	A
Aluminum Hydroxide (Solid)	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Aluminum Nitrate	A	A	A	A	A	A	–	B	B	B	B	B	B	B
Aluminum Sulfate	A	A	A	B	B	A	A	A	A	A	A	A	A	A
Alums	A	A	A	B	B	A	A	A	A	A	A	A	A	A
4-Aminodiphenyl	A	A	A	A	A	A	A	C	C	C	C	C	C	C
Ammonia, Gas, 150°F and below	A	A	A	A	A	A	A	A	A	B	A	A	A	A
Gas, Above 150°F	A	A	A	A	A	A	A	C	C	C	C	C	B	B
Liquid, Anhydrous	A	A	A	A	A	A	A	B	–	B	B	–	A	A
Ammonium Chloride	A	A	A	B	B	A	A	A	A	A	A	A	A	A
Ammonium Hydroxide	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Ammonium Nitrate	A	A	A	A	A	A	–	B	B	B	B	B	B	B
Ammonium Phosphate, Monobasic	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Dibasic	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Tribasic	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Ammonium Sulfate	A	A	A	B	B	A	A	A	A	A	A	A	A	A
Amyl Acetate	A	A	A	A	A	A	A	C	C	C	C	C	C	B
Amyl Alcohol	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Aniline, Aniline Oil	A	A	A	A	A	A	A	C	C	C	C	C	C	B
Aniline Dyes	A	A	A	A	A	A	A	C	B	C	C	B	B	B

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Chemical Resistance of Garlock Compressed Sheet and GYLON®

Medium	Garlock Style Number													
	GYLON®							IFG 5500 G-9900 9850	9800	ST-706	3000 3001 CP-3900	3200 3400 CP-3920	3300 3800	IFG 5507 3700
	3500	3565 3504	3510	3560	3561	3535 3540 3545	3530							
o-Anisidine	A	A	A	A	A	A	A	C	C	C	C	C	C	C
Aqua Regia	A	A	A	B	B	A	C	C	C	C	C	C	C	C
Aroclors	A	A	A	A	A	A	A	C	C	C	C	C	C	C
Asphalt	A	A	A	A	A	A	A	A	C	A	A	C	B	C
Aviation Gasoline	A	A	A	A	A	A	A	B	C	B	B	C	B	C
Barium Chloride	A	A	A	B	B	A	A	A	A	A	A	A	A	A
Barium Hydroxide	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Barium Sulfide	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Baygon	A	A	A	A	A	A	A	C	C	C	C	C	-	-
Beer ¹⁰	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Benzaldehyde	A	A	A	A	A	A	A	C	C	C	C	C	C	B
Benzene, Benzol	A	A	A	A	A	A	A	C	C	C	C	C	C	C
Benzidine	A	A	A	A	A	A	A	C	C	C	C	C	C	-
Benzoic Acid	A	A	A	A	A	A	A	B	B	B	B	B	B	B
Benzonitrile	A	A	A	A	A	A	A	C	-	C	C	-	-	C
Benzotrichloride	A	A	A	C	C	A	A	C	C	C	C	C	C	C
Benzoyl Chloride	A	A	A	-	-	A	A	C	-	C	C	-	C	C
Benzyl Alcohol	A	A	A	A	A	A	A	C	-	C	C	-	B	B
Benzyl Chloride	A	A	A	-	-	A	A	C	C	C	C	C	C	B
Biphenyl	A	A	A	B	B	A	A	C	C	C	C	C	C	C
Bis(2-chloroethyl)ether	A	A	A	-	-	A	A	C	C	C	C	C	C	C
Bis(chloromethyl)ether	A	A	A	-	-	A	A	C	C	C	C	C	C	B
Bis(2-ethylhexyl)phthalate	A	A	A	A	A	A	A	C	C	C	C	C	C	B
Black Sulfate Liquor	C	B	A	C	A	A	A	C	C	C	C	C	C	C
Blast Furnace Gas	A	A	A	A	A	A	A	B	C	B	B	C	B	C
Bleach (Sodium Hypochlorite)	A	A	A	B	B	A	-	C	-	C	C	-	C	C
Boiler Feed Water	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Borax	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Boric Acid	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Brine (Sodium Chloride)	A	A	A	B	B	A	A	A	A	A	A	A	A	A
Bromine	A	A	A	C	C	A	-	C	C	C	C	C	C	C
Bromine Trifluoride	C	C	C	C	C	C	C	C	C	C	C	C	C	C
Bromoform	A	A	A	A	A	A	A	C	C	C	C	C	C	C
Bromomethane	A	A	A	A	A	A	A	C	C	C	C	C	C	C
Butadiene	A ¹	A ¹	A ¹	A ¹	A ¹	A ¹	A ¹	C	C	C	C	C	-	C
Butane	A	A	A	A	A	A	A	A	C	B	A ¹²	C	B	C
2-Butanone	A	A	A	A	A	A	A	C	C	C	C	C	C	C
Butyl Acetate	A	A	A	A	A	A	A	C	C	C	C	C	C	B
Butyl Alcohol, Butanol	A	A	A	A	A	A	A	A	A	A	A	A	A	A
n-Butyl Amine	A	A	A	A	A	A	A	B	-	B	B	-	C	B
tert-Butyl Amine	A	A	A	A	A	A	A	B	-	B	B	-	C	B
Butyl Methacrylate	A ¹	A ¹	A ¹	A ¹	A ¹	A ¹	A ¹	C	C	C	C	C	C	C
Butyric Acid	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Calcium Bisulfite	A	A	A	A	A	A	A	B	-	B	B	-	B	C
Calcium Chloride	A	A	A	B	B	A	A	A	A	A	A	A	A	A
Calcium Cyanamide	A	A	A	A	A	A	A	B	B	B	B	B	B	B

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Medium	Garlock Style Number													
	GYLON®							IFG 5500 G-9900 9850	9800	ST-706	3000 3001 CP-3900	3200 3400 CP-3920	3300 3800	IFG 5507 3700
	3500	3565 3504	3510	3560	3561	3535 3540 3545	3530							
Calcium Hydroxide	-	A	A	-	A	A	A	A	A	A	A	A	A	A
Calcium Hypochlorite	A	A	A	B	B	A	-	B	B	B	C	C	C	C ²
Calcium Nitrate	A	A	A	-	-	A	C	B	B	B	B	B	B	B
Calflo AF	A	A	A	A	A	A	A	A	C	A	A	C	-	C
Calflo FG	A	A	A	A	A	A	A	A	C	A	A	C	-	C
Calflo HTF	A	A	A	A	A	A	A	A	C	A	A	C	-	C
Calflo LT	A	A	A	A	A	A	A	A	C	A	A	C	-	C
Cane Sugar Liquors	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Caprolactam	A	A	A	A	A	A	A	C	C	C	C	C	C	B
Captan	A	A	A	A	A	A	A	C	C	C	C	C	C	C
Carbaryl	A	A	A	A	A	A	A	C	C	C	C	C	C	C
Carbolic Acid, Phenol	A	A	A	A	A	A	A	C	C	C	C	C	C	B
Carbon Dioxide, Dry	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Wet	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Carbon Disulfide	A	A	A	A	A	A	A	C	C	C	C	C	C	C
Carbon Monoxide	A	A	A	A	A	A	A	B	B	B	B	B	B	B
Carbon Tetrachloride	A	A	A	B	B	A	A	C	C	C	C	C	C	C
Carbonic Acid	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Carbonyl Sulfide	A	A	A	-	-	A	A	C	C	C	C	C	C	C
Castor Oil	A	A	A	A	A	A	A	A	C	A	A	C	B	B
Catechol	A	A	A	A	A	A	A	C	B	C	C	B	-	-
Caustic Soda	C	B	A ⁶	C	A ⁶	A ¹¹	A ⁶	C	C	C	C	C	C	C
Cetane (Hexadecane)	A	A	A	A	A	A	A	A	C	A	A	C	B	C
China Wood Oil	A	A	A	A	A	A	A	A	C	A	A	C	B	C
Chloramben	A	A	A	-	-	A	A	C	C	C	C	C	C	C
Chlorazotic Acid (Aqua Regia)	A	A	A	B	B	A	C	C	C	C	C	C	C	C
Chlordane	A	A	A	-	-	A	A	C	C	C	C	C	C	C
Chlorinated Solvents, Dry	A	A	A	A	A	A	A	C	C	C	C	C	C	C
Wet	A	A	A	C	C	A	A	C	C	C	C	C	C	C
Chlorine, Dry	A	A	A	A	A	A	A	B	B	B	B	B	B	B
Wet	A	A	A	C	C	A	A	C	C	C	C	C	C	C
Chlorine Dioxide	A	A	A	-	-	A	C	C	C	C	C	C	C	C
Chlorine Trifluoride	C	C	C	C	C	C	C	C	C	C	C	C	C	C
Chloroacetic Acid	A	A	A	C	C	A	A	C	B	C	C	B	C	B
2-Chloroacetophenone	A	A	A	B	B	A	A	C	C	C	C	C	C	C
Chloroazotic Acid (Aqua Regia)	A	A	A	B	B	A	C	C	C	C	C	C	C	C
Chlorobenzene	A	A	A	A	A	A	A	C	C	C	C	C	C	C
Chlorobenzilate	A	A	A	-	-	A	A	C	C	C	C	C	C	C
Chloroethane	A	A	A	A	A	A	A	C	C	C	C	C	C	C
Chloroethylene	A	A	A	A	A	A	A	C	C	C	C	C	C	C
Chloroform	A	A	A	A	A	A	A	C	C	C	C	C	C	C
Chloromethyl Methyl Ether	A	A	A	-	-	A	A	C	C	C	C	C	C	C
Chloronitrous Acid (Aqua Regia)	A	A	A	B	B	A	C	C	C	C	C	C	C	C
Chloroprene	A	A	A	B	B	A	A	C	C	C	C	C	C	C
Chlorosulfonic Acid	A	A	A	-	-	A	-	C	C	C	C	C	C	C
Chrome Plating Solutions	- ⁵	- ⁵	A	- ⁵	B	A	A	C	C	C	C	C	C	C

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	3500	3565 3504	3510	3560	3561	3535 3540 3545	3530							
Chromic Acid	A	A	A	B	B	A	C	C	C	C	C	C	C	C
Chromic Anhydride	A	A	A	B	B	A	C	C	C	C	C	C	C	C
Chromium Trioxide	A	A	A	B	B	A	C	C	C	C	C	C	C	C
Citric Acid	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Coke Oven Gas	A	A	A	A	A	A	A	C	C	C	C	C	C	C
Copper Chloride	A	A	A	C	C	A	A	A	A	A	A	A	A	A
Copper Sulfate	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Corn Oil ¹⁰	A	A	A	A	A	A	A	A	C	A	A	C	B	B
Cotton Seed Oil ¹⁰	A	A	A	A	A	A	A	A	C	A	A	C	B	B
Creosote	A	A	A	A	A	A	A	B	C	B	B	C	B	C
Cresols, Cresylic Acid	A	A	A	A	A	A	A	C	C	C	C	C	C	C
Crotonic Acid	A	A	A	-	-	A	A	C	C	C	C	C	C	C
Crude Oil	A	A	A	B	B	A	A	A	B	A	A ¹²	B	B	C
Cumene	A	A	A	A	A	A	A	C	C	C	C	C	C	C
Cyclohexane	A	A	A	A	A	A	A	A	C	A	A	C	B	C
Cyclohexanone	A	A	A	A	A	A	A	C	C	C	C	C	C	B
2,4-D, Salts and Esters	A	A	A	-	-	A	A	C	C	C	C	C	C	C
Detergent Solutions	B	B	A	B	A	A	A	A	A	A	A	A	A	A
Diazomethane	A	A	A	A	A	A	A	-	-	-	-	-	-	-
Dibenzofuran	A	A	A	A	A	A	A	C	C	C	C	C	C	C
Dibenzylether	A	A	A	A	A	A	A	C	C	C	C	C	C	C
1,2-Dibromo-3-chloropropane	A	A	A	B	B	A	A	C	C	C	C	C	C	C
Dibromoethane	A	A	A	A	A	A	A	C	C	C	C	C	C	C
Dibutyl Phthalate	A	A	A	A	A	A	A	C	C	C	C	C	C	B
Dibutyl Sebacate	A	A	A	A	A	A	A	C	C	C	C	C	C	B
o-Dichlorobenzene	A	A	A	A	A	A	A	C	C	C	C	C	C	C
1,4-Dichlorobenzene	A	A	A	A	A	A	A	C	C	C	C	C	C	C
3,3-Dichlorobenzidene	A	A	A	-	-	A	A	C	C	C	C	C	C	C
Dichloroethane (1,1 or 1,2)	A	A	A	A	A	A	A	C	C	C	C	C	C	C
1,1-Dichloroethylene	A ¹	A ¹	A ¹	A ¹	A ¹	A ¹	A ¹	C	C	C	C	C	C	C
Dichloroethyl Ether	A	A	A	-	-	A	A	C	C	C	C	C	C	C
Dichloromethane	A	A	A	A	A	A	A	C	C	C	C	C	C	C
1,2-Dichloropropane	A	A	A	A	A	A	A	C	C	C	C	C	C	C
1,3-Dichloropropene	A	A	A	B	B	A	A	C	C	C	C	C	C	C
Dichlorvos	A	A	A	B	B	A	A	C	C	C	C	C	C	C
Diesel Oil	A	A	A	A	A	A	A	A	B	A	A ¹²	B	B	C
Diethanolamine	A	A	A	A	A	A	A	B	B	B	B	B	B	B
N,N-Diethylaniline	A	A	A	-	-	A	A	C	C	C	C	C	C	C
Diethyl Carbonate	A	A	A	-	-	A	A	C	-	C	C	-	C	-
Diethyl Sulfate	A	A	A	A	A	A	A	C	C	C	C	C	-	C
3,3-Dimethoxybenzidene	A	A	A	A	A	A	A	C	C	C	C	C	-	-
Dimethylaminoazobenzene	A	A	A	A	A	A	A	-	-	-	-	-	-	-
N,N-Dimethyl Aniline	A	A	A	-	-	A	A	C	C	C	C	C	C	C
3,3-Dimethylbenzidine	A	A	A	A	A	A	A	C	C	C	C	C	C	C
Dimethyl Carbamoyl Chloride	A	A	A	C	C	A	A	C	C	C	C	C	C	C
Dimethyl Ether	A	A	A	A	A	A	A	B	C	B	B	C	B	B

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	3500	3565 3504	3510	3560	3561	3535 3540 3545	3530							
Dimethylformamide	A	A	A	–	–	A	A	C	C	C	C	C	C	C
Dimethyl Hydrazine, Unsymmetrical	A	A	A	A	A	A	A	C	B	C	C	B	B	B
Dimethyl Phthalate	A	A	A	A	A	A	A	C	C	C	C	C	C	B
Dimethyl Sulfate	A	A	A	A	A	A	A	C	C	C	C	C	–	C
4,6-Dinitro-o-Cresol and Salts	A	A	A	A	A	A	A	C	C	C	C	C	C	C
2,4-Dinitrophenol	A	A	A	–	–	A	A	C	C	C	C	C	C	C
2,4-Dinitrotoluene	A	A	A	A	A	A	A	C	C	C	C	C	C	C
Dioxane	A	A	A	A	A	A	A	C	C	C	C	C	C	B
1,2-Diphenylhydrazine	A	A	A	A	A	A	A	C	B	C	C	B	–	–
Diphyl DT	A	A	A	A	A	A	A	C	C	C	C	C	C	C
Dowfrost	A	A	A	A	A	A	A	B	B	B	B	B	–	B
Dowfrost HD	A	A	A	A	A	A	A	B	B	B	B	B	–	B
Dowtherm 4000	A	A	A	A	A	A	A	B	B	B	B	B	B	B
Dowtherm A	A	A	A	A	A	A	A	C	C	C	C	C	C	C
Dowtherm E	A	A	A	A	A	A	A	C	C	C	C	C	C	C
Dowtherm G	A	A	A	A	A	A	A	C	C	C	C	C	C	C
Dowtherm HT	A	A	A	A	A	A	A	C	C	C	C	C	C	C
Dowtherm J	A	A	A	A	A	A	A	C	C	C	C	C	C	C
Dowtherm Q	A	A	A	A	A	A	A	C	C	C	C	C	C	C
Dowtherm SR-1	A	A	A	A	A	A	A	B	B	B	B	B	B	B
Epichlorohydrin	A	A	A	A	A	A	A	C	C	C	C	C	C	B
1,2-Epoxybutane	A	A	A	A	A	A	A	–	C	–	–	C	C	C
Ethane	A	A	A	A	A	A	A	A	B	B	A ¹²	B	B	C
Ethers	A	A	A	A	A	A	A	B	C	B	B	C	B	B
Ethyl Acetate	A	A	A	A	A	A	A	C	C	C	C	C	C	B
Ethyl Acrylate	A ¹	A ¹	A ¹	A ¹	A ¹	A ¹	A ¹	C	C	C	C	C	C	B
Ethyl Alcohol ¹⁰	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Ethylbenzene	A	A	A	A	A	A	A	C	C	C	C	C	C	C
Ethyl Carbamate	A	A	A	A	A	A	A	C	C	C	C	C	B	B
Ethyl Cellulose	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Ethyl Chloride	A	A	A	A	A	A	A	C	C	C	C	C	C	C
Ethyl Ether	A	A	A	A	A	A	A	B	C	B	B	C	B	B
Ethyl Hexoate	A	A	A	A	A	A	A	C	–	C	C	–	–	B
Ethylene	A	A	A	A	A	A	A	A	B	B	A	B	B	C
Ethylene Bromide	A	A	A	A	A	A	A	C	C	C	C	C	C	C
Ethylene Dibromide	A	A	A	A	A	A	A	C	C	C	C	C	C	C
Ethylene Dichloride	A	A	A	A	A	A	A	C	C	C	C	C	C	C
Ethylene Glycol	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Ethyleneimine	–	–	A	–	–	A	A	C	C	C	C	C	C	C
Ethylene Oxide	A ¹	A ¹	A ¹	A ¹	A ¹	A ¹	A ¹	C	C	C	C	C	C	C
Ethylene Thiourea	A	A	A	A	A	A	A	–	–	–	–	–	C	C
Ethylidene Chloride	A	A	A	A	A	A	A	C	C	C	C	C	C	C
Ferric Chloride	A	A	A	C	C	A	A	A	A	A	B	B	B	B ⁴
Ferric Phosphate	A	A	A	–	–	A	A	B	B	B	B	B	B	B
Ferric Sulfate	A	A	A	B	B	A	A	A	A	A	A	A	A	A
Fluorine, Gas	C	C	C	C	C	C	C	C	C	C	C	C	C	C

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	3500	3565 3504	3510	3560	3561	3535 3540 3545	3530							
Fluorine, Liquid	C	C	C	C	C	C	C	C	C	C	C	C	C	C
Fluorine Dioxide	C	C	C	C	C	C	C	C	C	C	C	C	C	C
Formaldehyde	A	A	A	A	A	A	A	A	B	A	A	B	B	A
Formic Acid	A	A	A	B	B	A	A	C	-	C	C	-	B	B
Fuel Oil	A	A	A	A	A	A	A	A	B	A	A ¹²	B	B	C
Fuel Oil, Acid	A	A	A	A	A	A	A	A	B	A	A ¹²	B	B	C
Furfural	A	A	A	A	A	A	A	C	C	C	C	C	B	B
Gasoline, Refined	A	A	A	A	A	A	A	A	C	A	A ¹²	C	B	C
Sour	A	A	A	A	A	A	A	A	C	A	A ¹²	C	B	C
Gelatin	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Glucose	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Glue, Protein Base	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Glycerine, Glycerol	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Glycol	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Grain Alcohol ¹⁰	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Grease, Petroleum Base	A	A	A	A	A	A	A	A	C	A	A	C	-	C
Green Sulfate Liquor	C	B	A	-	A	A	A	C	C	C	C	C	C	C
Heptachlor	A	A	A	-	-	A	A	C	C	C	C	C	C	C
Heptane	A	A	A	A	A	A	A	A	C	A	A ¹²	C	B	C
Hexachlorobenzene	A	A	A	A	A	A	A	C	C	C	C	C	C	C
Hexachlorobutadiene	A	A	A	A	A	A	A	C	C	C	C	C	C	C
Hexachlorocyclopentadiene	A	A	A	A	A	A	A	C	C	C	C	C	C	C
Hexachloroethane	A	A	A	-	-	A	A	C	C	C	C	C	C	C
Hexadecane	A	A	A	A	A	A	A	A	C	A	A	C	B	C
Hexamethylene Diisocyanate	A	A	A	A	A	A	A	-	C	-	-	C	-	C
Hexamethylphosphoramide	A	A	A	A	A	A	A	-	C	-	-	C	-	-
Hexane	A	A	A	A	A	A	A	A	C	A	A ¹²	C	B	C
Hexone	A	A	A	A	A	A	A	C	C	C	C	C	C	B
Hydraulic Oil, Mineral	A	A	A	A	A	A	A	A	B	A	A ¹²	B	B	C
Synthetic	A	A	A	A	A	A	A	C	C	C	C	C	C	B
Hydrazine	A	A	A	A	A	A	A	C	B	C	C	B	B	B
Hydrobromic Acid	A	A	A	C	C	A	A	C	C	C	C	C	C	C
Hydrochloric Acid	A	A	A	C	C	A	A	C	C	C	C	C	C	C
Hydrocyanic Acid	A	A	A	A	A	A	A	A	B	A	A	B	B	A
Hydrofluoric Acid, up to Anhydrous, 150°F & below	C	C	A	C	C	A	A	C	C	C	C	C	C	C
Less than 65%, Above 150°F	C	C	A	C	C	A	A	C	C	C	C	C	C	C
65% to Anhydrous, Above 150°F	C	C	-	C	C	A	A	C	C	C	C	C	C	C
Anhydrous	C	C	C	C	C	A	A	C	C	C	C	C	C	C
Hydrofluorosilicic Acid	C	C	A	C	C	A	A	C	C	C	C	C	C	C
Hydrofluosilicic Acid	C	C	A	C	C	A	A	C	C	C	C	C	C	C
Hydrogen	A	A	A	A	A	A	A	A	A	B	A	A	A	A
Hydrogen Bromide	A	A	A	-	-	A	A	C	C	C	C	C	C	C
Hydrogen Fluoride	C	C	C	C	C	A	A	C	C	C	C	C	C	C
Hydrogen Peroxide, 10%	A	A	A	A	A	A	A	B	B	B	B	B	B	B
10-90%	A	A	A	B	B	A	C	B	-	B	B	-	C	B
Hydrogen Sulfide, Dry or Wet	A	A	A	A	A	A	A	B	B	B	B	B	B	B

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	3500	3565 3504	3510	3560	3561	3535 3540 3545	3530							
Hydroquinone	A	A	A	A	A	A	A	C	B	C	C	B	C	C
Iodine Pentafluoride	-	-	-	-	-	-	C	C	C	C	C	C	C	C
Iodomethane	A	A	A	A	A	A	A	C	C	C	C	C	B	-
Isobutane	A	A	A	A	A	A	A	A	C	B	A ¹²	C	B	C
Isooctane	A	A	A	A	A	A	A	A	C	A	A ¹²	C	B	C
Isophorone	A	A	A	A	A	A	A	C	C	C	C	C	C	B
Isopropyl Alcohol	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Jet Fuels (JP Types)	A	A	A	A	A	A	A	A	C	A	A ¹²	C	B	C
Kerosene	A	A	A	A	A	A	A	A	C	A	A ¹²	C	B	C
Lacquer Solvents	A	A	A	A	A	A	A	C	C	C	C	C	C	C
Lacquers	A	A	A	A	A	A	A	C	C	C	C	C	C	C
Lactic Acid, 150°F and below	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Above 150°F	A	A	A	A	A	A	A	-	-	-	-	-	-	-
Lime Saltpeter (Calcium Nitrates)	A	A	A	-	-	A	C	B	B	B	B	B	B	B
Lindane	A	A	A	B	B	A	A	C	C	C	C	C	C	C
Linseed Oil	A	A	A	A	A	A	A	A	B	A	A	B	A	B
Lithium Bromide	A	A	A	A	A	A	A	A	-	A	A	-	A	A
Lithium, Elemental	C	C	C	C	C	C	C	C	C	C	C	C	C	C
Lubricating Oils, Mineral or Petroleum Types	A	A	A	A	A	A	A	A	B	A	A ¹²	B	B	C
Refined	A	A	A	A	A	A	A	A	B	A	A ¹²	B	B	C
Sour	A	A	A	A	A	A	A	B	B	B	B	B	B	C
Lye	C	B	A ⁶	C	A ⁶	A ¹¹	A ⁶	C	C	C	C	C	C	C
Magnesium Chloride	A	A	A	B	B	A	A	A	A	A	A	A	A	A
Magnesium Hydroxide	A	A	A	A	A	A	A	B	B	B	B	B	B	B
Magnesium Sulfate	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Maleic Acid	A	A	A	A	A	A	A	B	B	B	B	B	B	A
Maleic Anhydride	A	A	A	A	A	A	A	C	-	C	C	-	C	C
Mercuric Chloride	A	A	A	C	C	A	A	A	A	A	A	A	B	A
Mercury	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Methane	A	A	A	A	A	A	A	A	B	B	A	C	B	C
Methanol, Methyl Alcohol	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Methoxychlor	A	A	A	A	A	A	A	C	C	C	C	C	C	C
Methylacrylic Acid	A	A	A	-	-	A	A	C	C	C	C	C	C	C
Methyl Alcohol	A	A	A	A	A	A	A	A	A	A	A	A	A	A
2-Methylaziridine	-	-	A	-	-	A	A	C	C	C	C	C	C	C
Methyl Bromide	A	A	A	A	A	A	A	C	C	C	C	C	C	C
Methyl Chloride	A	A	A	B	B	A	A	C	C	C	C	C	C	C
Methyl Chloroform	A	A	A	A	A	A	A	C	C	C	C	C	C	C
4,4 Methylene Bis(2-chloroaniline)	A	A	A	-	-	A	A	C	C	C	C	C	C	C
Methylene Chloride	A	A	A	A	A	A	A	C	C	C	C	C	C	C
4,4-Methylene Dianiline	A	A	A	A	A	A	A	C	C	C	C	C	C	-
Methylene Diphenyldiisocyanate	A	A	A	-	-	A	A	C	C	C	C	C	C	-
Methyl Ethyl Ketone	A	A	A	A	A	A	A	C	C	C	C	C	C	C
Methyl Hydrazine	A	A	A	A	A	A	A	C	B	C	C	B	B	B
Methyl Iodide	A	A	A	A	A	A	A	C	C	C	C	C	B	-
Methyl Isobutyl Ketone (MIBK)	A	A	A	A	A	A	A	C	C	C	C	C	C	B

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	3500	3565 3504	3510	3560	3561	3535 3540 3545	3530							
Methyl Isocyanate	A	A	A	A	A	A	A	–	C	–	–	C	–	–
Methyl Methacrylate	A ¹	A ¹	A ¹	A ¹	A ¹	A ¹	A ¹	C	C	C	C	C	C	C
N-Methyl-2-Pyrrolidone	A	A	A	A	A	A	A	C	B	C	C	B	–	–
Methyl Tert. Butyl Ether (MTBE)	A	A	A	A	A	A	A	B	C	B	B	B	C	C
Milk ¹⁰	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Mineral Oils	A	A	A	A	A	A	A	A	B	A	A ¹²	B	B	C
Mobiltherm 600	A	A	A	A	A	A	A	A	C	A	A	C	–	C
Mobiltherm 603	A	A	A	A	A	A	A	A	C	A	A	C	–	C
Mobiltherm 605	A	A	A	A	A	A	A	A	C	A	A	C	–	C
Mobiltherm Light	A	A	A	A	A	A	A	C	C	C	C	C	C	C
Molten Alkali Metals	C	C	C	C	C	C	C	C	C	C	C	C	C	C
Monomethylamine	A	A	A	A	A	A	A	C	B	C	C	B	A	B
MultiTherm 100	A	A	A	A	A	A	A	A	C	A	A	C	B	C
MultiTherm 503	A	A	A	A	A	A	A	A	C	A	A	C	–	C
MultiTherm IG-2	A	A	A	A	A	A	A	A	C	A	A	C	B	C
MultiTherm PG-1	A	A	A	A	A	A	A	A	C	A	A	C	B	C
Muriatic Acid	A	A	A	C	C	A	A	C	C	C	C	C	C	C
Naphtha	A	A	A	A	A	A	A	A	C	A	A ¹²	C	B	C
Naphthalene	A	A	A	A	A	A	A	C	C	C	C	C	C	C
Naphthols	A	A	A	–	–	A	A	–	–	–	–	–	–	–
Natural Gas	A	A	A	A	A	A	A	A	B	B	A ¹²	B	B	B
Nickel Chloride	A	A	A	B	B	A	A	A	A	A	A	A	A	A
Nickel Sulfate	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Nitric Acid, Less than 30%	A	A	A	A	A	A	C	C	C	C	C	C	C	C
Above 30%	A	A	A	A	A	A	C	C	C	C	C	C	C	C
Crude	A	A	A	–	–	A	C	C	C	C	C	C	C	C
Red Fuming	A	A	A	B	B	A	C	C	C	C	C	C	C	C
Nitrobenzene	A	A	A	A	A	A	A	C	C	C	C	C	C	C
4-Nitrobiphenyl	A	A	A	A	A	A	A	C	C	C	C	C	C	C
2-Nitro-Butanol	A	A	A	–	–	A	–	C	–	C	C	–	C	–
Nitrocalcite (Calcium Nitrate)	A	A	A	–	–	A	C	B	B	B	B	B	B	B
Nitrogen	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Nitrogen Tetroxide	A	A	A	–	–	A	–	C	C	C	C	C	C	C
Nitrohydrochloric Acid (Aqua Regia)	A	A	A	B	B	A	C	C	C	C	C	C	C	C
Nitromethane	A	A	A	A	A	A	A	C	–	C	C	–	C	–
2-Nitro-2-Methyl Propanol	A	A	A	–	–	A	–	C	–	C	C	–	C	–
Nitromuriatic Acid (Aqua Regia)	A	A	A	B	B	A	C	C	C	C	C	C	C	C
4-Nitrophenol	A	A	A	–	–	A	A	C	C	C	C	C	C	C
2-Nitropropane	A	A	A	A	A	A	A	C	–	C	C	–	C	C
N-Nitrosodimethylamine	A	A	A	A	A	A	A	B	B	B	B	B	–	–
N-Nitroso-N-Methylurea	A	A	A	–	–	A	A	–	–	–	–	–	–	–
N-Nitrosomorpholine	A	A	A	A	A	A	A	C	–	C	C	–	C	–
Norge Niter (Calcium Nitrate)	A	A	A	–	–	A	C	B	B	B	B	B	B	B
Norwegian Saltpeter (Calcium Nitrate)	A	A	A	–	–	A	C	B	B	B	B	B	B	B
N-Octadecyl Alcohol	A	A	A	A	A	A	A	A	A	A	A	A	–	A
Octane	A	A	A	A	A	A	A	A	C	A	A ¹²	C	B	C

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	3500	3565 3504	3510	3560	3561	3535 3540 3545	3530								
Oil, Petroleum	A	A	A	A	A	A	A	A	B	A	A ¹²	B	B	C	
Oils, Animal and Vegetable ¹⁰	A	A	A	A	A	A	A	A	C	A	A	C	B	B	
Oleic Acid	A	A	A	A	A	A	A	B	-	B	B	-	C	C	
Oleum	A	-	C	C	C	A	-	C	C	C	C	C	C	C	
Orthodichlorobenzene	A	A	A	A	A	A	A	C	C	C	C	C	C	C	
Oxalic Acid	A	A	A	B	B	A	A	C	-	C	C	-	B	B	
Oxygen, Gas	See Note 7							C	C	C	C	C	C	C	C
Ozone	A	A	A	A	A	A	C	C	C	C	C	C	C	C	
Palmitic Acid	A	A	A	A	A	A	A	A	B	A	A	B	B	A	
Paraffin	A	A	A	A	A	A	A	A	B	A	A	B	B	C	
Paratherm HE	A	A	A	A	A	A	A	A	C	A	A	C	B	C	
Paratherm NF	A	A	A	A	A	A	A	A	C	A	A	C	-	C	
Parathion	A	A	A	A	A	A	A	C	C	C	C	C	C	C	
Paraxylene	A	A	A	A	A	A	A	C	C	C	C	C	C	C	
Pentachloronitrobenzene	A	A	A	-	-	A	A	C	C	C	C	C	C	C	
Pentachlorophenol	A	A	A	A	A	A	A	C	C	C	C	C	C	C	
Pentane	A	A	A	A	A	A	A	A	C	A	A ¹²	C	B	C	
Perchloric Acid	A	A	A	C	C	A	C	C	C	C	C	C	C	C	
Perchloroethylene	A	A	A	A	A	A	A	C	C	C	C	C	C	C	
Petroleum Oils, Crude	A	A	A	A	A	A	A	A	B	A	A ¹²	B	B	C	
Refined	A	A	A	A	A	A	A	A	B	A	A ¹²	B	B	C	
Phenol	A	A	A	A	A	A	A	C	C	C	C	C	C	B	
p-Phenylenediamine	A	A	A	A	A	A	A	C	C	C	C	C	-	-	
Phosgene	A	A	A	B	B	A	A	C	-	C	C	-	-	B	
Phosphate Esters	A	A	A	A	A	A	A	C	C	C	C	C	C	B	
Phosphine	A	A	A	A	A	A	A	-	-	-	-	-	-	-	
Phosphoric Acid, Crude	C	C	A	C	B	A	A	C	C	C	C	C	C	C	
Pure, Less than 45%	A	A	A	A	A	A	A	C	C	C	C	C	C	C	
Pure, Above 45%, 150°F and below	B	B	A	B	B	A	A	C	C	C	C	C	C	C	
Pure, Above 45%, Above 150°F	C	B	A	C	B	A	A	C	C	C	C	C	-	-	
Phosphorus, Elemental	A	A	A	A	A	A	A	C	C	C	C	C	C	C	
Phosphorus Pentachloride	A	A	A	B	B	A	A	C	C	C	C	C	C	C	
Phthalic Acid	A	A	A	A	A	A	A	C	-	C	C	-	B	-	
Phthalic Anhydride	A	A	A	A	A	A	A	C	-	C	C	-	C	B	
Picric Acid, Molten	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Water Solution	A	A	A	A	A	A	A	B	B	B	B	B	B	B	
Pinene	A	A	A	A	A	A	A	A	C	A	A	C	B	C	
Piperidine	A	A	A	A	A	A	A	C	C	C	C	C	C	C	
Polyacrylonitrile	A	A	A	A	A	A	A	A	A	A	A	A	A	A	
Polychlorinated Biphenyls	A	A	A	A	A	A	A	C	C	C	C	C	C	C	
Potash, Potassium Carbonate	A	A	A	A	A	A	A	A	A	A	A	A	A	A	
Potassium Acetate	A	A	A	A	A	A	A	A	A	A	A	A	A	A	
Potassium Bichromate	A	A	A	A	A	A	C	A	B	A	A	B	B	A	
Potassium Chromate, Red	A	A	A	A	A	A	C	A	B	A	A	B	B	A	
Potassium Cyanide	A	A	A	A	A	A	A	A	A	A	A	A	A	A	
Potassium Dichromate	A	A	A	A	A	A	C	A	B	A	A	B	B	A	

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	3500	3565 3504	3510	3560	3561	3535 3540 3545	3530							
Potassium, Elemental	C	C	C	C	C	C	C	C	C	C	C	C	C	C
Potassium Hydroxide	C	B	A ⁶	C	A ⁶	A ¹¹	A ⁶	C	C	C	C	C	C	C
Potassium Nitrate	A	A	A	A	A	A	–	B	B	B	B	B	B	B
Potassium Permanganate	A	A	A	A	A	A	–	B	–	B	B	–	B	B
Potassium Sulfate	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Producer Gas	A	A	A	A	A	A	A	A	C	B	A ¹²	C	B	C
Propane	A	A	A	A	A	A	A	A	C	B	A ¹²	C	B	C
1,3-Propane Sultone	A	A	A	–	–	A	A	–	–	–	–	–	–	–
Beta-Propiolactone	A	A	A	A	A	A	A	C	C	C	C	C	C	B
Propionaldehyde	A	A	A	A	A	A	A	C	C	C	C	C	–	–
Propoxur (Baygon)	A	A	A	A	A	A	A	C	C	C	C	C	–	–
Propyl Nitrate	A	A	A	A	A	A	A	C	C	C	C	C	C	C
Propylene	A	A	A	A	A	A	A	C	C	C	C	C	C	C
Propylene Dichloride	A	A	A	A	A	A	A	C	C	C	C	C	C	C
Propylene Oxide	A	A	A	A	A	A	A	C	C	C	C	C	C	B
1,2-Propylenimine	–	–	A	–	–	A	A	C	C	C	C	C	C	C
Prussic Acid, Hydrocyanic Acid	A	A	A	A	A	A	A	A	B	A	A	B	B	A
Pyridine	A	A	A	B	B	A	A	C	C	C	C	C	C	B
Quinoline	A	A	A	B	B	A	A	C	C	C	C	C	C	C
Quinone	A	A	A	A	A	A	–	–	–	–	–	–	–	–
Refrigerants	See Specific Ratings Below													
10	A	A	A	B	B	A	A	C	C	C	C	C	C	C
11	A	A	A	A	A	A	A	A	C	B	A	C	C	C
12	A	A	A	A	A	A	A	A	A	B	A	A	A	A
13	A	A	A	A	A	A	A	A	A	B	A	A	A	A
13B1	A	A	A	A	A	A	A	A	A	B	A	A	A	A
21	A	A	A	A	A	A	A	C	C	C	C	C	A	C
22	A	A	A	A	A	A	A	B	B	B	B	B	A	A
23	A	A	A	A	A	A	A	C	A	C	C	A	A	A
31	A	A	A	A	A	A	A	C	A	C	C	A	A	A
32	A	A	A	A	A	A	A	A	A	B	A	A	A	A
112	A	A	A	A	A	A	A	A	C	B	A	C	A	C
113	A	A	A	A	A	A	A	A	A	B	A	A	A	C
114	A	A	A	A	A	A	A	A	A	B	A	A	A	A
114B2	A	A	A	A	A	A	A	A	C	B	A	C	A	C
115	A	A	A	A	A	A	A	A	A	B	A	A	A	A
123	A	A	A	A	A	A	A	C ³	C	C ³	C ³	C	A ³	C
124	A	A	A	A	A	A	A	C	A	C	C	A	A	A
125	A	A	A	A	A	A	A	–	A	–	–	A	A	A
134a	A	A	A	A	A	A	A	B	A	B	B	A	A	A
141b	A	A	A	A	A	A	A	A	–	B	A	–	A	–
142b	A	A	A	A	A	A	A	A	A	B	A	A	A	A
143a	A	A	A	A	A	A	A	–	A	–	–	A	A	A
152a	A	A	A	A	A	A	A	A	A	B	A	A	A	A
218	A	A	A	A	A	A	A	A	A	B	A	A	A	A
290	A	A	A	A	A	A	A	A	C	B	A	C	A	C

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	3500	3565 3504	3510	3560	3561	3535 3540 3545	3530							
500	A	A	A	A	A	A	A	A	-	B	A	-	A	-
502	A	A	A	A	A	A	A	A	A	B	A	A	A	-
503	A	A	A	A	A	A	A	C	A	C	C	A	A	A
C316	A	A	A	A	A	A	A	A	A	B	A	A	A	A
C318	A	A	A	A	A	A	A	A	A	B	A	A	A	A
HP62	A	A	A	A	A	A	A	A	-	B	A	-	A	-
HP80	A	A	A	A	A	A	A	-	-	-	-	-	A	-
HP81	A	A	A	A	A	A	A	-	-	-	-	-	A	-
Salt Water	A	A	A	B	B	A	A	A	A	A	A	A	A	A
Saltpeter, Potassium Nitrate	A	A	A	A	A	A	-	B	B	B	B	B	B	B
2,4-D Salts and Esters	A	A	A	-	-	A	A	C	C	C	C	C	C	C
Sewage	A	A	A	A	A	A	A	A	B	A	A	B	B	B
Silver Nitrate	A	A	A	A	A	A	-	B	A	B	B	A	A	A
Skydrols	A	A	A	A	A	A	A	C	C	C	C	C	C	B
Soap Solutions	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Soda Ash, Sodium Carbonate	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Sodium Bicarbonate, Baking Soda	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Sodium Bisulfate, Dry	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Sodium Bisulfite	A	A	A	B	B	A	A	A	A	A	A	A	A	A
Sodium Chlorate	A	A	A	A	A	A	A	C	-	C	C	-	C	C
Sodium Chloride	A	A	A	B	B	A	A	A	A	A	A	A	A	A
Sodium Cyanide	C	C	A	C	C	A	A	C	C	C	C	C	C	C
Sodium, Elemental	C	C	C	C	C	C	C	C	C	C	C	C	C	C
Sodium Hydroxide	C	B	A ⁶	C	A ⁶	A ¹¹	A ⁶	C	C	C	C	C	C	C
Sodium Hypochlorite	A	A	A	B	B	A	-	C	-	C	C	-	C	C
Sodium Metaborate Peroxyhydrate	A	A	A	B	B	A	C	B	B	B	B	B	B	B
Sodium Metaphosphate	B	A	A	B	A	A	A	A	A	A	A	A	A	A
Sodium Nitrate	A	A	A	A	A	A	-	B	B	B	B	B	B	B
Sodium Perborate	A	A	A	B	B	A	C	B	B	B	B	B	B	B
Sodium Peroxide	A	A	A	A	A	A	C	C	C	C	C	C	C	C
Sodium Phosphate, Monobasic	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Dibasic	B	B	A	B	A	A	A	A	A	A	A	A	A	A
Tribasic	C	B	A	C	A	A	A	A	A	A	A	A	A	A
Sodium Silicate	B	B	A	B	A	A	A	B	B	B	B	B	B	B ⁴
Sodium Sulfate	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Sodium Sulfide	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Sodium Superoxide	A	A	A	A	A	A	C	C	C	C	C	C	C	C
Sodium Thiosulfate, "Hypo"	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Soybean Oil ¹⁰	A	A	A	A	A	A	A	A	C	A	A	C	B	B
Stannic Chloride	A	A	A	C	C	A	A	B	B	B	B	B	-	B
Steam, Saturated, to 150 psig ¹³	A	A	A	A	A	A	A	A	A	A	A ⁹	A	A	A
Superheated	-	-	-	-	-	-	-	C	C	A	C	C	C	C
Stearic Acid	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Stoddard Solvent	A	A	A	A	A	A	A	A	C	A	A ¹²	C	B	C
Styrene	A ¹	A ¹	A ¹	A ¹	A ¹	A ¹	A ¹	C	C	C	C	C	C	C
Styrene Oxide	A	A	A	A	A	A	A	C	C	C	C	C	C	C

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Chemical Resistance of Garlock Compressed Sheet and GYLON®

Medium	Garlock Style Number													
	GYLON®							IFG 5500 G-9900 9850	9800	ST-706	3000 3001 CP-3900	3200 3400 CP-3920	3300 3800	IFG 5507 3700
	3500	3565 3504	3510	3560	3561	3535 3540 3545	3530							
Sulfur Chloride	A	A	A	C	C	A	A	C	C	C	C	C	C	C
Sulfur Dioxide	A	A	A	A	A	A	A	C	C	C	C	C	C	B
Sulfur, Molten	A	A	A	A	A	A	A	C	C	C	C	C	B	C
Sulfur Trioxide, Dry	A	A	A	A	A	A	–	C	C	C	C	C	C	C
Wet	A	A	A	B	B	A	B	C	C	C	C	C	C	C
Sulfuric Acid, 10%, 150°F and below	A	A	A	B	B	A	–	C	C	C	C	C	C	C
10%, Above 150°F	A	A	A	C	C	A	–	–	C	–	–	C	C	C
10-75%, 500°F and below	A	A	A	C	C	A	–	–	C	–	–	C	C	C
75-98%, 150°F and below	A	A	B	C	C	A	C	C	C	C	C	C	C	C
75-98%, 150°F to 500°F	A	B	B	C	C	A	C	C	C	C	C	C	C	C
Sulfuric Acid, Fuming	A	–	C	C	C	A	C	C	C	C	C	C	C	C
Sulfurous Acid	A	A	A	B	B	A	–	B	B	B	B	B	–	–
Syltherm 800	A	A	A	A	A	A	A	B	B	B	B	B	B	B
Syltherm XLT	A	A	A	A	A	A	A	B	B	B	B	B	B	B
Tannic Acid	A	A	A	– ^B	– ^B	A	A	A	A	A	A	A	A	A
Tar	A	A	A	A	A	A	A	A	C	A	A	C	B	C
Tartaric Acid	A	A	A	A	A	A	A	A	A	A	A	A	A	A
2,3,7,8-TCDB-p-Dioxin	A	A	A	–	–	A	A	C	C	C	C	C	C	C
Tertiary Butyl Amine	A	A	A	A	A	A	A	B	–	B	B	–	C	B
Tetrabromoethane	A	A	A	A	A	A	A	C	C	C	C	C	C	C
Tetrachlorethane	A	A	A	A	A	A	A	C	C	C	C	C	C	C
Tetrachloroethylene	A	A	A	A	A	A	A	C	C	C	C	C	C	C
Tetrahydrofuran, THF	A	A	A	A	A	A	A	C	C	C	C	C	C	C
Therminol 44	A	A	A	A	A	A	A	C	C	C	C	C	C	C
Therminol 55	A	A	A	A	A	A	A	C	C	C	C	C	C	C
Therminol 59	A	A	A	A	A	A	A	C	C	C	C	C	C	C
Therminol 60	A	A	A	A	A	A	A	C	C	C	C	C	C	C
Therminol 66	A	A	A	A	A	A	A	C	C	C	C	C	C	C
Therminol 75	A	A	A	A	A	A	A	C	C	C	C	C	C	C
Therminol D12	A	A	A	A	A	A	A	B	C	B	B	C	B	C
Therminol LT	A	A	A	A	A	A	A	C	C	C	C	C	C	C
Therminol VP-1	A	A	A	A	A	A	A	C	C	C	C	C	C	C
Therminol XP	A	A	A	A	A	A	A	A	C	A	A	C	B	C
Thionyl Chloride	A	A	A	C	C	A	A	C	C	C	C	C	C	C
Titanium Sulfate	A	A	A	A	A	A	A	C	C	C	C	C	C	C
Titanium Tetrachloride	A	A	A	C	C	A	A	B	C	B	B	C	C	C
Toluene	A	A	A	A	A	A	A	C	C	C	C	C	C	C
2,4-Toluenediamine	A	A	A	A	A	A	A	–	C	–	–	C	C	C
2,4-Toluenediisocyanate	A	A	A	–	–	A	A	C	C	C	C	C	C	B
Toluene Sulfonic Acid	A	A	A	–	–	A	A	C	C	C	C	C	C	C
o-Toluidine	A	A	A	A	A	A	A	C	C	C	C	C	C	C
Toxaphine	A	A	A	–	–	A	A	C	C	C	C	C	C	C
Transformer Oil (Mineral Type)	A	A	A	A	A	A	A	A	C	A	A	C	B	C
Transmission Fluid A	A	A	A	A	A	A	A	A	C	A	A	C	B	C
Trichloroacetic Acid	A	A	A	C	C	A	A	C	C	C	C	C	C	C
1,2,4- Trichlorobenzene	A	A	A	A	A	A	A	C	C	C	C	C	C	C

Call Gasket Applications Engineering at 1-800-448-6688 for specific recommendations.

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Medium	Garlock Style Number													
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	3500	3565 3504	3510	3560	3561	3535 3540 3545	3530							
1,1,2-Trichloroethane	A	A	A	A	A	A	A	C	C	C	C	C	C	C
Trichloroethylene	A	A	A	A	A	A	A	C	C	C	C	C	C	C
2,4,5-Trichlorophenol	A	A	A	-	-	A	A	C	C	C	C	C	C	C
2,4,6-Trichlorophenol	A	A	A	-	-	A	A	C	C	C	C	C	C	C
Tricresylphosphate	A	A	A	A	A	A	A	C	C	C	C	C	C	B
Triethanolamine	A	A	A	-	-	A	A	B	B	B	B	B	B	B
Triethyl Aluminum	A	A	A	-	-	A	A	C	-	C	C	-	C	-
Triethylamine	A	A	A	A	A	A	A	B	B	B	B	B	B	A
Trifluralin	A	A	A	A	A	A	A	C	C	C	C	C	C	C
2,2,4-Trimethylpentane	A	A	A	A	A	A	A	A	C	A	A ¹²	C	B	C
Tung Oil	A	A	A	A	A	A	A	A	C	A	A	C	B	C
Turpentine	A	A	A	A	A	A	A	A	C	A	A ¹²	C	C	C
UCON Heat Transfer Fluid 500	A	A	A	A	A	A	A	A	B	A	A	B	B	B
UCON Process Fluid WS	A	A	A	A	A	A	A	A	B	A	A	B	B	B
Varnish	A	A	A	A	A	A	A	B	C	B	B	C	C	C
Vinegar ¹⁰	A	A	A	A	A	A	A	B	B	B	B	B	A	A
Vinyl Acetate	A ¹	A ¹	A ¹	A ¹	A ¹	A ¹	A ¹	B	C	B	B	C	B	B
Vinyl Bromide	A ¹	A ¹	A ¹	A ¹	A ¹	A ¹	A ¹	C	C	C	C	C	C	C
Vinyl Chloride	A ¹	A ¹	A ¹	A ¹	A ¹	A ¹	A ¹	C	C	C	C	C	C	C
Vinylidene Chloride	A ¹	A ¹	A ¹	A ¹	A ¹	A ¹	A ¹	C	C	C	C	C	C	C
Vinyl Methacrylate	A	A	A	A	A	A	A	C	C	C	C	C	C	C
Water, Acid Mine, with Oxidizing Salt	A	A	A	C	C	A	-	B	-	B	B	-	B	-
No Oxidizing Salts	A	A	A	A	A	A	A	A	-	A	A	-	B	A
Water, Distilled	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Return Condensate	A	A	A	A	A	A	A	A	-	A	A	-	-	A
Seawater	A	A	A	B	B	A	A	A	A	A	A	A	A	A
Tap	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Whiskey and Wines ¹⁰	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Wood Alcohol	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Xceltherm 550	A	A	A	A	A	A	A	B	C	B	B	C	B	C
Xceltherm 600	A	A	A	A	A	A	A	A	C	A	A	C	B	C
Xceltherm MK1	A	A	A	A	A	A	A	C	C	C	C	C	C	C
Xceltyherm XT	A	A	A	A	A	A	A	C	C	C	C	C	C	C
Xylene	A	A	A	A	A	A	A	C	C	C	C	C	C	C
Zinc Chloride	A	A	A	B	B	A	A	A	A	A	A	A	A	A
Zinc Sulfate	A	A	A	A	A	A	A	A	A	A	A	A	A	A

Key: A = Suitable; B = Depends on operating conditions; C = Unsuitable; - = No data or insufficient evidence

NOTES:

- Consult the factory regarding your specific applications. See "Monomers" in Gasketing Terms Section, page 45.
- IFG® Style 5507 is rated "B".
- There have been conflicting field reports concerning the suitability of NBR and neoprene bound gaskets in 123. End users should take note.
- IFG® Style 5507 is rated "A".
- Some chromium plating baths contain fluorides that can attack silica and silicate type fillers in some GYLON® styles. If the bath is known to contain little or no fluoride, all GYLON® styles should be suitable for use.
- These GYLON® styles can be expected to be suitable to 45-59% concentration at temperatures up to 250°F (121°C).
- Use GYLON® styles 3502, 3503, 3505, 3562, 3563. These styles are specially processed, cleaned and packaged for oxygen service.
- This GYLON® contains a stainless steel insert. There is a possibility that this might contribute traces of iron to form iron tannates, resulting in undesirable color in the tannic acid.
- Styles CP-3900, 3000 and 3001 are not preferred choices for steam service.
- If a gasketing material that conforms to FDA requirements is desired, contact factory for specific recommendations.
- These GYLON® styles can be expected to be suitable to 75% concentration at temperatures up to 400°F (204°C).
- Not a fire-tested material.
- For saturated steam above 150 psig, consult Garlock Engineering.

Call Gasket Applications Engineering at 1-800-448-6688 for specific recommendations.

Sheet Sizes and Tolerances

Compressed Gasketing

	60" x 60"						60" x 120"						60" x 180"						150" x 150"		
	1/64"	1/32"	3/64"	1/16"	3/32"	1/8"	1/64"	1/32"	3/64"	1/16"	3/32"	1/8"	1/64"	1/32"	3/64"	1/16"	3/32"	1/8"	1/32"	1/16"	1/8"
ST-706	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
IFG®	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
G-9900	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
9800/9850	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
BLUE-GARD®	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
3900/3920	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■

GYLON® Gasketing

	60" x 60"					70" x 70"				60" x 90"			40" x 40"			24" x 24"		20" x 20"			
	1/32"	1/16"	1/8"	3/16"	1/4"	1/32"	1/16"	1/8"	1/4"	1/32"	1/16"	1/8"	1/32"	1/16"	1/8"	1/16"	1/8"	1/32"	1/16"	1/8"	
Style 3500	■	■	■	■	■	■	■	■	■	■	■	■									
Style 3504		■	■	■	■	■	■	■	■	■	■	■	■								
Style 3510	■	■	■	■	■	■	■	■	■	■	■	■									
Style 3522																■	■	■	■	■	■
Style 3530		■	■										■	■	■						
Style 3540	■	■	■	■	■	■	■	■	■	■	■	■	■								
Style 3545	■	■	■	■	■	■	■	■	■	■	■	■									
Style HP-3560																■	■				
Style HP-3561																■	■				
Style 3565	■	■	■	■	■	■	■	■	■	■	■	■									

Flexible Graphite Gasketing

	24" x 24"			26" x 26"			39.4" x 39.4"			60" x 60"		
	1/32"	1/16"	1/8"	1/32"	1/16"	1/8"	1/32"	1/16"	1/8"	1/32"	1/16"	1/8"
Style 3123	■	■	■	■	■	■	■	■	■	■	■	■ ¹
Style 3124	■	■	■	■	■	■	■	■	■	■	■	■ ¹
Style 3125	■	■	■	■	■	■	■	■	■	■	■	■
Style 3125SS	■	■	■	■	■	■	■	■	■	■	■	■
Style 3125TC		■	■		■	■		■	■		■	■
Style 3126	■	■	■	■	■	■	■	■	■	■	■	■

Note: Tolerance is ±10% of thickness.

¹ 60" x 60" x 1/8" sheets of Styles 3123 and 3124 are laminated, not homogeneous.

Standard Commercial Tolerances of Compressed Fiber and GYLON® Gasketing

Nominal Thickness	Variation	Tolerance
1/64" (0.016")*	0.014" - 0.021"	+0.005"/-0.002"
0.020"	0.018" - 0.025"	+0.005"/-0.002"
1/32" (0.031")	0.026" - 0.036"	± 0.005"
3/64" (0.047")	0.042" - 0.052"	± 0.005"
1/16" (0.062")	0.056" - 0.068"	± 0.006"
5/64" (0.078")	0.071" - 0.085"	± 0.007"
3/32" (0.094")	0.086" - 0.102"	± 0.008"

* 1/64" GYLON® tolerance = ±0.005"

Questions? Call Gasket Applications Engineering at 1-800-448-6688

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Nominal Thickness	Variation	Tolerance
7/64" (0.109")	0.100" - 0.118"	± 0.009"
1/8" (0.125")	0.115" - 0.135"	± 0.010"
9/64" (0.141")	0.126" - 0.156"	± 0.015"
5/32" (0.156")	0.141" - 0.171"	± 0.015"
3/16" (0.188")	0.173" - 0.203"	± 0.015"
7/32" (0.219")	0.204" - 0.234"	± 0.015"
1/4" (0.25")	0.230" - 0.270"	± 0.020"

Close tolerance sheet available upon request.

Garlock Gasketing Products

Every gasketing application requires material that is best suited to that particular temperature, pressure, media, and other environmental factors. Garlock gasketing delivers superior torque retention and unequalled sealability for today's tough clean air requirements.

Since no single material is adaptable to all types of service, Garlock offers many quality gasketing products of both traditional and newly developed materials and construction. Garlock gasketing products are manufactured in completely modernized facilities under tight quality controls to assure product uniformity and conformance to specifications.

As the leader in the introduction of compressed asbestos-free gasketing, we continue to serve industry's needs.



Figure 1: P x T Graph for 1/32" and 1/16" Compressed Gasketing¹

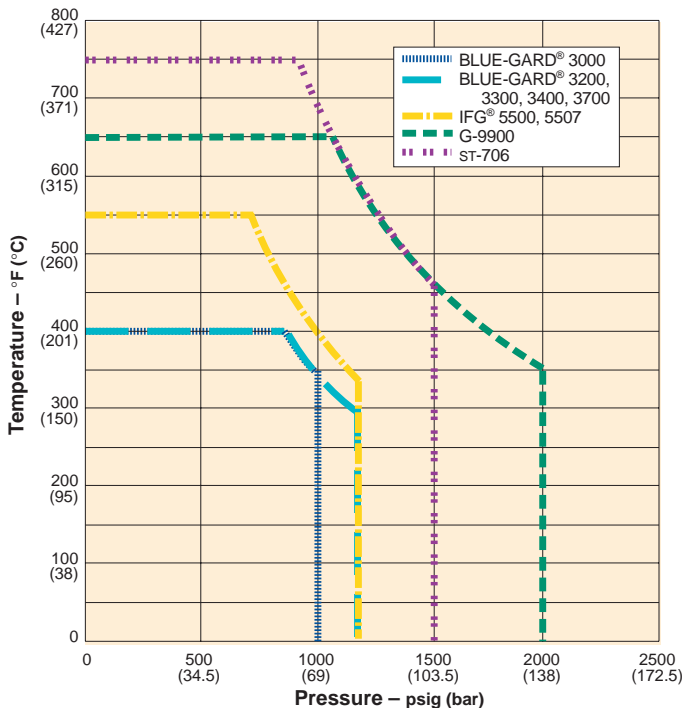
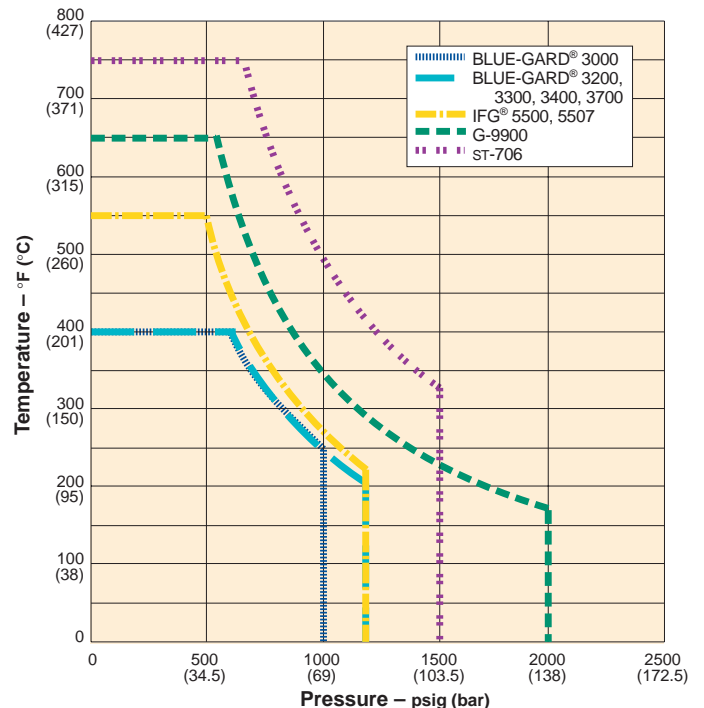


Figure 2: P x T Graph for 1/8" Compressed Gasketing¹



Notes:

- When approaching maximum pressure or continuous operating temperature, or 50% of maximum P x T, consult Garlock Applications Engineering.
- Style ST-706 is the only asbestos-free compressed sheet material recommended for superheated steam.

Compressed Inorganic Fiber Gasketing

Typical Physical Properties*

		ST-706	IFG® 5500	IFG® 5507
Color		White	Gray	Sage
Binder		Nitrile (NBR)	Nitrile (NBR)	EPDM
Temperature¹	Maximum	+1000°F (+540°C)	+800°F (+425°C)	+800°F (+425°C)
	Minimum	-40°F (-40°C)	-40°F (-40°C)	-40°F (-40°C)
	Continuous max.	+750°F (+400°C)	+550°F (+290°C)	+550°F (+290°C)
Pressure,¹ continuous max. psig (bar)		1500 (105)	1200 (83)	1200 (83)
P x T, max.¹ (psig x °F) (bar x °C)	1/32", 1/16" (0.8 mm, 1.6 mm)	700,000 (25,000)	400,000 (14,000)	400,000 (14,000)
	1/8" (3.2 mm)	500,000 (18,500)	275,000 (9,600)	275,000 (9,600)
Sealability (ASTM F37B)²				
ASTM Fuel A	ml/hr	0.5	0.2	0.1
Nitrogen	ml/hr	4.0	1.0	0.5
Creep Relaxation (ASTM F38) %		18	15	15
Compressibility Range (ASTM F36) %		7-17	7-17	7-17
Recovery (ASTM F36) min. %		50	50	50
Fluid Resistance (ASTM F146)				
ASTM #1 Oil at +300°F (+150°C)				
Thickness increase	range %	0-10	0-10	25-40
Weight increase	max. %	15	15	—
ASTM IRM #903 Oil at +300°F (+150°C)				
Thickness increase	range %	0-15	0-15	60-90
Tensile loss	max. %	55	40	—
ASTM Fuel A at +70-85°F (+20-30°C)				
Thickness increase	range %	0-15	0-10	10-30
Weight increase	max. %	20	10	—
ASTM Fuel B +70-85°F (+20-30°C)				
Thickness increase	range %	0-20	0-15	15-35
Weight increase	max. %	20	15	—
Tensile Strength across grain (ASTM F152)		1400 (9)	1500 (10)	1500 (10)
Density		105 (1.68)	110 (1.76)	110 (1.76)
Gas Permeability (DIN 3535 Part 4)³		—	0.05	0.04

Notes:

¹ When approaching maximum pressure or continuous operating temperature, or 50% of maximum PxT, consult Garlock Engineering.

² ASTM F37B Sealability

ASTM Fuel A (isooctane):

Gasket load = 500 psi (3.5 N/mm²), Int. pressure = 9.8 psig (0.7 bar)

Nitrogen:

Gasket load = 3000 psi (20.7 N/mm²), Int. pressure = 30 psig (2 bar)

³ DIN 3535 Part 4 Gas Permeability, cc/min. (1/16" thick)

Nitrogen:

Gasket load = 4640 psi (32 N/mm²), Int. pressure = 580 psig (40 bar)

This is a general guide and should not be the sole means of selecting or rejecting this material. ASTM test results in accordance with ASTM F-104; properties based on 1/32" (0.8mm) sheet thickness.

* **Values do not constitute specification limits**

All styles are furnished with an anti-stick parting agent as standard.

Style ST-706

Benefits

Heat and oxidation resistance

- Inorganic, asbestos-free fibers offer superior performance in saturated and superheated steam
- Thermally stable fibers retain effective seal even during thermal cycling to 750°F (400°C)

Long-lasting seal

- Unique manufacturing process minimizes cold flow and creep relaxation problems

Versatile

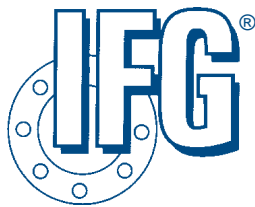
- Ideal for standard ANSI flanged connectors, as well as turbine crossover piping connectors
- Multiple applications in power generation, chemical processing, hydrocarbon processing, and other industries

Patent #5,603,513

Media

ST-706:	Steam, oils, grease, water, heat transfer fluids*
IFG® 5500:	Water, aliphatic hydrocarbons, oils, gasoline, saturated steam, inert gases, most refrigerants
IFG® 5507:	Water, saturated steam, mild chemicals and mild alkalies

Style IFG®



Benefits

Tighter seal

- Inorganic fiber gasketing offers excellent thermal stability with minimal weight loss
- Reduced creep relaxation and improved torque retention provide optimal sealability

Temperature resistant

- Non-oxidizing fibers withstand a continuous operating temperature of up to 550°F (290°C), and maximum spike of 800°F (425°C)
- IFG® 5500 has passed the Garlock Fire Test and is ABS Fire Safe Type Approved.

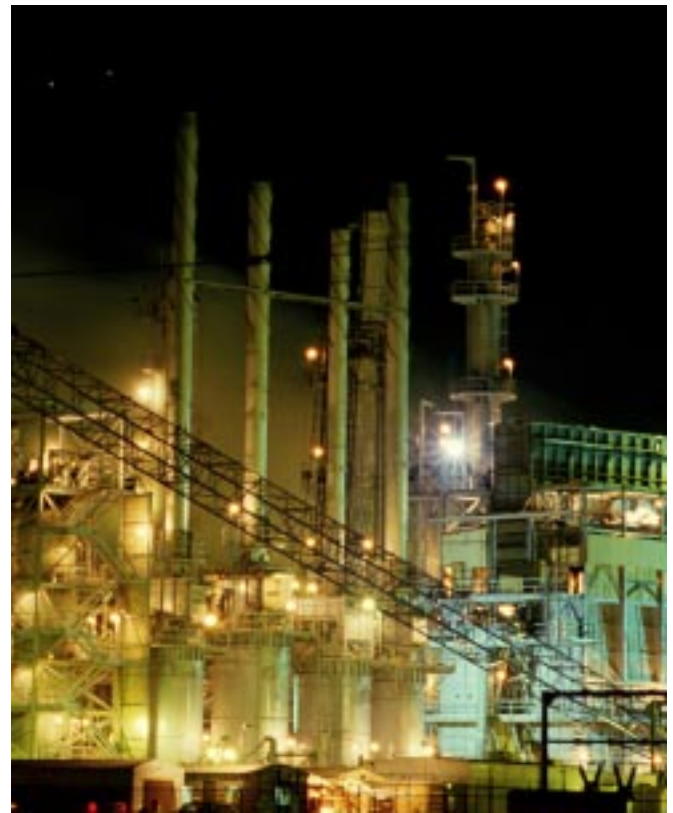
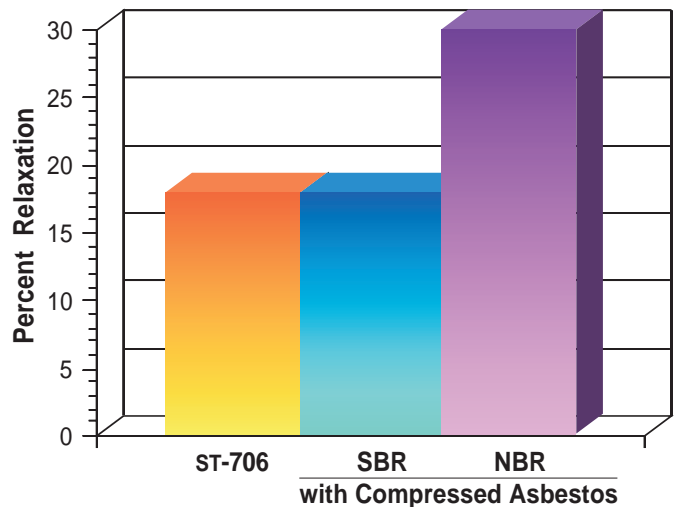


Figure 3: ASTM F38 Typical Creep Relaxation



* Contact Garlock Engineering with specific transfer fluid application.

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High Temp Compressed Graphite or Carbon Fiber Gasketing

Typical Physical Properties*

		G-9900	9800	9850
Color		Mahogany	Black	Black
Composition		Graphite with nitrile	Carbon with SBR	Carbon with nitrile
Temperature¹	Maximum	+1000°F (+540°C)	+900°F (+480°C)	+900°F (+480°C)
	Minimum	-40°F (-40°C)	-40°F (-40°C)	-40°F (-40°C)
	Continuous max.	+650°F (+340°C)	+650°F (+340°C)	+650°F (+340°C)
Pressure¹	psig	2000	2000	2000
	(bar)	(138)	(138)	(138)
P x T, max.¹ (psig x °F) (bar x °C)	1/32", 1/16"	700,000	700,000	700,000
	(0.8 mm, 1.6 mm)	(25,000)	(25,000)	(25,000)
	1/8"	350,000	350,000	350,000
	(3.2 mm)	(12,000)	(12,000)	(12,000)
Sealability (ASTM F37B)²				
ASTM Fuel A	ml/hr	0.1	0.1	0.1
Nitrogen	ml/hr	0.1	0.1	0.1
Creep Relaxation (ASTM F38)	%	9	15	15
Compressibility Range (ASTM F36)	%	7-17	7-17	7-17
Recovery (ASTM F36)	min. %	65	55	56
Fluid Resistance (ASTM F146)				
ASTM #1 Oil at +300°F (+150°C)				
Thickness increase	range %	0-5	0-10	0-5
Weight increase	max. %	10	20	10
ASTM IRM #903 Oil at +300°F (+150°C)				
Thickness increase	range %	0-10	15-40	0-10
Tensile loss	max. %	35	65	35
ASTM Fuel A at +70-85°F (+20-30°C)				
Thickness increase	range %	0-5	0-10	0-5
Weight increase	max. %	7	20	7
ASTM Fuel B +70-85°F (+20-30°C)				
Thickness increase	range %	0-10	5-20	0-10
Weight increase	max. %	15	20	15
Tensile Strength across grain	psi	1800	1500	1800
(ASTM F152)	(N/mm ²)	(12)	(10)	(12)
Density	lbs/ft ³	110	105	105
	(g/cm ³)	(1.76)	(1.68)	(1.68)
Gas Permeability				
(DIN 3535 Part 4) ³	cc/min.	0.015	0.015	0.015

Notes:

¹ When approaching maximum pressure or continuous operating temperature, or 50% of maximum P x T, consult Garlock Engineering.

² ASTM F37B Sealability
ASTM Fuel A (isooctane):
Gasket load = 500 psi (3.5 N/mm²), Int. pressure = 9.8 psig (0.7 bar)
Nitrogen:
Gasket load = 3000 psi (20.7 N/mm²), Int. pressure = 30 psig (2 bar)

This is a general guide and should not be the sole means of selecting or rejecting this material. ASTM test results in accordance with ASTM F-104; properties based on 1/32" (0.8mm) sheet thickness.

³ DIN 3535 Part 4 Gas Permeability, cc/min. (1/16" thick)
Nitrogen:
Gasket load = 4640 psi (32 N/mm²), Int. pressure = 580 psig (40 bar)

All styles are furnished with an anti-stick parting agent as standard.

* Values do not constitute specification limits

Style G-9900



Benefits

Tough and reliable

- Graphite fiber gasketing withstands extreme temperatures and pressures, as well as many chemicals
- Passed Garlock Fire tests, and is ABS Fire Safe Type Approved
- Meets Navy Spec STR 508

Tighter seal

- Maintains superior seal during thermal cycling, even in saturated steam and hot oils
- Significantly reduces emissions to meet stringent Clean Air Act requirements

Easy to install

- Patented* graphite fiber sheet is easier to handle and cut than exfoliated graphite sheets or metal-inserted gasket material

* Patent #4,859,526

Note: For nuclear orders, specify Style G-9920.



At the Garlock on-site fire test facility, valves and sealing materials are tested for functionality in the most extreme applications. G-9900, 9800, 9850 and IFG® 5500 meet these stringent fire test standards.

Hi-Temp Styles 9800 / 9850

Benefits

Heat and pressure resistant

- Carbon fiber gasketing excels in harshest conditions—intense heat, high pressure, saturated steam and hot oils
- Laboratory-tested for fire safety

Tighter seal

- Maintains effective seal during pressure and temperature fluctuations
- Superior torque retention lowers leakage rates and reduces maintenance time

Convenient

- Flexible material is easy to handle and cut
- Sheet sizes to 150" x 150" (3.8 m x 3.8 m) minimize waste and inventory costs

* Patent 4,859,526

Media

G-9900: Saturated steam, water, inert gases, aliphatic hydrocarbons, oils, gasoline, most refrigerants

9800: Saturated steam, water, inert gases

9850: Water, saturated steam, aliphatic hydrocarbons, oils, gasoline, most refrigerants



Questions? Call Gasket Applications Engineering at 1-800-448-6688.

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BLUE-GARD[®] Compressed Gasketing

Typical Physical Properties*

		3000	3200 [†] / 3400	3300	3700	
Color		Blue	Off-white/Grey-black	Black	Light grey	
Binder		Nitrile (NBR)	SBR	Neoprene (CR)	EPDM	
Temperature¹	Maximum	+700°F (+370°C)	+700°F (+370°C)	+700°F (+370°C)	+700°F (+370°C)	
	Minimum	-40°F (-40°C)	-40°F (-40°C)	-40°F (-40°C)	-40°F (-40°C)	
	Continuous max.	+400°F (+205°C)	+400°F (+205°C)	+400°F (+205°C)	+400°F (+205°C)	
Pressure, max.¹	psig (bar)	1000 (70)	1200 (83)	1200 (83)	1200 (83)	
P x T, max.¹ (psig x °F) (bar x °C)	1/32", 1/16"	350,000	350,000	350,000	350,000	
	(0.8mm, 1.6 mm)	(12,000)	(12,000)	(12,000)	(12,000)	
	1/8"	250,000	250,000	250,000	250,000	
	(3.2 mm)	(8,600)	(8,600)	(8,600)	(8,600)	
Sealability (ASTM F37B)²						
ASTM Fuel A	ml/hr	0.2	0.1	0.2	0.1	
Nitrogen	ml/hr	0.6	0.4	1.0	0.7	
Gas Permeability (DIN 3535 Part 4) ³		cc/min.	0.05	0.03	0.08	0.04
Creep Relaxation (ASTM F38)	%	21	18	18	25	
Compressibility Range (ASTM F36)		%	7-17	7-17	7-17	7-17
Recovery (ASTM F36)	min. %	50	50	50	40	
Tensile Strength across grain (ASTM F152)		psi (N/mm ²)	2250 (15)	2250 (15)	2800 (19)	2500 (17)
Fluid Resistance						
ASTM #1 Oil at +300°F (+150°C)						
Thickness increase	range %	0-5	0-10	0-5	20-35	
Weight increase	max. %	8	20	15	—	
ASTM IRM #903 Oil at +300°F (+150°C)						
Thickness increase	range %	0-15	15-30	15-30	60-100	
Tensile loss	max. %	35	70	50	—	
ASTM Fuel A at +70-85°F (+20-30°C)						
Thickness increase	range %	0-5	0-15	0-10	10-40	
Weight increase	max. %	8	25	20	—	
ASTM Fuel B +70-85°F (+20-30°C)						
Thickness increase	range %	0-10	5-20	5-20	20-50	
Weight increase	max. %	15	30	20	—	
Density 1/16" (1.6 mm) thick	lbs/ft ³ (g/cm ³)	100 (1.60)	100 (1.60)	100 (1.60)	100 (1.60)	

[†] Meets Mil-G-24696B

* Values do not constitute specification limits

Notes:

- When approaching maximum pressure or continuous operating temperature, or 50% of maximum P x T, consult Garlock Applications Engineering.
- ASTM F37B Sealability, milliliters/hour (1/32" thick)
ASTM Fuel A (isooctane):
Gasket load = 500 psi (3.5 N/mm²),
Internal pressure = 9.8 psig (0.7 bar)

Nitrogen:

Gasket load = 3000 psi (20.7 N/mm²),
Internal pressure = 30 psig (2 bar)

- DIN 3535 Part 4 Gas Permeability, cc/min. (1/16" thick)

Nitrogen:

Gasket load = 4640 psi (32 N/mm²),
Internal pressure = 580 psig (40 bar)

All styles are furnished with an anti-stick parting agent as standard.

	3800	CP-3900	CP-3920
	Orange	Black	Off-white
	Neoprene	Nitrile (NBR)	SBR
	+700°F (+370°C)	+700°F (+370°C)	+700°F (+370°C)
	-40°F (-40°C)	-40°F (-40°C)	-40°F (-40°C)
	+400°F (+205°C)	+400°F (+205°C)	+400°F (+205°C)
	1200 (83)	1000 (70)	1000 (70)
	350,000	350,000	350,000
	(12,000)	(12,000)	(12,000)
	250,000	250,000	250,000
	(8,600)	(8,600)	(8,600)
	0.20	0.1	0.1
	0.25	0.3	0.3
	—	0.01	0.01
	15	30	30
	7-17	15-30	15-30
	45	40	40
	1800 (12)	2000 (14)	1500 (10)
	—	0-5	0-15
	—	25	45
	—	0-15	0-40
	—	40	65
	—	0-10	0-15
	—	20	30
	—	0-15	0-25
	—	30	45
	110 (1.76)	65 (1.04)	65 (1.04)



Questions? Call Gasket Applications Engineering at 1-800-448-6688.

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BLUE-GARD®

Styles 3000 to 3700

Benefits

Excellent sealability

- Unique blend of aramid fibers, fillers and elastomeric binders provides improved torque retention and drastically lowered emissions levels

Versatile

- Variety of elastomers excel in a wide range of services

Cost savings

- Cuts operational costs through reduced:
 - Waste
 - Fluid loss
 - Maintenance
 - Energy consumption
 - Stocked inventory



WARNING:

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Media

- 3000:** Water, aliphatic hydrocarbons, oils, gasoline
- 3200, 3400:** Water, saturated steam, inert gases (Style 3200 meets MIL-G-24696B)
- 3300:** Water, saturated steam, refrigerants, oils, fuels
- 3700:** Water, saturated steam, mild chemicals
- 3800:** Refrigerants, oils, water, compressed air, natural gas, inert gases
- CP-3900:** Water, aliphatic hydrocarbons, oils, gasoline
- CP-3920:** Water, saturated steam, inert gases

Style 3800

Benefits

Ideal for compressor sealing

- Highly compressible
- Excellent torque retention to maintain effective seal through thermal cycling and vibration

CP-3900 / 3920

Benefits

Excellent compressibility

- Premium-grade gasketing materials offer compressibility up to 30%
- Low torque requirements ensure tight seal in cast iron or other soft metallic flanges—as found in pipelines, valves, filters, strainers and pump casings

Temperature and chemical resistance

- Combination of aramid fibers, high-temperature fillers and tough elastomeric matrix perform well in a wide range of difficult applications

GRAPH-LOCK® Gasketing

Benefits

Excellent resistance

- Pure exfoliated graphite flake material excels in extreme conditions, withstanding heat, pressure, and aggressive chemicals
- Proven fire-safe

Reliable seal

- Seals easily under moderate bolt load, offers superior torque retention
- Retains dimensional stability in high temperatures; seals tightly even during pressure fluctuations

Versatility

- Available in two grades—industrial grade is 98% pure; nuclear grade is 99.5% pure
- Available as standard homogeneous sheet or metal-inserted sheet for applications requiring extra strength



Typical Physical Properties*

		GRAPH-LOCK®
Color		Black, white brand
Temperature ¹	Minimum	-400°F (-240°C)
	Max. in atmosphere	+850°F (+454°C)
	Max. in steam	+1200°F (+650°C)
	Continuous in reducing or inert media	+5432°F (+3000°C) ⁵
Pressure, max. ¹	psig (bar)	2000 (140)
P x T, max. ¹	(psig x °F): 1/32", 1/16"	700,000
	(bar x °C): (0.8 mm), 1.6 mm)	(25,000)
	1/8" (3.2 mm)	350,000 (12,000)

	3123	3124	3125	3125 SS	3125 TC	3126
Description	Homogeneous	316SS Wire Inserted	Laminated	0.002" 316SS Foil Inserted	0.004" 316SS Tang Inserted	316SS Wire, Laminated
Sealability (ASTM F37B) ²						
ASTM Fuel A ml/hr	0.2	1.5 ³	0.3	0.25	0.3 ³	1.5 ³
Nitrogen ml/hr	0.5	0.2	0.5	0.2	0.3	0.2
Gas Permeability cc/min. (DIN 3535 Part 4) ⁴	0.4	0.1	0.4	0.4	0.4	0.1
Creep Relaxation % (ASTM F38)	5	17	10	12	15	17
Compressibility % (ASTM F36)	40	40	40	35	35	40
Recovery min. % (ASTM F36)	15	12	15	20	20	12
Tensile Strength psi (ASTM F152) (N/mm ²)	600 (4)	3300 (23)	600 (4)	4500 (31)	3500 (24)	3300 (23)

Also available:

Style 3120: Nuclear-grade homogeneous sheet

Style 3122: High-purity homogeneous sheet

This is a general guide and should not be the sole means of selecting or rejecting this material. ASTM test results in accordance with ASTM F-104; properties based on 1/32" (0.8mm) sheet thickness.

All styles furnished with an anti-stick parting agent as standard.

* Values do not constitute specification limits

Notes:

¹ Maximum temperature of +975°F (+525°C) for GRAPH-LOCK® with oxidation inhibitors. Consult Garlock Applications Engineering when approaching maximum pressure or 50% of maximum P x T.

² ASTM F37B Sealability, milliliters/hour (1/32" thick)
 ASTM Fuel A (isooctane): Gasket load = 500 psi (3.5 N/mm²),
 Internal pressure = 9.8 psig (0.7 bar)
 Nitrogen: Gasket load = 3000 psi (20.7 N/mm²),
 Internal pressure = 30 psig (2 bar)

³ 1000 psi gasket load

⁴ DIN 3535 Part 4 Gas Permeability, cc/min. (1/16" thick)
 Nitrogen: Gasket load = 4640 psi (32 N/mm²),
 Internal pressure = 580 psig (40 bar)

⁵ Styles 3123 and 3125 only.

GYLON® Gasketing

Typical Physical Properties*

GYLON® Styles	3500	3504	3510	3530	3540	3545	3565
Color	Fawn with black brand	Blue with black brand	Off-white with black brand	Black with no brand	White with black brand	White with black brand	White and blue w/black brand
Composition	PTFE with silica	PTFE w/ glass microspheres	PTFE with barium sulfate	PTFE with graphite	Microcellular PTFE	Microcellular PTFE	PTFE w/ glass microspheres
Sealability							
ASTM Fuel A ml/hr (ASTM F37B) ⁴	0.22	0.12	0.04	0.02	0.25 ³	0.15 ³	0.33
Gas Permeability cc/min. (DIN 3535 Part 4) ⁵	< 0.015	< 0.015	< 0.015	< 0.015	< 0.015 ³	< 0.015 ³	< 0.015
Creep Relaxation % (ASTM F38)	18	40	11	29	10 ³	15 ³	35
Compressibility Range (ASTM F36)							
%	7-12	25-45	4-10	7-17	70-85 ³	60-70 ³	35-50
Recovery min. % (ASTM F36)	40	30	40	40	8 ³	15 ³	35
Tensile Strength psi (ASTM D1708) (N/mm ²)	2000 (14)	2000 (14)	2000 (14)	3000 (21)	—	—	1800 (13)
Flammability	Will not support flame						
Bacterial Growth	Will not support						

GYLON® Styles	3500, 3504, 3510, 3530, 3535, 3540, 3545, 3565	HP 3560 HP 3561
Temperature ¹	Cont. max. +500°F (+260°C) Minimum -450°F (-268°C)	
Pressure, Cont. max. ¹	psig 1200 ² (83)	2500 (172)
P x T, max. ¹	1/32", 1/16" (0.8 mm, 1.6 mm)	350,000 ³ (12,000)
psig x °F (bar x °C)	1/8" (3.2 mm) 250,000 (8,600)	450,000 (15,000)

This is a general guide and should not be the sole means of selecting or rejecting this material. ASTM test results in accordance with ASTM F-104; properties based on 1/32" (0.8mm) sheet thickness, except Style 3565, based on 1/16" (1.6mm).

* Values do not constitute specification limits

Notes:

- When approaching maximum pressure or temperature, or 50% of maximum P x T, consult Garlock Engineering. For Styles HP 3560 and HP 3561, consult Garlock if approaching maximum temperature, or 50% of maximum pressure or P x T.
- Except 3504 and 3535: 800 psi (55 bar).
- For 3540, 3545, HP 3560, HP 3561, 1/16" thickness only; for 3535, 1/4" thickness only.

GYLON® Styles	HP 3560	HP 3561
Color	Fawn with black brand	Off-white with black brand
Composition	GYLON® with perforated 316L stainless steel insert	
Sealability (ASTM F37B) ⁴		
ASTM Fuel A ml/hr	0.02	0.01
Gas Permeability cc/min. (DIN 3535 Part 4) ⁵	< 0.015	< 0.015
Creep Relaxation % (ASTM F38)	20	20
Compressibility Range % (ASTM F36)	4-9	3-7
Recovery min. % (ASTM F36)	45	50
Tensile Strength psi (ASTM D1708) (N/mm ²)	5000 (34)	5000 (34)
Flammability	Will not support flame	
Bacterial Growth	Will not support	

⁴ ASTM F37B Sealability, milliliters/hour (1/32" thick) ASTM Fuel A (isooctane):

Gasket load = 1000 psi (7 N/mm²),
Internal pressure = 9.8 psig (0.7 bar)

⁵ DIN 3535 Part 4 Gas Permeability, cc/min. (1/16" thick)
Nitrogen: Internal pressure = 580 psig (40 bar),
Gasket load = 4640 psi (32 N/mm²)

GYLON® Gasketing

Benefits

Tighter seal

- Improved performance over conventional PTFE
- Reduced product loss and emissions

Reduced creep relaxation

- Unique manufacturing process minimizes cold flow problems typical of skived and expanded PTFE sheets
- Excellent bolt torque retention

Chemical resistance

- Withstands a wide range of chemicals for extended service life in a wide variety of applications

Cost savings

- Cuts operational costs through reduced:
 - Fluid loss
 - Energy consumption
 - Maintenance costs
 - Inventory costs
 - Waste

Largest sheet sizes*

- Offers some of the largest sheet sizes in the industry
- Improved material utilization reduces waste

Branding and color coding

- Easy identification of superior GYLON® products
- Reduces misapplication and use of unauthorized, inferior substitutes

* 60"x 60" (1524 mm x 1524 mm), 70" x 70" (1778 mm x 1778 mm), 60" x 90" (1524 mm x 2286 mm)

Media

GYLON® 3500: Strong acids (except hydrofluoric), solvents, hydrocarbons, water, steam, chlorine, cryogenics

(For oxygen service, specify "Style 3502 for oxygen service.")

GYLON® 3504: Moderate concentrations of acids and some caustics, hydrocarbons, solvents, water, refrigerants, cryogenics, hydrogen peroxide

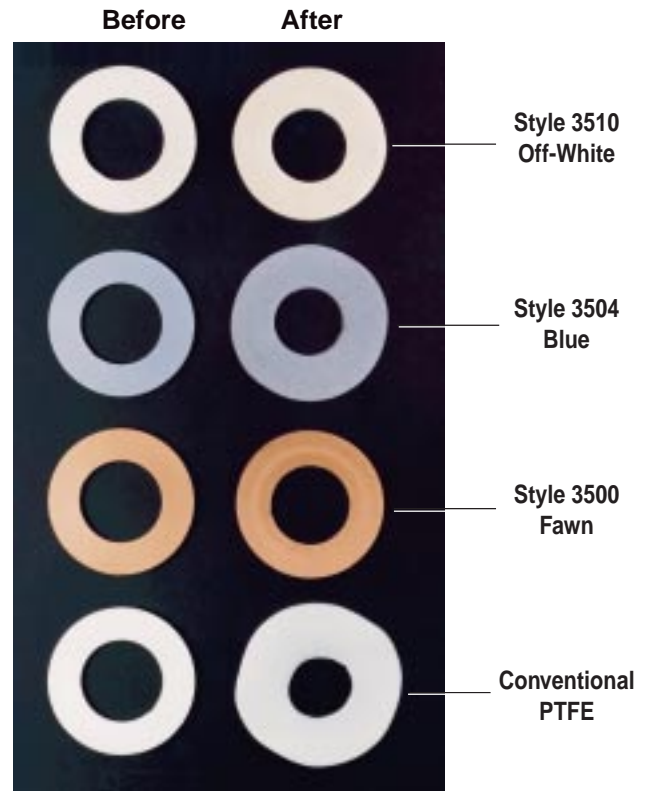
(For oxygen service, specify "Style 3505 for oxygen service.")

GYLON® 3510: Strong caustics, moderate acids, chlorine, gases, water, steam, hydrocarbons, cryogenics and aluminum fluoride

(For oxygen service, specify "Style 3503 for oxygen service.")

Test Data

Compression at 2000 psi (14 N/mm²) for 1 hour at 500°F (260°C)



Note the uneven cold flow shown by conventional PTFE.



Questions? Call Gasket Applications Engineering at 1-800-448-6688.

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GYLON® Style 3545

Benefits



Tighter seal

- Highly compressible PTFE outer layers seal under low bolt load—suitable for many non-metallic flanges*
- Compressible layers conform to surface irregularities, especially on warped, pitted or scratched flanges
- Rigid PTFE core reduces cold flow and creep normally associated with conventional PTFE gaskets

Excellent chemical compatibility

- Pure PTFE withstands a wide range of chemicals

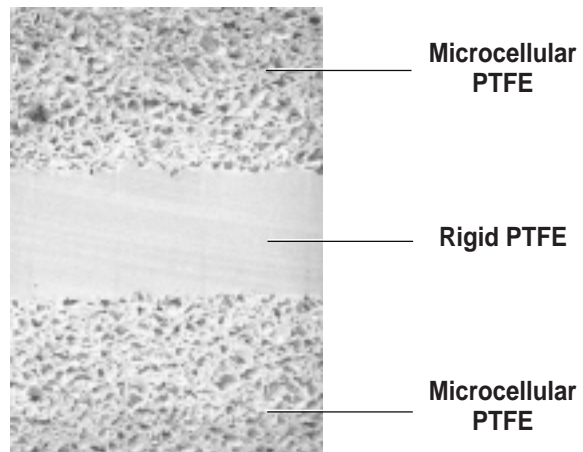
Easy to cut and install

- Soft PTFE can be cut easily from larger sheets, reducing inventory costs and expensive downtime
- Rigid PTFE core facilitates installation, especially on large diameter flanges and hard-to-reach areas

GYLON® Style 3540

- Pure microcellular PTFE
- Similar to Style 3545, but without rigid core
- Ideal for wavy, warped, pitted, or scratched flanges, and for many types of non-metallic* flanges

Configuration



Cross-sectional view under electron microscope
All layers manufactured using proprietary GYLON® process—thermally fused layers, without the use of adhesives

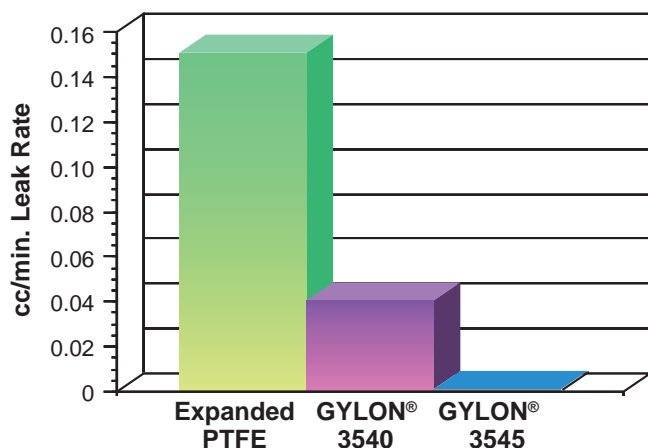
Media

- GYLON® 3540:** Strong caustics, strong acids, hydrocarbons, chlorine, cryogenics, glass-lined equipment
- GYLON® 3545:** Strong caustics, strong acids, hydrocarbons, chlorine, cryogenics, glass-lined equipment, plastic piping,* low bolt load applications

* For PVC and FRP flanges, a minimum compressive stress of 2400 psi (166 bar) is recommended on the contacted gasket area for 150 psig (10.4 bar) liquid service. Consult with the flange manufacturer to confirm that adequate compressive stress is available.

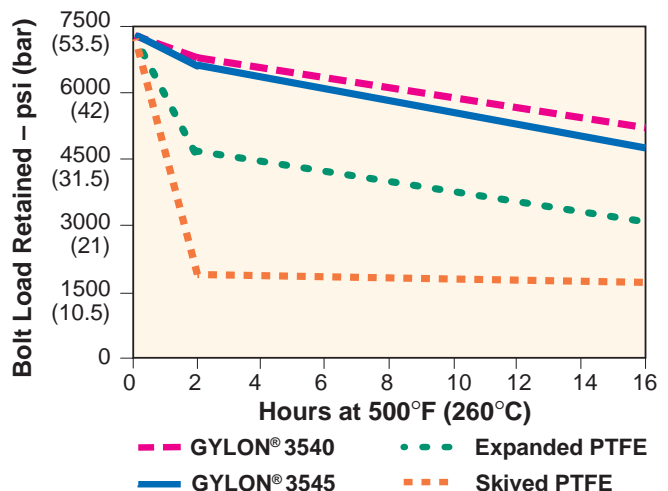
Test Results

Figure 4: DIN 3535 Gasket Permeation Test



Note the dramatically reduced leakage of GYLON® 3540 and 3545. Average of three tests, using 580 psig nitrogen with 4640 psi gasket load according to DIN 3535 requirements. All samples 1/16" (1.6 mm) thick.

Figure 5: DIN 52913 Gasket Bolt Load vs. Time



High bolt load retention of GYLON® 3540 and 3545, especially at high temperatures, indicates gasket is less likely to incur gross leakage (blowout).

Styles HP3560 / HP3561

Benefits

Tight seal

- Perforated stainless steel core increases resistance to pressure fluctuations and thermal cycling
- GYLON® offers superior cold flow and creep resistance, eliminating the need for frequent retorquing
- Excellent replacement for metal-inserted envelope gaskets, PTFE-filled spiral wounds and wire-inserted asbestos gaskets in many applications*

Chemical resistance

- Seals aggressive chemicals in hostile environments where safety or blowout resistance is crucial

* Consult Garlock Applications Engineering when using flanges in pressure classes above 300 lbs.

GYLON® Style 3565 ENVELON® Gasketing*

Benefits

Tighter seal

- Soft, deformable exterior conforms to surface irregularities; ideal for worn, warped or pitted flanges
- Stable blue core improves cold flow resistance
- Low bolt load requirements ensure a tight seal on glass-lined or wavy flanges †
- Direct sintering of GYLON® layers prevents leak paths and adhesive contamination

Easy to install

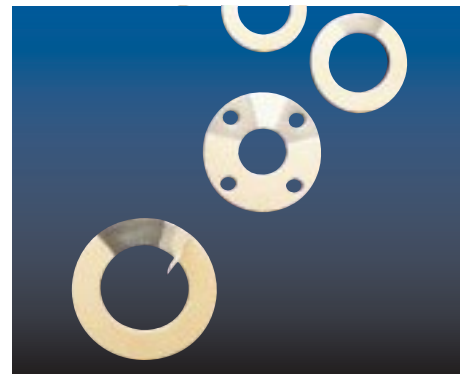
- Unitized construction avoids jacket foldover
- Rigid core facilitates installation of large gaskets

Minimizes inventory

- Custom-cut gaskets from large sheets offer convenience while reducing costly inventory buildup
- Ideal replacement for slit, milled, formed shield and double jacketed envelope gaskets †

* Patents #4,961,891; #4,900,629

† When sealing uneven flanges, gasket must be four times thicker than maximum gap between flanges.



Media

HP 3560: Strong acids (except hydrofluoric), solvents, hydrocarbons, water, steam, chlorine, and cryogenics
(For oxygen service, specify "HP3562 for oxygen service.")

HP 3561: Strong caustics, moderate acids, chlorine, gases, water, steam, hydrocarbons, cryogenics, and aluminum fluoride
(For oxygen service, specify "HP3563 for oxygen service.")

**Style 3565:
ENVELON®** Moderate concentrations of acids and caustics, hydrocarbons, solvents, cryogenics, and glass-lined equipment



Questions? Call Gasket Applications Engineering at 1-800-448-6688.

WARNING:

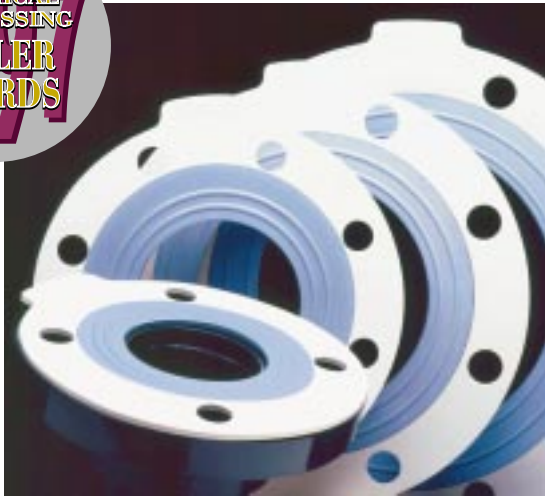
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GARLOCK is a registered trademark for packings, seals, gaskets, and other products of Garlock.

STRESS SAVER®



Typical Physical Properties

STRESS SAVER®†	Style 370	Style 6800
Construction	100% Pure PTFE bonded to EPDM	EPDM only (65 durometer)
Color	PTFE: Sky blue	EPDM: Off-white
Temperature	Max. +300°F (+150°C) Min. -40°F (-40°C)	+300°F (+150°C) -40°F (-40°C)
Pressure, max	psig 250 (bar) (17)	250 (17)
P x T, max. (psig x °F) (bar x °C)	50,000 (1717)	50,000 (1717)

† Also available in fluoroelastomer, Style 9580. Contact Garlock.

GYLON® Style 3530

Benefits

Tighter seal

- Graphite-filled PTFE offers extremely low void content for minimal emissions

Chemical resistance

- Black GYLON® delivers long service against volatile hazardous pollutants (VHAP and VOC)
- Withstands high concentrations of hydrofluoric acids and other glass-dissolving media

Media

Monomer service, cryogenics, highly concentrated hydrofluoric acid, volatile hazardous air pollutants (VHAP)

Benefits

Tighter seal

- Raised, molded-in sealing rings seal with 75% less surface area for high performance in non-metallic flanges†

Chemical resistance

- Pure PTFE sealing surface resists many chemicals

High purity

- Contaminant-free EPDM is ideal for pure service—electronics,* pharmaceutical and food industries**
- Proprietary process bonds PTFE to elastomer, won't delaminate or leach
- Special packaging available for high-purity applications

† Flat face flanges strongly recommended.

* Tested by BALASZ Labs for trace metal extractables, Anions, Cations and T.O.C.s. Results available on request.

** Consult Garlock Applications Engineering for FDA information.



Media

PTFE / EPDM: Acids, caustics, gases, water, hydrocarbons

EPDM only: Water, very mild acids and caustics

Style 3535 Joint Sealant

Benefits

Chemical resistance

- Pure PTFE is chemically inert, withstands a wide range of chemicals

Easy to install

- Continuous length on spools is easily cut and formed
- Strong adhesive backing aids installation on narrow or hard-to-reach flanges



Typical Physical Properties

Sealability (ASTM F37B)¹	ml/hr	0.1
Gas Permeability (DIN 3535 Part 4)²	cc/min.	0.05

¹ ASTM F37B Sealability, milliliters/hour (1/4" thick)

ASTM Fuel A (isooctane):

Gasket load: 3000 psi (20.7 N/mm²), Internal pressure: 30 psig (2 bar)

² DIN 3535 Part 4 Gas Permeability, cc/min. (1/4" thick) Nitrogen:

Internal pressure: 580 psig (40 bar), Gasket load: 4640 psi (32 N/mm²)

GYLON® Style 3522 Diaphragm Material

Benefits

Chemical and temperature resistance

- Withstands aggressive chemicals and temperatures from -350°F (-210°C) to +500°F (+260°C)

Resilience

- Up to three times the flex life of conventional PTFE

FDA Conformance

Welded GYLON®

Benefits

Effective seal

- Patented* welding process produces large gaskets† without dovetailed joints that permit leakage
- GYLON® material provides the excellent chemical resistance of PTFE without creep relaxation and cold flow problems

Versatile

- Ideal for corrosive applications with extra-large flanges
- Styles 3500, 3504, and 3510 can be welded using this unique process

* Patent #4,990,296

† O.D. sizes 70" (1778 mm) and over

Comparison of Typical Physical Properties

		GYLON® 3522	Skived PTFE
Color		Clear, translucent	
Composition		PTFE	
Temperature	Maximum ¹	+500°F (+260°C)	
	Minimum	-350°F (-210°C)	
Creep Relaxation (ASTM F38)	%	35	51
Specific Gravity (D792)		2.19	2.185
Compressibility (ASTM F36)	% Range	20-25	20-25
Recovery (ASTM F36)	Min. %	50	50
Tensile Strength (ASTM D1708)			
X direction	psi (N/mm ²)	5000 (35)	4050 (28)
Y direction	psi (N/mm ²)	5100 (36)	3000 (21)
Ultimate Elongation (ASTM D1708)			
X direction	%	500	550
Y direction	%	520	450
Gas Permeability (ASTM D1434V)	cc/M ² /24 hrs	10,000	35,000
Flammability		Will not burn	
Bacterial Growth		Will not support	

**Questions?
Call Gasket Applications Engineering
at 1-800-448-6688.**

This is a general guide and should not be the sole means of selecting or rejecting this material. ASTM test results in accordance with ASTM F-104; properties based on 1/32" (0.8mm) sheet thickness.

Notes:

- When approaching maximum pressure and temperature, consult Garlock Applications Engineering.

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Vegetable Fiber Gasketing



Typical Physical Properties*

		660	670	681
Material		Vegetable fiber with cork granules and glue-glycerin binder	Cellulose fiber with cork, nitrile rubber	Vegetable fiber with glue-glycerin binder
Temperature, max.		+212°F (+100°C)	+300°F (+149°C)	+212°F (+100°C)
Pressure, max	psig (bar)	200 (15)	—	200 (15)
P x T, max.	psig x °F (bar x °C)	40,000 (1300)	—	40,000 (1300)
Widths available (standard)	inches	36	43	36
Thicknesses available	inches	0.010, 1/64, 0.021, 1/32, 3/64, 1/16, 3/32, 1/8, 3/16, 1/4	1/64, 1/32, 1/16, 1/8	0.006, 0.010, 1/64, 0.021, 1/32, 3/64, 1/16, 3/32, 1/8, 3/16, 1/4
Fluid Resistance¹				
ASTM IRM #903 Oil				
Thickness increase	max. %	5	25	5
Weight increase	max. %	30	95	15
ASTM Fuel B				
Thickness increase	max. %	5	25	5
Weight increase	max. %	30	85	15
Distilled Water				
Thickness increase	max. %	30	45	30
Weight increase	max. %	100	70	90
Compressibility at 1000 psi	Range %	40-55	30-50	25-40
Recovery	Min. %	40	30	40
Tensile Strength, min.	psi (N/mm ²)	1000 (7)	800 (6)	2000 (14)
Meets Specifications		ASTM-D-1170-62T, Grade P-3415-A; SAE J90, Grade P-3415-A; MIL-G-12803C, Grade P-3415-A		ASTM-D-1170-62T, Grade P-3313-B; SAE J90, Grade P-3313-B; MIL-G-12803C, Grade P-3313-B; HH-P-96F Type 1

¹ Gasket materials are immersed in fluids for 22 hours at 70°-85°F (21-29°C).

* Values do not constitute specification limits

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Vegetable Fiber Tolerances on Thicknesses

0.006"	± 0.0035"	0.062"	± 0.005"
0.010"	± 0.0035"	0.096" (3/32")	± 0.008"
0.015"	± 0.0035"	0.125"	± 0.016"
0.021"	± 0.005"	0.187"	± 0.016"
0.031"	± 0.005"	0.250"	± 0.016"
0.046"	± 0.005"		

"M" and "Y" Data

"M" and "Y" data are to be used for flange designs only as specified in the ASME Boiler and Pressure Vessel Code Division 1, Section VIII, Appendix 2. They are not meant to be used as gasket seating stress values in actual service. Our bolt torque tables give that information and should be used as such.

"M" - Maintenance Factor

A factor that provides the additional preload needed in the flange fasteners to maintain the compressive load on a gasket after internal pressure is applied to a joint. The net operating stress on a pressurized gasket should be at least (m) x (design pressure, psi).

"Y" - Minimum Design Seating Stress

The minimum compressive stress in pounds per square inch (or bar) on the contact area of the gasket that is required to provide a seal at an internal pressure of 2 psig (0.14 bar).

Style	Thick-ness	M	Y (psi)
ST-706	1/16"	11.4*	4800
	1/8"	22.0*	6500
3000	1/16"	4.2	3050
	1/8"	5.2	4400
3001	1/16"	4.5	2200
	1/8"	4.5	3600
3123 (Homogeneous)	1/16"	2.0	2500
	1/8"	2.0	2500
3124 (Wire-Inserted)	1/16"	2.0	2500
	1/8"	2.0	2500
3125SS	1/16"	6.5	3300
	1/8"	11.8*	5900
3125TC	1/16"	2.6	2500
	1/8"	6.0	3000
3200 / 3400	1/16"	3.5	2100
	1/8"	6.6	3000
3300	1/16"	2.1	3050
	1/8"	4.0	3500
3500	1/16"	5.0	2750
	1/8"	5.0	3500
3504	1/16"	3.0	1650
	1/8"	2.5	3000
	3/16"	2.5	3000
	1/4"	2.5	3000
3510	1/16"	2.0	2350
	1/8"	2.0	2500
3530	1/16"	2.8	1650
3540	1/16"	3.0	1700
	1/8"	3.0	2200
	3/16"	2.0	2200
	1/4"	2.0	2500

Style	Thick-ness	M	Y (psi)
3545	1/16"	2.6	1500
	1/8"	2.0	2200
	3/16"	2.0	2200
	1/4"	7.0	3700
HP 3560	1/16"	5.0	3500
	1/8"	5.0	4000
HP 3561	1/16"	5.0	3500
	1/8"	5.0	4000
3565	1/16"	2.8	1400
	1/8"	3.7	2300
	3/16"	5.5	2800
	1/4"	6.0	2800
3700	1/16"	3.5	2800
	1/8"	6.7	4200
3800	1/16"	2.0	2000
CP-3900	1/16"	1.5	1800
	1/8"	1.5	3600
IFG® 5500	1/16"	6.6	2600
	1/8"	6.6	3300
IFG® 5507	1/16"	3.5	2400
	1/8"	5.5	3900
9800	1/16"	3.5	2350
	1/8"	8.0	3200
9850	1/16"	6.5	2550
	1/8"	8.0	2800
G-9900	1/16"	4.5	4100
	1/8"	6.0	4100
STRESS SAVER®	1/8"	2.0	400

* These M values, based on ambient temperature leakage with nitrogen, are high. Field experience has shown that lower values would be workable in elevated temperatures. Consult Applications Engineering.

Gasket Constants

Product Style	Thickness (inches)	G _b	a	G _s	S100	S1000	S3000	S5000	S10000	T _{pmin}	T _{pmax}
3500	1/16	949	0.253	2.6	3,043	5,448	7,194	8,187	9,755.9	373	16,890
3504	1/16	183	0.357	0.00401	947	2,155	3,190	3,828	4,902.9	3097	14,817
3510	1/16	289	0.274	6.61E-11	1,021	1,918	2,592	2,981	3,604.9	11,881	25,501
	1/8	444	0.332	0.0129	2,048	4,399	6,336	7,506	9,448.9	1,770	17,550
3535	3/8	430	0.286	1.69E-09	1,605	3,101	4,245	4,913	5,990.6	373	—
3540	1/16	550	0.304	0.764	2,230	4,491	6,272	7,326	9,044	973	23,670
3545	3/16	628	0.249	7.93E-05	1,977	3,507	4,611	5,236	6,222.4	373	—
3561	1/16	72.3	0.466	0.261	618	1,808	3,016	3,827	5,286.1	1,688	21,755
3700	1/8	1,318	0.258	0.6	4,324	7,833	10,400	11,865	14,188	373	—
IFG® 5500	1/16	1,247	0.249	11	3,925	6,964	9,155	10,397	12,356	373	—
ST-706	1/16	2,455	0.267	0.622	8,396	15,526	20,818	23,860	28,711	—	—

G_b = stress at which seal is initiated; "a" = the slope of the log/log tightness curve; G_s = intersection of the unload curve with the vertical axis (Tp1).

Note: For a 5" OD gasket at 800 psig, Tp100 = 102ml/min. leakage, Tp1,000 = 1.02ml/min. leakage, Tp10,000 = 0.01 ml/min. leakage.

ASTM F104 Line Callouts

Style ¹	ASTM Line Callout	A9: Leakage in		E99: % Increase in ASTM Fuel B	K: Thermal Conductivity*	M9: Tensile Strength
		Fuel A (Isooctane) ²	Nitrogen ³			
ST-706	F712100A9B3E34K5M9	Typical: 0.5 ml/hr Max: 1.5 ml/hr	—	—	K5	1400 psi min. (9.7 N/mm ² min.)
3000	F712100A9B4E22K5M6	Typical: 0.2 ml/hr Max: 1.0 ml/hr	Typical: 0.6 ml/hr Max: 1.5 ml/hr	—	K5	—
3124, 3125 SS and TC	F516000A9B1M3	Typical: 0.2 ml/hr Max: 1.0 ml/hr	Typical: 0.5 ml/hr Max: 1.5 ml/hr	—	—	—
3200/3400	F712900A9B4E45K5M9	Typical: 0.1 ml/hr Max: 1.0 ml/hr	Typical: 0.4 ml/hr Max: 1.0 ml/hr	—	K5	2,250 psi min. (15 N/mm ² min.)
3300	F712400A9B4E34K5M9	Typical: 0.2 ml/hr Max: 1.5 ml/hr	Typical: 1.0 ml/hr Max: 2.0 ml/hr	—	K5	2,500 psi min. (17 N/mm ² min.)
3700	F712900A9B4E99K5M9	Typical: 0.1 ml/hr Max: 1.0 ml/hr	Typical: 0.7 ml/hr Max: 2.0 ml/hr	Weight: 100% max. Thickness: 20-50%	K5	2,250 psi (15 N/mm ² min.)
CP-3900	F719240A9E43K4M6	Typical: 0.1 ml/hr Max: 1.0 ml/hr	Typical: 0.3 ml/h Max: 1.0 ml/hr	—	K4	—
CP-3920	F719560A9E66K4M5	Typical: 0.1 ml/hr Max: 1.0 ml/hr	Typical: 0.3 ml/ Max: 1.0 ml/hr	—	K4	—
IFG® 5500	F712100A9B2E23K7M5	Typical: 0.2 ml/hr Max: 1.0 ml/hr	Typical: 0.5 ml/hr Max: 1.5 ml/hr	—	K7	—
IFG® 5507	F712500A9B2E36K9M5	Typical: 0.1 ml/hr Max: 1.0 ml/hr	Typical: 0.5 ml/hr Max: 1.5 ml/hr	—	K9: 0.61 W/m ² K (4.27 btu-in./h-ft ² -°F)	—
9800	F712400A9B2E34K8M9	Typical: 0.1 ml/hr Max: 0.5 ml/hr	Typical: 0.1 ml/hr Max: 0.5 ml/hr	—	K8	1400 psi min. (9.7 N/mm ² min.)
9850	F712200A9B2E22K8M9	Typical: 0.1 ml/hr Max: 0.5 ml/hr	Typical: 0.1 ml/hr Max: 0.5 ml/hr	—	K8	1600 psi min. (11 N/mm ² min.)
G-9900	F712100A9B2E22K9M5	Typical: 0.1 ml/hr Max: 0.5 ml/hr	Typical: 0.1 ml/hr Max: 0.5 ml/hr	—	K9: 0.87 W/m ² K (6.0 btu-in./h-ft ² -°F)	—

GYLON® Style ⁴	ASTM Line Callout	Fourth Numeral 9: % Increase in IRM Oil #903	Fifth Numeral 9: % Increase in IRM Oil #903	Sixth Numeral 9: % Increase in Water	A9: Leakage in Fuel A (Isooctane) ⁵	E99: % Increase in ASTM Fuel B
3500	F451999A9B1E99K6M6	Thickness: 1.0% max.	Weight: 2.0% max.	Weight: 1.0% max.	Typical: 0.22 ml/hr Max: 1.0 ml/hr	Weight: 2.0% max. Thickness: 1.0% max.
3504	F456999A9B7E99K3M6	Thickness: 1.0% max.	Weight: 2.0% max.	Weight: 1.0% max.	Typical: 0.12 ml/hr Max: 1.0 ml/hr	Weight: 2.0% max. Thickness: 1.0% max.
3510	F451999A9B2E99K5M6	Thickness: 1.0% max.	Weight: 2.0% max.	Weight: 1.0% max.	Typical: 0.04 ml/hr Max: 1.0 ml/hr	Weight: 2.0% max. Thickness: 1.0% max.
3540 ⁶	F419000A9B2	—	—	—	Typical: 0.25 ml/hr Max: 1.0 ml/hr	—
3545 ⁶	F419000A9B3	—	—	—	Typical: 0.15 ml/hr Max: 1.0 ml/hr	—
HP 3560 ⁷	F451999A9B1E99K6M6	Thickness: 1.0% max.	Weight: 2.0% max.	Weight: 1.0% max.	Typical: 0.22 ml/hr Max: 1.0 ml/hr	Weight: 2.0% max. Thickness: 1.0% max.
HP 3561 ⁷	F451999A9B2E99K5M6	Thickness: 1.0% max.	Weight: 2.0% max.	Weight: 1.0% max.	Typical: 0.04 ml/hr Max: 1.0 ml/hr	Weight: 2.0% max. Thickness: 1.0% max.
3565	F457999A9B6E99M6	Thickness: 1.0% max.	Weight: 2.0% max.	Weight: 1.0% max.	Typical: 0.33 ml/hr Max: 1.0 ml/hr	Weight: 2.0% max. Thickness: 1.0% max.

Style ¹	ASTM Line Callout
660	F328148M4
681	F326128M6
3123	F517100B1M3

¹ For these styles, thickness is 1/32".

² Gasket load = 500 psi (3.5 N/mm²); internal pressure = 9.8 psig (0.7 bar).

³ Gasket load = 3,000 psi (20.7 N/mm²); internal pressure = 30 psig (2 bar).

⁴ For Styles 3500 thru 3545, thickness is 1/32"; for Styles 3560-3565, thickness is 1/16".

⁵ Gasket load = 1,000 psi (7.0 N/mm²); internal pressure = 9.8 psig (0.7 bar).

⁶ Third numeral 9: F36 Compressibility 3540: 70-85%, 3545: 60-70%.

⁷ Line callout = OFMF9: 9 = Perforated stainless steel, F = F451999A9B1E99K6M6 (HP 3560); F = F451999A9B2E99K5M6 (HP 3561).

* NOTE: K1 thru K9 thermal conductivity characteristics shall be determined in accordance with F-104, 9.10.

The K-factor obtained in W/m²K (btu-in./h-ft²-°F) shall fall within the ranges indicated by the numeral of the K symbol:

K1 = 0 to 0.09 (0 to 0.65)

K2 = 0.07 to 0.17 (0.50 to 1.15)

K3 = 0.14 to 0.24 (1.00 to 1.65)

K4 = 0.22 to 0.31 (1.50 to 2.15)

K5 = 0.29 to 0.38 (2.00 to 2.65)

K6 = 0.36 to 0.45 (2.50 to 3.15)

K7 = 0.43 to 0.53 (3.00 to 3.65)

K8 = 0.50 to 0.60 (3.50 to 4.15)

K9 = as specified

Bolting and Flange Information

The gasket's function is to seal two different surfaces held together by one of several means, the most common being screw-threaded devices such as bolts. Sometimes the fastener itself must be sealed, as in the case of a steel drum bung.

The bolt is a spring. It is an elastic member that has been stretched to develop a load. The more spring provided by the bolt, the better the retention of stress on the gasket to maintain a leakproof joint. It must not be over-elongated (over-strained), or the elastic limit of the steel will be exceeded. The bolt then deforms and, with continued loading (stressing), may rupture.

To avoid such problems with bolt tightening, the use of a torque wrench is recommended. The torque tables on page 39 show the recommended torque values for Garlock compressed sheet, GYLON® and GRAPH-LOCK® gasketing materials in 150 lb. and 300 lb. raised face flanges. The equipment designer may specify the recommended torque to prevent damage to the equipment from overtorquing. Garlock's recommended assembly stresses, page 38, may help the equipment designer determine the maximum allowable torque per bolt. The load will be retained better by using a bolt with a longer grip, thereby ensuring a leakproof joint.

There are limits on the degree of flange surface imperfection that can be sealed successfully with a gasket. Large nicks, dents, or gouges must be avoided, since a gasket cannot properly seal against them. The surface finish of a flange is described as follows:

1. **Roughness:** Roughness is read in millionths of an inch (or meter) as the average of the peaks and valleys measured from a midline of the flange surface. This is expressed either as rms (root mean square) or AA (arithmetic average). The difference between these two methods of reading is so small that they may be used interchangeably. Roughness is also expressed as AARH (arithmetic average roughness height).
2. **Lay:** Lay is the direction of the predominant surface-roughness pattern. Example: multidirectional, phonographic spiral serrations, etc.
3. **Waviness:** Waviness is measured in thousandths or fractions of an inch. Basically, it is the departure from overall flatness.

Typical roughness readings can be from 125 to 500 micro-inches for serrated flanges and 125-250 micro-inches for non-serrated flanges. Fine finishes, such as polished surfaces, should be avoided. Adequate "bite" in the surface is required to develop enough friction to prevent the gasket from being blown out or from extruding or creeping excessively.

The lay of the finish should follow the midline of the gasket if possible. Take, for example, concentric circles on a round flange, or a phonographic spiral. Every effort should be made to avoid lines across the face, such as linear surface grinding, which at 180° points will cross the seal area at right angles to the gasket, allowing a direct leak path.

Waviness is seldom a problem under normal conditions. There are two areas that must be watched, however, since excessive waviness is very difficult to handle.

The first area is glass-lined equipment where the natural flow of the fused glass creates extreme waviness. Often the answer here is to use thick and highly compressible gasketing.

The second area of concern is warped flanges. If warpage is caused by heat or internal stresses, re-machining is generally sufficient. However, warpage due to excessive bolt loads or insufficient flange thickness results in what is generally called bowing.

The solution is to redesign for greater flange rigidity. Sometimes backer plates can be added to strengthen the design without having to replace the parts. Another step would be to add more bolts. When this is done, usually smaller bolt diameters are possible, thus adding more bolt stretch and better joint performance.

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Before Installation

- Remove old gasket, and clean flange surface of all debris. For best results, use a metal flange scraper, an aerosol gasket remover and a wire brush, then inspect the flange for damage. Be sure surface finish and flatness are satisfactory.
- Use the thinnest possible gasket. However, flanges that are warped, bowed or severely pitted require thicker gaskets.
- Whenever possible, use ring gaskets. Full face gaskets have more surface area, requiring additional compressive load on the gasket.
- Use dry anti-seize, rather than wet. Talc is best, while graphite and mica are also acceptable. Never use metal-based anti-seize, since particles may accumulate in the surface imperfections, thereby creating a flange surface that is too smooth to be effective.

Installation

- Center the gasket on the flange. This is extremely vital where raised faces are involved.
Note: Standard ANSI ring gaskets, when properly cut, should center themselves when the bolts are in place.
- Use a torque wrench and well-lubricated fasteners with hardened flat washers to ensure correct initial loading.
- Tighten bolts to compress gasket uniformly. This means going from side to side around the joint in a star-like crossing pattern. See Figure 6 at right.
- All bolts should be tightened in one-third increments, according to proper bolting patterns.
- Retorque 12 to 24 hours after start-up, whenever possible. All applicable safety standards including lockout/tagout procedure should be observed.
- Never use liquid or metallic based anti-stick or lubricating compounds on the gaskets. Premature failure could occur as a result.

Gasket Assembly Stress Recommendations

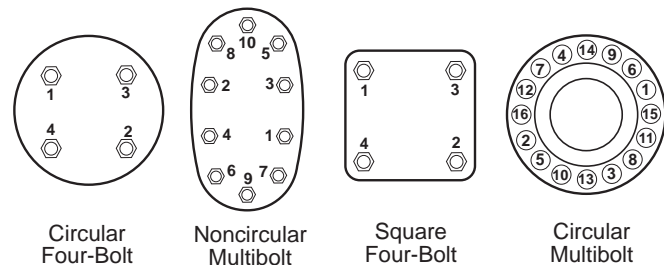
The minimum recommended assembly stress for Garlock compressed sheet, GYLON® and GRAPH-LOCK® products differs from "M" and "Y" values. "M" and "Y" do not take factors such as flange condition and blowout resistance into account. Garlock offers the following minimum assembly stresses as rules of thumb to use to calculate installation bolt torques.

Operating Pressure in psig (bar)	Minimum Assembly Stress Recommended psi (N/mm ²)		
	1/32" (0.8 mm) Thick	1/16" (1.6 mm) Thick	1/8" (3.2 mm) Thick
Up to 300 (21)	2500 (17)	3600 (25)	4800 (33)
Up to 800 (55)	4800 (33)	5400 (37)	6400 (44)
Up to 2000 (140)	7400 (51)	8400 (58)	9400 (65)

Maximum recommended compressive stress for all compressed fiber and GYLON® gaskets = 15,000 psi.

Maximum recommended compressive stress for all GRAPH-LOCK® gaskets = 10,000 psi.

Figure 6: Correct Bolting Patterns



WARNING:

Properties/applications shown throughout this brochure are typical. Your specific application should not be undertaken without independent study and evaluation for suitability. For specific application recommendations consult Garlock. Failure to select the proper sealing products could result in property damage and/or serious personal injury.

Performance data published in this brochure has been developed from field testing, customer field reports and/or in-house testing.

While the utmost care has been used in compiling this brochure, we assume no responsibility for errors. Specifications subject to change without notice. This edition cancels all previous issues. Subject to change without notice.

GARLOCK is a registered trademark for packings, seals, gaskets, and other products of Garlock.

Torque Tables

ASME B 16.5 Raised Face Flanges with A193 Gr B7 Bolts

150# flanges, compressed sheet and GYLON® gaskets

Nom. Pipe Size (Inches)	No. of Bolts	Size of Bolts (Inches)	Internal Pressure (psig)	Minimum Torque (ft.-lbs.)	Preferred Torque (ft.-lbs.)
0.50	4	0.50	300	9	28
0.75	4	0.50	300	13	40
1.00	4	0.50	300	17	53
1.25	4	0.50	300	26	60
1.50	4	0.50	300	35	60
2.00	4	0.63	300	69	120
2.50	4	0.63	300	81	120
3.00	4	0.63	300	119	120
3.50	8	0.63	300	66	120
4.00	8	0.63	300	84	120
5.00	8	0.75	300	117	200
6.00	8	0.75	300	148	200
8.00	8	0.75	300	200	200
10.00	12	0.88	300	188	320
12.00	12	0.88	300	250	320
14.00	12	1.00	300	317	490
16.00	16	1.00	300	301	490
18.00	16	1.13	300	448	710
20.00	20	1.13	300	395	710
24.00	20	1.25	300	563	1000

300# flanges, compressed sheet and GYLON® gaskets

Nom. Pipe Size (Inches)	No. of Bolts	Size of Bolts (Inches)	Internal Pressure (psig)	Minimum Torque (ft.-lbs.)	Preferred Torque (ft.-lbs.)
0.50	4	0.50	800	12	28
0.75	4	0.63	800	21	51
1.00	4	0.63	800	28	67
1.25	4	0.63	800	43	102
1.50	4	0.75	800	64	151
2.00	8	0.63	800	46	108
2.50	8	0.75	800	60	141
3.00	8	0.75	800	88	200
3.50	8	0.75	800	99	200
4.00	8	0.75	800	125	200
5.00	8	0.75	800	156	200
6.00	12	0.75	800	131	200
8.00	12	0.88	800	205	320
10.00	16	1.00	800	219	490
12.00	16	1.13	800	319	710
14.00	20	1.13	800	287	652
16.00	20	1.25	800	401	912
18.00	24	1.25	800	439	1,000
20.00	24	1.25	800	484	1,000
24.00	24	1.50	800	662	1,552

150# flanges, GRAPH-LOCK® gaskets

Nom. Pipe Size (Inches)	No. of Bolts	Size of Bolts (Inches)	Internal Pressure (psig)	Minimum Torque (ft.-lbs.)	Preferred Torque (ft.-lbs.)
0.50	4	0.50	300	9	20
0.75	4	0.50	300	13	27
1.00	4	0.50	300	17	35
1.25	4	0.50	300	26	54
1.50	4	0.50	300	35	60
2.00	4	0.63	300	69	120
2.50	4	0.63	300	81	120
3.00	4	0.63	300	119	120
3.50	8	0.63	300	66	120
4.00	8	0.63	300	84	120
5.00	8	0.75	300	117	200
6.00	8	0.75	300	148	200
8.00	8	0.75	300	200	200
10.00	12	0.88	300	188	320
12.00	12	0.88	300	250	320
14.00	12	1.00	300	317	490
16.00	16	1.00	300	301	490
18.00	16	1.13	300	448	710
20.00	20	1.13	300	395	710
24.00	20	1.25	300	563	1000

300# flanges, GRAPH-LOCK® gaskets

Nom. Pipe Size (Inches)	No. of Bolts	Size of Bolts (Inches)	Internal Pressure (psig)	Minimum Torque (ft.-lbs.)	Preferred Torque (ft.-lbs.)
0.50	4	0.50	800	12	20
0.75	4	0.63	800	21	34
1.00	4	0.63	800	28	45
1.25	4	0.63	800	43	68
1.50	4	0.75	800	64	101
2.00	8	0.63	800	46	72
2.50	8	0.75	800	60	94
3.00	8	0.75	800	88	138
3.50	8	0.75	800	99	154
4.00	8	0.75	800	125	196
5.00	8	0.75	800	156	200
6.00	12	0.75	800	131	200
8.00	12	0.88	800	205	320
10.00	16	1.00	800	219	341
12.00	16	1.13	800	319	498
14.00	20	1.13	800	287	435
16.00	20	1.25	800	401	608
18.00	24	1.25	800	439	1,000
20.00	24	1.25	800	484	1,000
24.00	24	1.50	800	662	1,035

Note: Consult Engineering for all other torque tables.

Load on Machine Bolts and Cold Rolled Steel Stud Bolts Under Torque

Nominal Diameter of Bolt (inches)	Number of Threads Per Inch	Diameter of Root of Thread (inches)	Area at Root of Thread (sq. in.)	Stress					
				7,500 psi		15,000 psi		30,000 psi	
				Torque (ft. lbs.)	Clamping Force (lbs./bolt)	Torque (ft. lbs.)	Clamping Force (lbs./bolt)	Torque (ft. lbs.)	Clamping Force (lbs./bolt)
1/4	20	0.185	0.027	1	203	2	405	4	810
5/16	18	0.240	0.045	2	338	4	675	8	1,350
3/8	16	0.294	0.068	3	510	6	1,020	12	2,040
7/16	14	0.345	0.093	5	698	10	1,395	20	2,790
1/2	13	0.400	0.126	8	945	15	1,890	30	3,780
9/16	12	0.454	0.162	12	1,215	23	2,430	45	4,860
5/8	11	0.507	0.202	15	1,515	30	3,030	60	6,060
3/4	10	0.620	0.302	25	2,265	50	4,530	100	9,060
7/8	9	0.731	0.419	40	3,143	80	6,285	160	12,570
1	8	0.838	0.551	62	4,133	123	8,265	245	16,530
1-1/8	7	0.939	0.693	98	5,190	195	10,380	390	20,760
1-1/4	7	1.064	0.890	137	6,675	273	13,350	545	26,700
1-3/8	6	1.158	1.054	183	7,905	365	15,810	730	31,620
1-1/2	6	1.283	1.294	219	9,705	437	19,410	875	38,820
1-5/8	5-1/2	1.389	1.515	300	11,363	600	22,725	1,200	45,450
1-3/4	5	1.490	1.744	390	13,080	775	26,160	1,550	52,320
1-7/8	5	1.615	2.049	525	15,368	1,050	30,735	2,100	61,470
2	4-1/2	1.711	2.300	563	17,250	1,125	34,500	2,250	69,000

Load on Alloy Steel Stud Bolts Under Torque

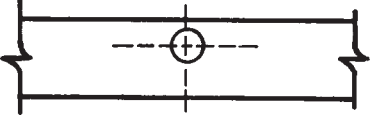
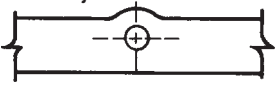
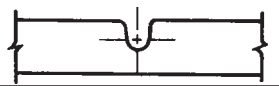


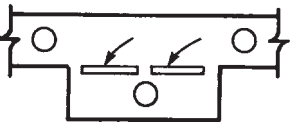
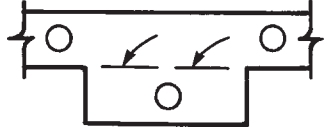
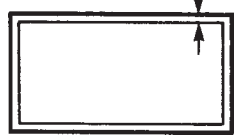
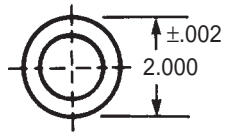

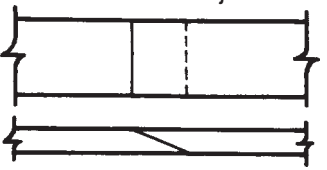

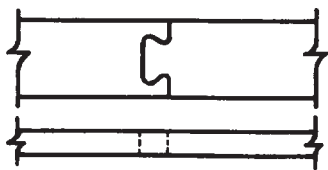
Nominal Diameter of Bolt (inches)	Number of Threads Per Inch	Diameter of Root of Thread (inches)	Area at Root of Thread (sq. in.)	Stress					
				30,000 psi		45,000 psi		60,000 psi	
				Torque (ft. lbs.)	Clamping Force (lbs./bolt)	Torque (ft. lbs.)	Clamping Force (lbs./bolt)	Torque (ft. lbs.)	Clamping Force (lbs./bolt)
1/4	20	0.185	0.027	4	810	6	1,215	8	1,620
5/16	18	0.240	0.045	8	1,350	12	2,025	16	2,700
3/8	16	0.294	0.068	12	2,040	18	3,060	24	4,080
7/16	14	0.345	0.093	20	2,790	30	4,185	40	5,580
1/2	13	0.400	0.126	30	3,780	45	5,670	60	7,560
9/16	12	0.454	0.162	45	4,860	68	7,290	90	9,720
5/8	11	0.507	0.202	60	6,060	90	9,090	120	12,120
3/4	10	0.620	0.302	100	9,060	150	13,590	200	18,120
7/8	9	0.731	0.419	160	12,570	240	18,855	320	25,140
1	8	0.838	0.551	245	16,530	368	24,795	490	33,060
1-1/8	8	0.963	0.728	355	21,840	533	32,760	710	43,680
1-1/4	8	1.088	0.929	500	27,870	750	41,805	1,000	55,740
1-3/8	8	1.213	1.155	680	34,650	1,020	51,975	1,360	69,300
1-1/2	8	1.338	1.405	800	42,150	1,200	63,225	1,600	84,300
1-5/8	8	1.463	1.680	1,100	50,400	1,650	75,600	2,200	100,800
1-3/4	8	1.588	1.980	1,500	59,400	2,250	89,100	3,000	118,800
1-7/8	8	1.713	2.304	2,000	69,120	3,000	103,680	4,000	138,240
2	8	1.838	2.652	2,200	79,560	3,300	119,340	4,400	159,120
2-1/4	8	2.088	3.423	3,180	102,690	4,770	154,035	6,360	205,380
2-1/2	8	2.338	4.292	4,400	128,760	6,600	193,140	8,800	257,520
2-3/4	8	2.588	5.259	5,920	157,770	8,800	236,655	11,840	315,540
3	8	2.838	6.324	7,720	189,720	11,580	284,580	15,440	379,440

Values shown in these tables are based on steel bolting that has been well-lubricated with heavy graphite and oil mixture.

Research has shown that a non-lubricated bolt has about 50%

of the efficiency of a well-lubricated bolt. It has been further found that different lubricants produce results varying between the limit of 50% and 100% of the tabulated stress figures.

Gasket Design Tips

Problem	Result	Suggested Solutions
<p>Bolt holes close to edge</p> 	<p>Causes breakage in stripping and assembling</p>	<p>Projection or "ear"</p>  <p>Notch instead of hole</p> 
<p>Very small bolt holes or non-circular openings</p> 	<p>Require handpicking... easy to miss</p>	<p>Avoid hole sizes under 3/32" diameter. If small hole is for locating or indexing, change to notch.</p> 
<p>Tear-away parts with open slots at attached edges</p> 	<p>Slots require handpicking, costly dies and die maintenance</p>	<p>Simple perforation</p> 
<p>Thin walls, delicate cross-section in relation to overall size</p> 	<p>High scrap loss; stretching or distortion in shipment or use. Restricts choice to high tensile strength materials</p>	<p>Have the gasket in mind during early design stages</p>
<p>Metalworking tolerances applied to gasket thickness, diameters, length, width, etc.</p> 	<p>Results in perfectly usable parts being rejected at incoming inspection. Requires time and correspondence to reach agreement on practical limits. Increases cost of parts and tooling. Delays delivery.</p>	<p>Most gasket materials are compressible. Many are affected by humidity changes. Try standard or commercial tolerances before concluding that special accuracy is required.</p>
<p>Transference of fillets, radii, etc. from mating metal parts to gasket</p> 	<p>Unless part is molded, such features mean extra operations and higher cost</p>	<p>Most gasket stocks will conform to mating parts without pre-shaping. Be sure radii, chamfers, etc., are functional, not merely copied from metal members.</p>
<p>Large gaskets made in sections with beveled joints</p> 	<p>Extra operations to skive or glue. Difficult to obtain smooth, even joints without steps or transverse grooves.</p> 	<p>Die-cut dovetailed joint</p> 

Gasketing Terms

American Bureau of Shipping



Garlock styles on the American Bureau of Shipping Type Approval program:

- ST-706
- 2550
- BLUE-GARD® 3000, 3200
- GRAPH-LOCK® 3125SS, 3125TC
- GYLON® 3500, 3504, 3510
- IFG® 5500*
- G-9900*

Anti-Stick

While we prefer that gaskets be installed with only the factory-applied anti-stick, experience shows that additional anti-stick is helpful in some situations, such as areas where flanges cannot be separated easily. Coatings should be as light as possible. Dry powders are strongly recommended over pastes and grease-type compounds, which can drastically reduce the crush strength and blowout resistance of the gasket. Additionally, grease or paste type materials may deteriorate or dissolve in service, leaving a possible leak path across the gasket. Garlock provides a talc-based anti-stick in both aerosol and water-based pump spray.

Aviation Gasoline

Gasoline with a high octane number is used for prop driven airplane engines, as opposed to jet fuel for jet engines. Aviation gasoline contains a high percentage of aromatics. GYLON® is preferred; compressed sheet styles with nitrile binders can be successful in some applications (see Jet Fuel). Consult Engineering if you are unsure.

Bubble Tests

Some end users perform bubble tests of their system to check gasket tightness. This information is helpful before specifying a gasket. Bubble tests are an

* Accepted for use where "fire safe" requirements are specified by ABS rules, and US Coast Guard regulations.

extremely tough test for a gasketed joint, and may not be an appropriate means to verify correct installation. Lightweight flanges with low available compressive load may never achieve "bubble tight" results.

Chlorine Service

We recommend our GYLON® styles for chlorine. The style selection is made based on flange information. Style 3510 is approved by the Chlorine Institute.

Compression

The amount of compression expected on a particular gasket type depends on its compressibility data and the load applied. Sealing problems are often a result of lack of compression. Graphs of compression vs. load on popular gasketing styles are available upon request. Close tolerance sheet should be considered for applications requiring tight internal clearances such as split case pumps (see Modulus of Elasticity).

Compressive Stress

Undercompression: Underloaded gaskets will have higher leak rates and lower blowout resistance than properly loaded gaskets. This has a profound effect on performance and is the most frequent cause of joint problems.

Overcompression: Overcompression can lead to crushing, which accelerates the degradation of the gasket and can even cause immediate failure.

Uneven Compression: Gaskets resist blowout based on the friction of the gasket against the flange. The higher the compressive load, both initially and during service, the higher the blowout resistance. When areas of high and low compression exist in a flange joint, the areas of low compression are prime candidates for blowout.

Crush Strength

Garlock recommends a maximum compressive stress of 15,000 psi on compressed fiber and GYLON® gasketing, and 10,000 psi on GRAPH-LOCK® gasketing. The actual crush strength of these materials is typically higher than that of homogeneous rubber.

Cryogenic Service

We recommend our GYLON® styles down to -450°F (-268°C), and our compressed sheet gasketing is typically recommended to -40°F (-40°C).

Dielectric Breakdown Voltage

Many applications require a gasket which is not a good conductor of electricity. Garlock has dielectric breakdown voltage test data available on our most popular gasketing styles. Generally speaking, GYLON® styles and compressed sheet that does not use carbon or graphite fibers have high dielectric breakdown values. Under humid or wet conditions, Styles 3504 and 3565 are particularly resistant to dielectric breakdown.

Emissions

There is certainly a great deal of interest in limiting emissions of the numerous chemicals and other substances regulated under the Clean Air Act. Garlock has performed testing in this area and our report, available on request, covers the effects of gasket type, compressive load, internal pressure and flange finish on relative emissions levels. The use of heavier flanges where possible and the selection of premium gasket materials with good sealability numbers are the easiest ways to reduce emissions. Due to the aggressive nature of these chemicals, we recommend our GYLON® family of products.

FDA

Garlock offers gasket styles for Food and Drug Administration (FDA) applications. Consult Garlock Applications Engineering for information.

Fire Tests

Garlock has developed a Fire Test Standard modeled after industry fire tests API 589 and 607. Styles G-9900, 9850, ST-706, IFG® 5500 and GRAPH-LOCK® styles have all passed this fire test. Test procedures and results are available upon request.

Flanges

Flanges come in all shapes and sizes, and the type of flange used in a service has a large impact on the type of gasketing material recommended. Standard ANSI raised face flanges are best suited for use with compressed fiber and GYLON® gaskets. Elastomer (rubber) gaskets may be crushed in these flanges.

Flat faced non-metallic flanges work best with the STRESS SAVER® gasket and the highly compressible GYLON® Style 3545. Compressed fiber and standard GYLON® are frequently used in flat-faced carbon

steel flanges, but it should be noted the compressive stress available in these flanges is well below our minimums. The result is that the gaskets are compressed very little; if there is a significant flange irregularity present, the gasket may not seal. Since leakage rates of gaskets depend on the available compressive stress, the joint may not be as tight as the customer would like.

Glass-lined flanges are found in many chemical applications. Due to the inherent "waviness" created when these flanges are fired to apply the glass, the softer GYLON® styles such as Styles 3545, 3565, and 3504 are preferred. The gap between the flanges, when placed together empty, must be measured before the gasket is ordered. Gasket thickness should be four to five times the maximum gap observed.

Stainless steel (SS) flanges are common in many plants for chemical service, and often utilize low strength SS bolts. Due to the chemicals present and the low compressive stress generated by the bolts, Styles 3545, 3565, and 3504 are often recommended. We do prefer, however, the use of high strength, strain-hardened stainless steel bolts.

Flange Finish

We recommend the flange finish conform, whenever possible, to 30-55 serrations per inch, in a concentric or spiral pattern, cut with a 1/16" radius, round-nosed tool. This finish is usually difficult or impossible to create in non-circular flanges. We recommend that machined surfaces which can not be serrated have a surface finish with a multi-directional lay and roughness of 125-250 micro-inch RMS.

Fuel Additives

The chemical MTBE (methyl t-butyl ether) has become a very common fuel additive and gasketing compatibility inquiries on this material are frequent. Garlock in-house testing has shown GYLON® gasketing to be unaffected by MTBE. We have also found compressed sheet Styles 9850 and 3000 to be suitable for MTBE service. These materials are recommended for MTBE alone or mixed with gasoline.

**Questions? Call Gasket Applications Engineering
at 1-800-448-6688**

Gasket Constants

ASTM is working on a new system and new set of numbers to be used in the ASME code calculations for flange design. These new constants address leak rates at installation and during loss of compressive load and therefore are meant to help end users design for a certain leak level. The use of a defined leak rate will generally generate much higher bolt load requirements for the flanges, which should improve performance of designed joints. ***For gasket constant values, see page 35.***

Also see M & Y Values and Emissions.

Gasket Grooves

Gaskets installed in grooves or tongue and groove flanges require one extra consideration: the compressed height of the gasket must fill the groove. This is typically important where a highly compressible gasket such as GYLON® Styles 3545 and 3540 or one of the GRAPH-LOCK® styles is used to replace a compressed sheet gasket. The fully compressed thickness, not the original thickness, must be greater than the groove depth or the space between the tongue and groove when flanges contact each other. Ideally, the tongue should be at least as tall as the groove depth.

Gasohol

Gasohol is a blend of gasoline with an alcohol—usually 15% ethyl alcohol. GYLON® styles are preferred; nitrile-bound compressed sheet styles should be acceptable; most rubber gaskets are not recommended.

Installation

Garlock strongly recommends the use of calibrated torque wrenches to tighten bolts to the correct load. We have an installation procedure and discussion available upon request. A video covering the same material is also available.

Insulation Kits

Customers will occasionally ask for a flange insulation or isolation kit or gasket to electrically insulate one flange from the mating flange. Kits are available from a variety of distributors and include an insulating gasket along with a sleeve for the bolts and

insulating washer to be installed under the steel washers and nuts.

Garlock does not currently sell kits, but we do offer many gasket styles with good electrical insulating properties (see Dielectric Breakdown Voltage).

Jet Fuels

Jet fuels are typically refined petroleum products similar to kerosene. We recommend our GYLON®, nitrile bound compressed sheet and GRAPH-LOCK® products. (See Aviation Gasoline)

Leachable Levels (chemical)

Some pipe specifications call out maximum levels of "leachables" for gaskets. These limits are usually most concerned with leachable chlorides, fluorides, halogens and sulfur. These ions, or charged particles, are of concern due to their tendency to promote corrosion of piping systems. Garlock keeps test results for numerous gasket styles on file and we will test and certify leachable chlorides, etc., where required. There is a charge for these tests. Due to the nature of this type of analysis, we publish "typical" leachables only on certain styles such as our nuclear grade Style 9920.

"M" and "Y" Values for Flange Design

See page 35.

Note: Our testing shows an increase in "M" and "Y" values as gasket thickness increases. This is the opposite of the trend found in the ASME Code. Fugitive emission and gasket blowout studies have validated this trend.

Modulus of Elasticity

Some flange programs ask for the modulus of elasticity for the gasket material. This could be erroneous, since only rubber gaskets are elastic. Other types of gasketing do not have a true modulus. Garlock Applications Engineering does have compression vs. load curves which can be inverted to calculate a rough estimate for use in these calculations (see Compression).

Questions? Call Gasket Applications Engineering at 1-800-448-6688

Monomers

Monomers are materials, such as styrene and vinyl chloride, which can combine with themselves and become polymers, such as polystyrene and polyvinyl chloride. GYLON® Styles 3510 and 3530 are recommended for monomers, since elastomer-bound gaskets are rarely compatible with monomers. Some monomers, under certain conditions, will penetrate a gasket and polymerize inside the gasket, causing the gasket to swell and, occasionally, rupture. This effect is known as "pop-corning". This effect can be reduced or eliminated with additional compressive load which lowers the void space inherent in a gasket.

Oxidizers

Certain chemicals are known as strong oxidizers and, as such, will readily combine with organic compounds. We recommend our GYLON® material for use in oxidizers.

Oxygen Service

We recommend GYLON® Styles 3502, 3505, 3503 and metal-inserted Styles 3562 and 3563. These gaskets are specially manufactured and packaged to eliminate contamination by organic material.

pH

The pH scale is a measure of the acidity or alkalinity of a solution. A pH of 7 is a neutral reading; it is neither acidic or alkaline. Readings of 1-2 are strongly acidic, while 13-14 indicates a strong alkaline or caustic media.

Note: A pH reading alone without the names of the chemicals involved is not enough to select a gasket. Also, since the pH scale is quite limited in range, a reading of "1" or "14" does not fully describe the concentration. We need the concentration expressed as a percentage. For example, sodium hydroxide at a concentration of around 4% will "peg" the pH scale at 14, the same reading produced by a 40% concentration.

Pressure Spikes

Very high pressure spikes can occur in any line pumping a liquid if a valve is closed rapidly, leaving the fluid flow nowhere to go. The inertia of the fluid may create extreme pressure spikes. These spikes occur

too rapidly to be detected by a pressure gage but can cause a gasket to blow out.

Radiation Resistance

We have conducted gamma radiation tests on our compressed sheet Styles 3000, 3200, 3400, 3700, 5500, 5507, 9800, 9850, 9920 and ST-706. These tests indicate our compressed non-asbestos styles will handle a total exposure of approximately 5×10^7 rads of gamma radiation. GYLON® Styles 3510 and 3545 have been tested. Test results are available.

Refrigerants

A number of new refrigerants have been introduced in an effort to protect the environment. CFC-type refrigerants, believed to be responsible for depleting the ozone layer, are being phased out and replaced by HCFCs and HFCs. The compatibility inquiries we've received seem to concentrate on R-134a, R-123 and R-141b. Information provided to us by the refrigerant manufacturers indicates our Style 3300 will be preferred for R-134a and R-123. Styles 5500, 3000 and 3300 are recommended for R-141b. Refer to the Chemical Resistance chart for a complete listing of refrigerants. The compatibility of the lubricants used with these refrigerants should be considered.

Reuse of Gaskets

We are frequently asked about reusing a gasket. We do not recommend this practice. A gasket's function is to conform to flange high and low spots when compressed, and its ability to reseal decreases after it is compressed. Gaskets which contain rubber and which have experienced elevated temperatures will be even less likely to reseal.

Shelf Life

Garlock has spec sheets detailing proper storage conditions and expected shelf life for our products. Available upon request.

Spacers in Flanges

Some installations require a very thick gasket to fill a large gap between flanges. We do not recommend stacking numerous gaskets in the same flange. In-house tests have shown that a better way to fill a 1/2" gap, for example, is to install a 1/16" gasket on each side of a 3/8" thick incompressible spacer ring. Ideally,

the spacer ring will be consistent with piping metallurgy, serrated, and cut to the same dimensions as the gasket. We recommend higher minimum torques when using this arrangement.

Steam

Steam can be found in plants in two forms: saturated and superheated. Saturated steam is standard boiler steam and has a definite temperature for each pressure. Superheated steam is steam at a higher temperature than is found on the saturated steam curve for that particular pressure. We recommend ST-706 and our GRAPH-LOCK® styles for superheated steam. Please be aware of the pressure and P x T limits for each style when making a selection, and consult with Garlock Engineering when approaching these limits.

Thickness, Gasket

Garlock recommends the use of thinner gaskets wherever possible. This not only lowers the cost of the gasket, it increases the performance of the joint by lowering emissions and product loss and increasing blowout resistance. Thinner gaskets will not seal as many flange irregularities as thicker gaskets, however, and require flatter flanges. Experience with the particular flange system is often an important guide when specifying a gasket thickness. A more complete discussion of the subject is available.

Torques, Bolt

We realize many end users resist using a torque wrench for installation. We have found the use of a torque wrench to be the least painful way to gain a

substantial increase in performance. Any method which accurately controls the compressive load on the gasket is acceptable.

See Bolt Torque Tables for ANSI/ASME B16.5 RF flanges on page 40. For non-standard flanges, contact Applications Engineering.

The maximum torque values for flanges such as glass-lined or PTFE-lined, FRP and PVC-type flanges are established by the flange manufacturer to avoid damage to the flanges. We recommend the use of the maximum allowable torque for each size. These maximum torques are usually lower, and often much lower, than we would recommend.

Traced Lines (Heat Traced)

Heat traced lines pumping materials which are solid at ambient temperature can present a number of problems for gaskets:

1. The bolts are usually hotter than the flanges since the heat is applied from outside the pipe. This causes the bolts to expand more than the pipe, which lowers the compressive stress on the gasket.
2. Any line which is shut down will freeze solid. When the line is reheated on start-up, there is occasionally a plug of solid material blocking a section of the pipe. The heating may cause some areas of the material to liquefy and then expand. The expansion can create extremely high pressures inside the joint if the solid plug is blocking a section of the line.

***Questions? Call Gasket Applications Engineering
at 1-800-448-6688***

Test Procedures

Blowout of Gasket Products

(No ASTM Designation)

Garlock developed the equipment and test procedure used for testing the blowout resistance of gaskets at varying pressures and temperatures.

This test method and procedure enable us to compare the blowout resistance of all types of non-metallic gasketing products. The test fluid is nitrogen gas. Internal pressures can be varied from atmospheric to approximately 5000 psig (345 bar). The flanges and gaskets can be exposed to temperatures up to 1000°F (540°C).

Garlock blowout tests are primarily used to compare various products, and do not represent results that can be expected under actual field conditions. The experience gained over many years in blowout testing provides part of the technical backup of our data on longer term P (psig or bar) x T (°F or °C) values.

Compressibility and Recovery of Gasket Material

ASTM Designation: F36

This method covers determination of the short-time compressibility and recovery at room temperature of sheet gasket materials.

This test method is not intended as a test for compressibility under prolonged stress applications, generally referred to as "creep", or for recovery following such prolonged stress applications, the inverse of which is generally referred to as "compression set".

Some initial compressibility is essential for proper installation of a gasket and is required to compensate for any flange irregularities such as minor flaws or nicks, non-parallelism, corrosion and variations in groove depth. Voids must be filled to obtain proper seating of the gasket or premature failure will occur.

In addition, good recovery upon release of load is indicative of torque retention of a gasketed joint.

Compressibility and recovery as defined by ASTM are two worthwhile physical property criteria for supplier and purchaser to agree upon as routine tests.

Creep Relaxation of Gasket Material

ASTM Designation: F38 Method B

Measured by means of a calibrated bolt with dial indicator, ASTM F38 provides a means for measuring the amount of creep relaxation of a gasket material at a stated time after a compressive stress has been applied. There is no fluid involved.

This method is designed to compare related products under controlled conditions in regard to their ability to maintain a given compressive stress as a function of time. A portion of the torque loss on the bolted flange is a result of creep relaxation. Creep relaxation is defined by ASTM as: "A transient stress-strain condition in which the strain increases concurrently with the decay of stress." The result of creep relaxation is loss of thickness of a gasket, which causes bolt torque loss, resulting in leakage.

Torque loss also can be caused by elongation of bolts, flange distortion and vibration. Therefore, results obtained in lab conditions should be correlated with field results.

Also see Torque Retention Test (page 50) for further information.

Fluid Resistance of Gasket Materials

ASTM Designation: F146

These methods provide a standardized procedure for measuring the effect of immersion on physical properties of non-metallic gasketing materials in specified fluids under defined conditions of time and temperature. The types of materials covered are those included in the first numeral described in Classification F104. They are not applicable to the testing of vulcanized rubber, a method described in Test Method D471.

The test fluids and conditions outlined were selected as typical for the purposes of comparing different materials, and can be used as a routine test when agreed upon between the supplier and purchaser.

The results of immersion tests are not intended to give any direct correlation with service conditions in view of the wide variations in temperature and special uses encountered in gasket applications.

Gas Permeability

DIN Designation: 3535*

This standard provides a means of measuring leakage of a gas through a gasket. This test is designed to compare the leakage rates of different products.

The fluid used is nitrogen gas at an internal pressure of 580 psig (40 bar) and a gasket loading of 4640 psi (32 N/mm²). The apparatus is considerably more versatile than that used in ASTM F37. The sample gasket size can be varied; much higher internal pressures can be used. Normally measurements are made at room temperature. However, we have the ability to test at elevated temperatures.

The test measures the effects on leakage rates due to changes in gasket products themselves, in gasket thicknesses, in gasket flange widths, in varying internal pressures, in varying gasket loads, and at varying temperatures.

Helium Mass Spectrometer Test

The ability to control and detect leakage on an ever-decreasing scale is a requirement of industry today. Mass spectrometer technology is used where stringent leak detection is needed such as in the manufacture of devices used in body implants, nuclear vessels and cathode ray tubes.

The Helium Mass Spectrometer Leak Detector (HeMSLD) develops a high vacuum which enables it to detect trace amounts of helium that are present. Helium gas is used as a test media in standard flange fixtures or the DIN 3535 gas permeability fixture. The HeMSLD detects the helium leakage through the gasketed joint by way of a hand held "sniffer" probe or by a hard piped connection from the DIN 3535 fixture or equipment where other leak detection systems are used. Leakage as low as 1×10^{-9} standard cc He/second can be detected.

* DIN: Deutsches Institut für Normung e.V.

Other ASTM Tests

Purchasers may want to consider the use of the following ASTM test methods, depending on their gasketing needs:

- F147 Test Methods for Flexibility of Non-Metallic Gasket Materials
- F363 Method for Corrosion Testing of Gaskets
- F607 Test Method for Adhesion of Gasket Materials to Metal Surfaces

Sealability of Gasket Materials

ASTM Designation: F37

Test methods A and B provide a means of evaluating fluid sealing properties at room temperature. Method A is restricted to liquid measurements and Method B (most common) can be used for both gas and liquid measurements.

These test methods are suitable for evaluating the sealing characteristics of a gasket product under differing compression flange loads. Since this physical property is so important to the proper function of a gasket, it should be used as an acceptance test when test methods are agreed upon between supplier and purchaser as follows: fluid, internal pressure of fluid, and flange load on the gasket specimen.

The most commonly used fluids are isooctane and nitrogen gas. Gasket load, fluid and internal pressures can vary according to customer needs. However, our experience indicates a strong preference for nitrogen gas, with a gasket load of 3000 psi (20.7 N/mm²) at an internal pressure of 30 psig (2 bar).

These precise measurements of leakage rates are designed to compare gasketing products under controlled conditions. The leakage measured comes either through the gasket, or between the gasket and the flange faces, or both. Our experience over many years with thousands of test samples indicates that, in most cases, the leakage measured is a result of leakage through the gasket.

It is not a question of whether or not any fibrous type gasketing product allows leakage through the gasket, but *how much* leakage, under any set of given conditions of time, temperature and pressure.

Standard Classification for Non-metallic Gasket Materials

ASTM Designation: F104

This classification system provides a means for specifying or describing pertinent properties of commercial non-metallic gasket materials. Materials composed of asbestos, cork, cellulose, and other non-asbestos materials in combination with various binders or fillers are included. Materials normally classified as rubber compounds are covered in Method D2000.

Since all the properties that contribute to gasket performance are not included, use of the classification system as a basis for selecting materials is limited.

The purpose of the classification system is intended to provide a common language for communication between suppliers and purchasers; to guide engineers and designers in the test methods commonly used for commercially available materials, and be versatile enough to cover new materials and test methods as they are introduced.

It is based on the principle that non-metallic gasket materials should be described, insofar as possible, in terms of specific physical and functional characteristics. An infinite number of such descriptions can be formulated by use of one or more standard statements based on standard tests.

All fibrous and PTFE type gasketing materials in this catalog show our F104 Line Callout.

Steam Trap Test

The use of steam traps for functional testing of gasketing products is an excellent method for qualifying products. Tests are severe since gasket flange widths are narrow and, in several steam trap designs, the steam enters the trap at a rather high velocity right at the gasket I.D.

A variety of different steam trap designs are cycled on and off at 250 psig (15 bar) and 405°F (205°C) to test the life and function of the gasket.

Tests continue until visible leaks occur or, if no such leakage occurs, for a period of one year.

Questions? Call Gasket Applications Engineering at 1-800-448-6688

Tension of Non-metallic Gasket Materials

ASTM Designation: F152

The Universal Tester is used to determine the tensile strength of non-metallic gasketing products. The types of products covered are those containing various organic fibers, inorganic fibers, flexible graphite, or fluorocarbons as described in F104.

F152 is not applicable to the testing of vulcanized rubber, a method that is described in Test Method D142, nor for rubber O-rings, a method that is described in D1414.

The measurement of tensile strength characterizes various classes and grades of products of a given type. It also will aid the purchaser in determining whether the gasketing product approved for a given application is being manufactured to acceptable quality. Various procedures are given for different types of materials, and in order to compare results from one lab to another, it is imperative that the applicable procedure be used.

The measurement of tensile strength should not be construed as an indication of the performance of that product in use.

Thermal Analysis Test

Thermal Analysis, often referred to as TA, is a series of techniques that characterize materials by measuring and analyzing changes in their physical and chemical properties resulting from controlled and measured changes in temperature. The TA techniques include DSC (Differential Scanning Calorimetry), TGA (Thermal Gravimetric Analysis) and TMA (Thermal Mechanical Analysis).

DSC measures heat flow into or out of a material as it is undergoing a programmed thermal profile. The resulting plot of heat flow vs. temperature can reveal a great deal of information about a material. DSC is being used to determine such things about a material as specific heat, melting point, crystallinity, glass transition temperature, degree of cure of thermosets, purity, oxidative stability, and reaction kinetics.

TGA measures changes in the weight of a material. By heating a sample in a controlled manner in various atmospheres, the composition of various materials can

be determined. The technique is also useful for performing thermal stability studies.

TMA provides measurements of penetration, expansion, contraction, extension, and relaxation of materials as a function of either time or temperature. By using various probes and accessories, TMA can be used to determine expansion coefficients, softening points, heat-deflection temperatures, viscosity, creep, and stress relaxation.

Torque Retention

DIN 52913

This test is designed to determine the torque retention capabilities of gasketing products, when subjected to the compression load and operating temperature as defined by the test procedure.

The test consists of applying a predetermined load on the test gasket via a tension screw, then heating the gasket/flange assembly to the desired temperature (there is no internal pressure). The standard test period is either sixteen (16) hours or one hundred (100) hours. At the end of the required time period, the compression load which is left acting on the test gasket is measured. This allows one to calculate the torque retention capabilities of various gasketing products.

**Questions? Call Gasket Applications Engineering
at 1-800-448-6688**

WARNING:

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Test Equipment

Infrared Analyzer

This instrument is equipped with a number of attachments that allow scanning of liquids and solids either by transmittance or reflectance. The spectrum of the scanned sample can be compared against standard spectra contained in internal libraries within the instrument. The search program automatically finds the best match. The sample and library spectra can be displayed together on the screen for comparison.

Programmable, Multi-Functional Test Stand

This new addition to the Garlock Test Lab equipment is a highly sophisticated, PC-driven stand for evaluating various properties of gasketing materials under varying conditions. The PC can be programmed to test leak rates at various internal pressures, compressive loads, or test temperatures. One of these parameters can be programmed to ramp up while the other conditions are held constant, in order to study the effects these conditions have on the sealability of materials. Leak rates and gasket thickness are monitored to determine percent compression vs. load, leak rate vs. compressive stress, maximum crush resistance, and more.

Capabilities:

Compressive Stress:

To 36,000 psi (250 MPa) at room temperature

To 23,000 psi (160 MPa) at 570°F (300°C)

Temperature: to 840°F (450°C)

Gasket Thickness: 0-5/16" (0-8mm)

Internal Pressure: 75-1450 psig (5-100 bar)



Application Data Form

Date _____
For: Garlock Gasketing Engineering
Fax 315-597-3196
Page: 1 of _____
Drawing attached Yes No

From _____
Title _____
Company _____
Address _____
Phone No. _____
Fax No. _____
E-mail Address _____

Application

- | | |
|---|--|
| <input type="checkbox"/> Pipe Flange | <input type="checkbox"/> Pumps – centrifugal/horizontal split case |
| <input type="checkbox"/> Heat Exchanger | <input type="checkbox"/> Flue Duct |
| <input type="checkbox"/> Manway | <input type="checkbox"/> Valve Bonnet |
| <input type="checkbox"/> Compressor | <input type="checkbox"/> Other _____ |

Service Conditions

Maximum Temperature _____ °F/°C Continuous Operating Temperature _____ °F/°C
Internal Pressure _____ psig/bar PSIG/bar Continuous Intermittent
Thermal Cycling _____ / 24 hours Vibration Yes No
Other (specify) _____

Bolts

Grade _____ Diameter _____
Length _____ Number _____

Chemical Compatibility

Media _____ pH _____
Concentration _____ Liquid or Gas _____

Flange

Standard

Material _____
Size _____ Rating _____
Surface Finish _____ RMS
 Phonographic Concentric
Face (raised, flat, tongue & groove, etc.) _____

Non-Standard

Material _____
I.D./O.D. _____
Flange Thickness _____
Bolt Circle Diameter _____
Surface Finish _____ RMS
 Phonographic Concentric
Face (raised, flat, tongue & groove, etc.) _____

Comments: _____

Common Abbreviations

SI - International Metric Standard	N - Newton
Pa - Pascal	in - inch
psi - pounds per square inch	ft - foot
psig - pounds per square inch gage	yd - yard
oz - ounce	m - meter
g - gram	gal - gallon
lbf - pound force	l - liter
kgf - kilogram force	

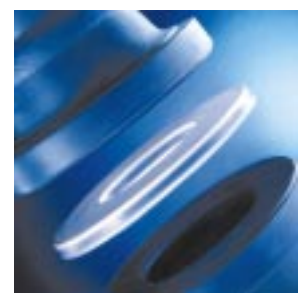
Prefixes

M (mega) = 1,000,000 = 10^6
 k (kilo) = 1,000 = 10^3
 c (centi) = 0.01 = 10^2
 m (milli) = 0.001 = 10^{-3}
 u (micro) = 0.000001 = 10^{-6}

Metric Conversions

To Convert from:	To SI Units:	Multiply by:
Length		
mil	mm	0.0254
in	mm	25.4
in	cm	2.54
ft	m	0.3048
yd	m	0.9144
Weight		
oz	g	28.3495
oz	kg	0.0283
lb	g	453.5924
lb	kg	0.4536
lb	N	4.4482
Force		
lbf	N	4.4482
kgf	N	9.8066
Area		
in ²	cm ²	6.4516
ft ²	m ²	0.0929
Pressure		
psi	Pa	6894.757
psi	kPa	6.8947
psi	bar	0.069
psi	MPa	0.0069
N/m ²	Pa	1.000
Torque		
in lb	Nm	0.113
ft lb	Nm	1.3558
Density		
oz/in ³	g/cm ³	1.73
g/cm ³	kg/m ³	1000.
lb/ft ³	kg/m ³	16.0185
Adhesion		
lb/in	kN/m	0.1751
Volume		
gal	l	3.7854
gal	m ³	0.0038

Style No.	Description	Page No.
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670	Cellulose Fiber/Cork/Nitrile Sheet	34
681	Vegetable Fiber Sheet	34
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3000	BLUE-GARD® Compressed Asbestos-Free Sheet (Nitrile)	24, 26
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6800	STRESS SAVER® (EPDM only)	32
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9850	Compressed Carbon Fiber High Temp Gasketing (NBR)	22
G-9900	Compressed Graphite Fiber High Temp Gasketing (NBR)	22
	Welded GYLON®	33



More than just great products...

Beyond offering you the widest available range of products for packing and sealing, Garlock enhances the value of its products with technical services and comprehensive training programs:

- ISO 9002-94 registration for Industrial Gasketing, Industrial Packing, KLOZURE® Oil Seals, Bearing Protectors, Expansion Joints, Hydraulic Components, Mechanical Seals, and Industrial Rubber Products.
- A global network of stocking Authorized Garlock Distributors.
- Factory sales representatives and applications engineers available for problem solving when and where it is needed.
- Toll-free 800 telephone and fax numbers for immediate product information.
- In-plant surveys of equipment and processes, providing the customer with recommendations to identify and eliminate sealing and packing problems before they start.
- The most sophisticated and most comprehensive test facilities available.
- Technical field seminars on all Garlock products.
- Factory-sponsored product training programs, including hands-on seminars, to ensure that Garlock representatives and their distributor personnel are the best in the industry.
- Technical bulletins to keep you up-to-date on product enhancements and changes.

Customers who specify Garlock fluid sealing products get, at no extra cost, the high quality support needed to run a profitable operation.

AUTHORIZED DISTRIBUTOR



**ISO 9002-94
Cert. #001762**

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